

Revista de la Asociación Argentina de Ortopedia y Traumatología



AN ORGAN OF THE ASOCIACIÓN ARGENTINA DE ORTOPEDIA Y TRAUMATOLOGÍA

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The path is our goal

Dr. Federico Alfano

President of the Argentine Association of Shoulder and Elbow Surgery



Aside from celebrating 30 years of incessant work and continuous growth as a scientific society, we celebrate our consolidation as an institution: the *Asociación Argentina de Cirugía de Hombro y Codo* [Argentine Association of Shoulder and Elbow Surgery].

Our institution has rightfully earned a privileged place on the world map of the art and science of shoulder and elbow surgery, basing its strategy on unconditional camaraderie, solidarity, self-criticism, scientific solidity, and institutional honesty. We tirelessly pursue these values that, far from a formal agreement, we consider genuinely sacred commandments worth defending. These values have brought us together and represented us through the different management committees.

I have witnessed that the *Asociación Argentina de Cirugía de Hombro y Codo* has always prioritized the content level taught in its hundreds of courses, conferences, and congresses, as well as the development of teaching tools. Our academic programs were built for the benefit of the medical specialist in training. Our greatest satisfaction is to see this benefit extended to patient care. In this sense, we believe in the development of diagnostic-therapeutic techniques of the medical specialist and in the dignity of their humanism.

Throughout these 30 years, we have safeguarded and promoted respect for our scope of practice, interdisciplinary work, federal spirit, Ibero-Latin American brotherhood, and intellectual honesty. Thus, we firmly hold the flag of bias-free medicine. We choose to teach medicine centered on the patient's needs of the patient over the interests of the professionals or the medical industry.

All members of this scientific institution are proud to represent these values. We believe that, with humbleness, work, and honesty, merit always beats success. In any case, our greatest success was having founded and developed a scientific society of great academic value that always stands for the nobility of its decisions and triumphs.

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30 years of the Argentine Association of Shoulder and Elbow Surgery

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In 1992, a group of members of the Argentine Association of Orthopedics and Traumatology decided to move forward with the challenge of creating a new scientific society that would integrate those interested in Shoulder and Elbow pathology. This initiative was in line with a phenomenon that, at that time, was beginning to manifest itself internationally. A few years earlier, Charles Rockwood had defined it as an “explosion of interest” regarding the subject.¹

The years have shown that these pioneers were not wrong. In the case of the shoulder region, aside from the complexity of its anatomy and function, a long list of differential diagnoses has been added (more than ninety have been described). On the other hand, treatment requires, in addition to an accurate diagnosis, the application of a wide variety of therapeutic tools. All of the above justifies the need for an institution dedicated to this anatomical region and its neighboring joint, the elbow.

These three decades witnessed intense work that has provided our Association with the administrative, economic, academic and human resources to fully meet the objectives defined in our Statute.

We believe that the purest form of graduate training is that offered by scientific societies, in which narcissism and commercial bias are diluted by the group spirit and the contribution of varied ideas. We offer programs at different levels of education, not only for doctors and other professionals in the healthcare field, but also for children starting from the preschool level thanks to our non-profit activity.

Some milestones in this long path were the organization of the most successful World Congress of our subspecialty in history,² and the Latin American Shoulder and Elbow Congress of 2011, the largest of the 25 so far organized in our subcontinent. Surely this issue of the *Revista de la Asociación Argentina de Ortopedia y Traumatología*, as well as the *Primer Curso Internacional Patagónico de Hombro y Codo*, which we will carry out next October in the city of Ushuaia, will be new milestones that we will add to our history.

Today, our Association is the only institution recognized in our country as a referent in the pathology of both anatomical regions by the *International Board of Shoulder and Elbow Surgery*,³ the *Sociedad Latinoamericana de Hombro y Codo*,⁴ and by the rest of the continental and national societies in the world. This international recognition goes beyond the administrative and also includes the appreciation of our intense activity at a global level.

The celebration of these first 30 years finds us with a solid structure in which the fundamental basis is camaraderie and coincidence in basic values, everything else is technical and, therefore, changing and debatable. Fortunately, there are still many challenges ahead that, as usual, we are willing to face. Our doors are open to all those who share these values and enthusiasm.

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30 years of a successful path

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Shoulder and elbow surgery underwent rapid evolution in the 1960s and 1970s worldwide, especially due to the development of rotator cuff arthroplasty and repair techniques. Iconic names such as **Mac Laughlin, Nevasier, Neer, Bateman, Rowe, De Palma, Cofield, Rockwood, De Anquin, Patte, Bristow, Latarjet, Nobuhara, Randelli, Gschwend, Bailey, Kessel**, among others, described techniques, established principles, and shaped the new orthopedic specialty at a time of rapidly increasing average life expectancy around the world.

The immediate consequence of this scientific and technological advance was the formation of numerous national and continental societies for the exclusive study of shoulder and elbow surgery in the 1980s and 1990s. The creation of the **Asociación Argentina de Cirugía de Hombro y Codo (AAHYC) [Argentine Association of Shoulder and Elbow Surgery]** in 1992 was an extraordinary milestone that occurred in the same year as the creation of the **International Journal of Shoulder and Elbow Surgery (JSES)**, and the establishment of the **International Board of Shoulder and Elbow Surgery (IBSES)**, both led by Charles Neer.

The 35 founding members have multiplied and today there are 220 distributed in all corners of Argentina. The gradual and structured growth of the AAHYC was stimulated by the personal efforts of its presidents: **De Anquin E., Firpo, Varaona O., Allende, De Anquin A., Lafrenz, Piqué, Raffa, Gorosito, Maignon, Gosak, Moya, Vaineras, Oettinger, Lencina, Salamone, Gómez, Varaona J., Ranalletta, Patiño, Vila, Simone and Alfano**. To these presidents, my congratulations on the mission.

The performances of **Daniel Moya and Emilse Pérez** at the AAHYC, however, deserve everyone's attention, applause and recognition. These personal friends live the day-to-day life of the society in an unusual way and they are true ambassadors of the AAHYC's actions in Argentina and abroad, making it one of the most active in the world.

On behalf of IBSES, which keeps alive **Kessel's dream** in which the world of shoulder and elbow surgery could grow in harmony and teach and learn from each other through a world congress every three years, as it was done in Buenos Aires, in 2019 through the 14th ICSES/6th ICSET, **congratulations to all the shoulder and elbow surgeons in Argentina**.

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Case Presentation

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Case resolution on page 605.

A 72-year-old man consulted for pain in the left shoulder, predominantly at night, of 5 months of evolution, and inability to carry out overhead movements. He did not report a history of trauma.

Upon physical examination, there were no palpable masses. Both passive and active ranges of motion were decreased, and rotator cuff tests were positive. A radiograph of the left shoulder in internal and external rotation (Figure 1) and an ultrasound of the shoulder (Figure 2) were ordered.



Figure 1. Left shoulder radiograph. **A.** Internal rotation: osteoarthritic changes at the glenohumeral and acromioclavicular level, with a decrease in the acromiohumeral space (asterisk). A tumor can be visualized at the metaphyseal-diaphyseal level with a defined proximal limit and little differentiation to the distal (arrows) and radiodense lines inside it, in relation to sclerosis. There is no visible cortical involvement. **B.** External rotation: a calcification can be visualized in the topography of the rotator cuff (arrow).

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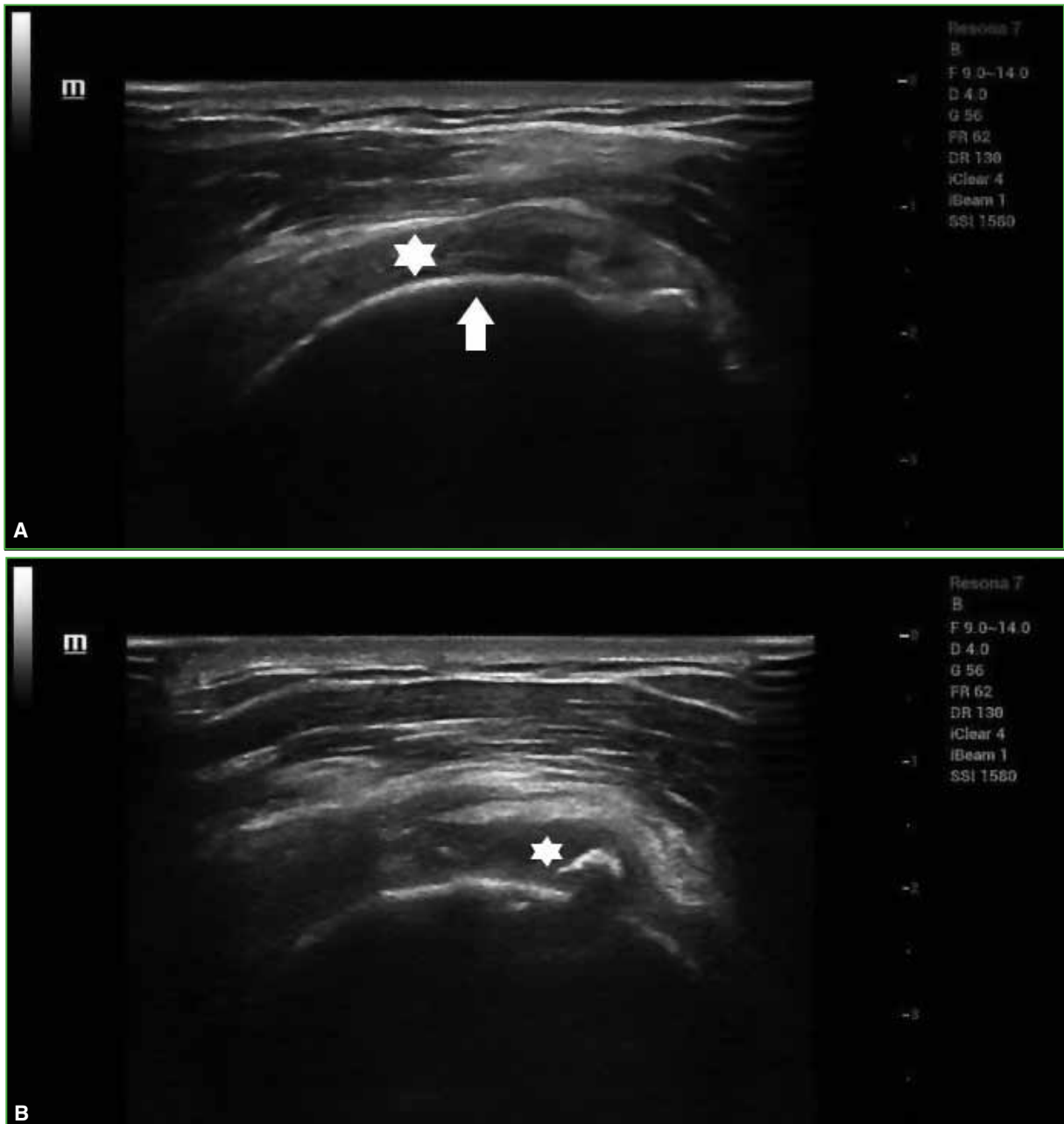


Figure 2. Left shoulder ultrasound. **A.** Complete tear of the supraspinatus (asterisk). The arrow marks the cortical bone of the humerus. **B.** Calcification in the topography of the infraspinatus (asterisk).

FINDING AND INTERPRETATION OF IMAGING STUDIES

The left shoulder radiograph showed osteoarthritic changes at the glenohumeral and acromioclavicular levels, with a decrease in the acromiohumeral space. At the metaphyseal-diaphyseal level, a hypodense tumor was visualized, with sclerotic traces inside without cortical perforation. The left shoulder ultrasound revealed complete supraspinatus tear and partial subscapularis tear, with calcification in the infraspinatus topography.

Imaging studies were completed with an MRI of the left shoulder.

Influence of the Consolidation of the Tuberosities on the Clinical Outcomes of the Reverse Arthroplasty in Proximal Humerus Fractures

Luciano A. Rossi, Camila Juana, Cecilia Fieiras, Rodrigo Brandariz, Ignacio Tanoira, Maximiliano Ranalletta

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ABSTRACT

Objective: The objective of this study was to compare the clinical outcomes and complications of a consecutive series of patients with proximal humerus fractures (PHF) treated with reverse shoulder arthroplasty (RSA), with and without anatomical healing of the tuberosities. **Materials and Methods:** We evaluated 113 patients >65 years old with PHF treated with RSA. Seventy patients presented anatomical healing of the tuberosities and 43 presented absence of healing. Range of motion (ROM), Constant score, ASES score, visual analog scale (VAS) and the score of the numerical evaluation of single evaluation (SANE) were evaluated. **Results:** The mean follow-up was 56 months (range, 24-96 months) and the mean age was 73 years (range, 65-83 years). Mean postoperative active elevation and internal rotation were $131^\circ (\pm 14)$ and $27^\circ (\pm 5)$, respectively. The mean postoperative external rotation in abduction and adduction was $27^\circ (\pm 1)$ and $15^\circ (\pm 6)$ respectively. The mean postoperative VAS was 1.7 (± 0.8). The mean ASES, Constant and SANE scores were 76 (± 6), 62 (± 11) and 74% (± 7), respectively. Anterior elevation, external rotation, and final mean ASES and Constant functional scores were significantly better in the group with tuberosity healing than in the group without healing. **Conclusions:** In patients >65 years old with PHF treated with RSA, both postoperative ranges of motion and functional scores were significantly better in patients where anatomic tuberosity healing was achieved than in those where it was not achieved.

Key words: Proximal humerus fracture; reverse arthroplasty; tuberosities reconstruction.

Level of Evidence: III

Influencia de la consolidación de las tuberosidades en los resultados clínicos de la prótesis invertida para fracturas de húmero proximal

RESUMEN

Objetivo: Comparar los resultados clínicos y las complicaciones de una serie consecutiva de pacientes con fracturas de húmero proximal tratados con prótesis invertida de hombro y con consolidación anatómica de las tuberosidades o sin ella. **Materiales y Métodos:** Se evaluó a 113 pacientes >65 años con fractura de húmero proximal tratados con prótesis invertida de hombro. Setenta presentaron consolidación anatómica de las tuberosidades y 43, ausencia de consolidación. Se evaluó el rango de movilidad, y se utilizaron los puntajes de Constant-Murley, ASES, SANE y la escala analógica visual. Se documentaron todas las complicaciones y las reoperaciones. **Resultados:** El seguimiento promedio fue de 56 meses (rango 24-96) y la edad media era de 73 años (rango 65-83). La elevación activa y la rotación interna medias posoperatorias fueron $131^\circ (\pm 14)$ y $27^\circ (\pm 5)$, respectivamente. La rotación externa posoperatoria media en abducción y aducción fue $27^\circ (\pm 1)$ y $15^\circ (\pm 6)$, respectivamente. La escala analógica visual promedio posoperatoria fue de 1,7 ($\pm 0,8$). Los puntajes ASES, de Constant-Murley y SANE promedio fueron 76 (± 6), 62 (± 11) y 74% (± 7), respectivamente. La elevación anterior, la rotación externa y los puntajes funcionales promedio finales ASES y de Constant-Murley fueron significativamente mejores en el grupo con consolidación de las tuberosidades. **Conclusiones:** En pacientes >65 años con fractura de húmero proximal tratados con prótesis invertida de hombro tanto la movilidad posoperatoria, como los puntajes funcionales fueron significativamente mejores en los pacientes con consolidación anatómica de las tuberosidades.

Palabras clave: Fractura de húmero proximal; prótesis invertida; reconstrucción tuberositaria.

Nivel de Evidencia: III

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INTRODUCTION

Although the majority of proximal humerus fractures (PHF) in patients >65 years of age improve with conservative treatment, a subgroup of complex fractures is associated with poor functional outcomes and a high rate of complications, such as nonunions and malunions.^{1,2} This subgroup includes four-part fractures with comminution of the tuberosities, dislocation fractures, and fractures that present a split of the humeral head.¹⁻³

Osteosynthesis of these fracture subgroups is also associated with suboptimal outcomes, mainly at the expense of a high rate of implant-related complications, such as osteosynthesis failure and secondary osteonecrosis.⁴ Another alternative proposed for the management of these complex fractures was the replacement of the humeral head with a hemiarthroplasty.⁵ However, a disadvantage of this procedure is that it depends entirely on the anatomical consolidation of the tuberosities for its normal function.⁵ This is often a challenge in the context of complex fractures in patients with osteoporotic bone, often with comminution or very poor bone quality for reconstruction around the implant. Boileau et al. evaluated 66 patients treated with hemiarthroplasty for displaced PHF and reported that 50% of patients had tuberosity malposition on the final evaluation radiograph. This was associated with unsatisfactory outcomes, superior migration of the prosthesis, stiffness, and persistent pain.⁶

The unpredictable outcomes of osteosynthesis and hemiarthroplasty in this subgroup of patients have motivated different surgeons to use reverse shoulder arthroplasty (RSA) to manage these complex patterns.⁷ By using mainly the deltoid for its normal function, the RSA does not depend on the consolidation of the tuberosities to achieve a good clinical outcome.^{8,9} However, the main external and internal rotators of the shoulder insert at the greater tuberosity and lesser tuberosity, respectively. Therefore, some authors argue that, despite the main driver of RSA being the deltoid, every effort should be made to reconstruct the tuberosities and achieve the best possible postoperative function.^{10,11}

The objective of this study was to compare the clinical outcomes and complications of patients with PHF treated with RSA, with or without anatomical consolidation of the tuberosities.

MATERIALS AND METHODS

A comparative retrospective cohort study was carried out. All patients who had undergone a RSA for the treatment of a PHF at our institution between January 2013 and February 2019 were screened for inclusion in this study. The information for the development of the study was obtained from the registry of shoulder arthroplasties of our institution. Initially, 160 patients were identified for inclusion in the study.

Selection criteria

Inclusion criteria were patients >65 years of age with acute PHF (<4 weeks from injury), treated with RSA, and a minimum follow-up of two years. Exclusion criteria were patient death or loss to follow-up and RSA due to fracture sequelae (nonunion or malunion). 37 patients were excluded: 20 had been treated for fracture sequelae (14 nonunions, 6 malunions), eight had died, five were <65 years old, and four developed severe dementia and were hospitalized for which evaluation was impossible. Additionally, 10 patients were lost to follow-up. Thus, 113 patients were eligible for inclusion in the study: 70 with anatomical consolidation of the tuberosities and 43 without consolidation. Preoperative radiographs and computed tomography were reviewed to classify fracture patterns according to the Neer classification.¹²

Surgical technique

The surgery was performed by three shoulder surgeons from our institution who used the Biomet reverse shoulder prosthesis (Biomet Comprehensive® Shoulder System). The patients were operated in the beach chair position. All prostheses were implanted using a standard deltopectoral approach. Once the tuberosities were located, they were secured using nonabsorbable sutures through the tendinous insertion. For the glenoid preparation, the metaglene guide was aligned with the inferior glenoid rim with a 10° inferior tilt. The metaglene was impacted into the glenoid and fixed with a central cortical screw and four peripheral locking screws. After inserting the metaglene, the chosen glenosphere was inserted. The size of the glenosphere (36mm or 40mm) was chosen based on the size of the patient. The humeral medullary canal was reamed to the appropriate size. All placed stems were cemented and a cement restrictor was placed in the humeral canal at an

appropriate depth for the selected stem. Humeral prostheses were placed at 20° retroversion and mini-stems were used in all patients. The humeral stem was cemented into the humeral shaft after creating two holes in the lateral cortex of the humerus and passing non-absorbable sutures through these holes. Once the stem was cemented, the polyethylene trial was inserted. The intraoperative stability of the implant was then confirmed and the patient was found to have full passive range of motion. After verifying that these two conditions were met, the definitive polyethylene was placed. Tuberosity reconstruction was performed in a standardized manner in all patients. To do this, the tuberosities were first tied to the diaphysis with two vertical sutures. Two horizontal cerclage sutures were then tied to compress the anatomically reduced tuberosity onto the humeral stem (Figure 1). The wound was then closed, first the muscle plane, then the subcutaneous cell tissue, and finally the skin. No drains were placed.

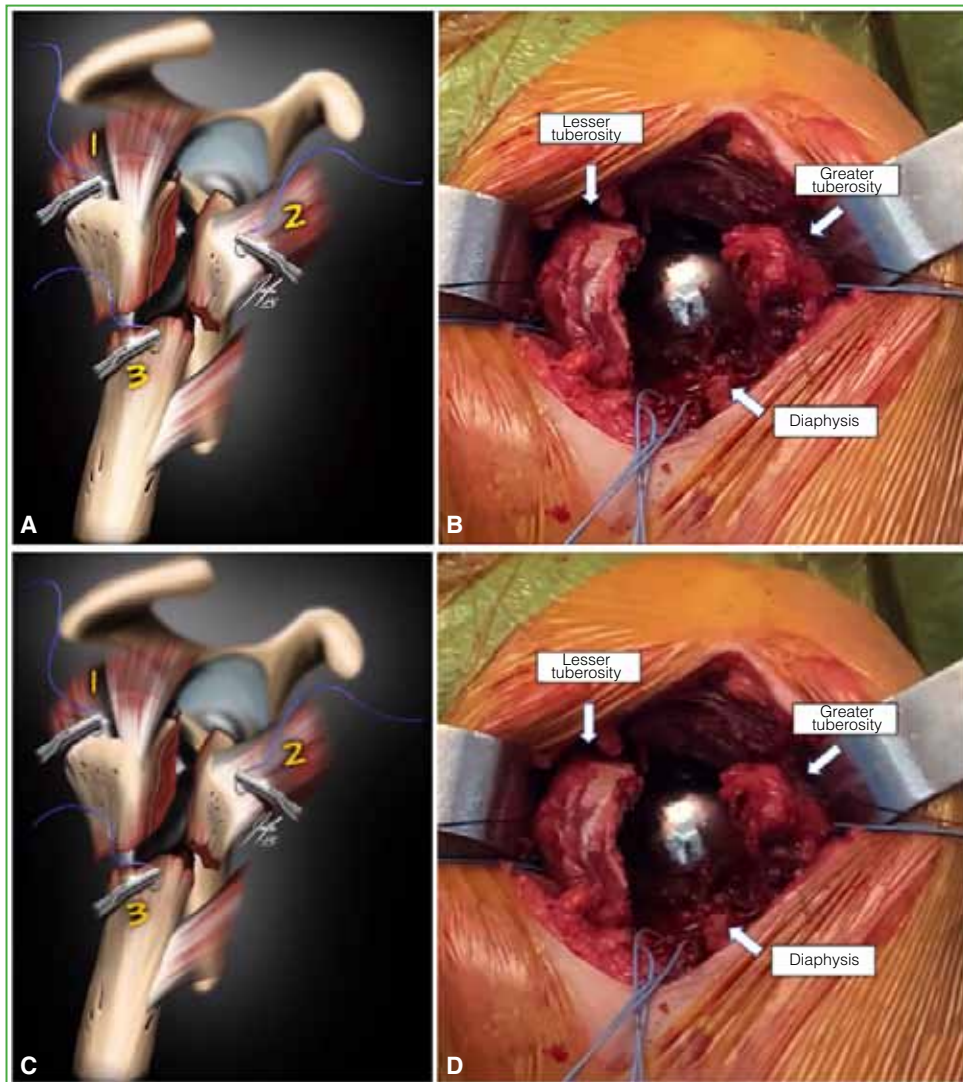


Figure 1. A. Illustration. B. Intraoperative image of the tuberosities before their reconstruction. C. Illustration. D. Intraoperative image of the reconstructed tuberosities around the prosthesis.

Rehabilitation protocol

All patients were treated with the same postoperative rehabilitation protocol. They were immobilized with a shoulder sling for a period of four weeks and were encouraged to perform active elbow, wrist and hand movement exercises. In the fifth week, the sling was removed and passive shoulder range of motion exercises with limited forward flexion to 90° were indicated for two weeks. Active range of motion exercises started at 6-8 weeks postoperatively and were followed by strength and coordination training.

Clinical and radiographic evaluation

Postoperative controls were performed at 2-week, 4-week, 3-month, 6-month, and 12-month intervals, and annually thereafter. Each postoperative evaluation included a clinical examination and radiographic images of anteroposterior and lateral incidences of the shoulder. Assessments at each visit from the third month onwards included: range of motion, Constant-Murley, ASES (American Shoulder and Elbow Surgeons) and SANE (Single Assessment Numeric Evaluation) scores, and visual analog scale (VAS). Anatomic consolidation of the tuberosities was defined as bony union of the healed greater tuberosity visible on the anteroposterior radiograph in neutral rotation (Figures 2 and 3).¹⁰

Radiographic evaluations were performed by two independent physicians (LR and IT). In case of discrepancy, the presence of anatomical consolidation was defined by consensus between the two evaluators.

All intraoperative and postoperative complications and reoperations were documented.



Figure 2. Anteroposterior left shoulder radiographs of a fracture of the left proximal humerus, in the preoperative period (A) and one year after surgery with a reverse prosthesis (B). The anatomical consolidation of the tuberosities is observed.



Figure 3. Anteroposterior radiograph of the right shoulder, preoperative (A) and one year after surgery for a fracture of the right proximal humerus treated with an reverse arthroplasty. Resorption of the tuberosities is observed.

Statistical methodology

Continuous variables are presented as means and standard deviations, and categorical variables as absolute and relative frequencies. Patient characteristics were compared between the ‘with anatomical union’ and ‘without anatomical union’ groups using the χ^2 test and the t-test for categorical and continuous variables. To calculate differences in range of motion and functional scores between groups, Student’s independent t-test was used. It was considered statistically significant at a p value <0.05.

Statistical analysis was performed with the STATA MP version 16 program (Stata Corporation, College Station, TX, USA).

RESULTS

The mean follow-up was 56 months (range 24-96) and the mean age was 73 years (range 65-83). 62% were women (70 patients) and 38% were men (43 patients). There were no significant differences between the anatomical union and non-union groups in terms of patient and injury characteristics (Table 1).

Table 1. Comparison of baseline clinical characteristics between patients with and without consolidation of the tuberosities

	Group 1 Consolidation (n = 70)	Group 2 No consolidation (n = 43)	p
Age, mean (SD), years	73.7 (7)	74.1 (8)	0.6484*
Dominant limb, n (%)	40 (57%)	24 (56%)	0.6132#
Women, n (%)	42 (60%)	28 (65%)	0.8518#
Body mass index, mean (SD)	30.2 (7)	29.9 (9)	0.4273*
Operated side: right, n (%)	36 (51%)	23 (53%)	0.9759#
ASA score, n (%)			
II	31 (44%)	20 (47%)	0.8513#
III	39 (56%)	23 (53%)	
Follow-up, mean (SD), months	55.1 (8.2)	58.3 (9.5)	0.0827*
Fracture classification			
4 parts, n (%)	25 (36%)	11 (26%)	
3 parts, n (%)	30 (43%)	19 (44%)	
Fracture dislocation, n (%)	10 (14%)	10 (23%)	
Head split, n (%)	5 (7%)	(7%)	

ASA = American Society of Anesthesiologists.

*t-test for independent samples with similar variances.

χ^2 test.

Overall, mean postoperative active elevation and internal rotation were $131^\circ (\pm 14)$ and $27^\circ (\pm 5)$, respectively. Postoperative mean external rotation in abduction and adduction was $27^\circ (\pm 1)$ and $15^\circ (\pm 6)$, respectively. The mean postoperative VAS score was $1.7 (\pm 0.8)$. The mean postoperative ASES, Constant-Murley, and SANE scores were $76 (\pm 6)$, $62 (\pm 11)$, and $74\% (\pm 7)$, respectively. 85% of patients reported being satisfied with the procedure. Anterior elevation, external rotation, and endpoint mean Constant-Murley and ASES functional scores were significantly better in the group with tuberosity union than in the group without union (Table 2). There were 13 complications (11.5%), eight in the group with consolidation (11%) and five in the group without consolidation (12%) ($p = 0.579$) (Table 3).

Table 2. Comparison of functional outcomes between patients with and without tuberosity consolidation

	Group 1 Consolidation (n = 70)	Group 2 No consolidation (n = 43)	p
Active elevation	137° (19)	120° (11)	<0.001*
External rotation, abduction	36° (9)	23° (8)	<0.001*
External rotation, adduction	22° (7)	13° (7)	0.0187*
Internal rotation, adduction	28° (6)	26° (7)	0.7803*
VAS for pain	1.6 (0.6)	1.8 (0.9)	0.0791*
ASES score	78 (6)	65 (6)	<0.001*
Constant score	64 (9)	53 (8)	<0.001*
SANE score, %	79% (9)	73% (9)	0.4052*
Satisfaction, %	87% (8)	84% (7)	0.6752*

VAS = visual analog scale, ASES = *American Shoulder and Elbow Surgeons*, SANE = *Single Assessment Numeric Evaluation*.

Data are presented as mean (standard deviation).

*T test for independent samples with similar variances.

Table 3. Comparison of complications between patients with and without union of the tuberosities.

	Total (n = 13)	Group 1 Consolidation (n = 8)	Group 2 No consolidation (n = 5)	Treatment
Complications				
Dislocation	4	2	2	Liner change
Periprosthetic fracture	3	2	1	ORIF*
Periprosthetic infection	3	2	1	2-stage revision
Neuropraxias	2	1	1	Control
Loosening of the glenosphere	1	1	0	Glenosphere change
Radiographic findings				
Notching#	4	3	1	Asymptomatic
Humeral radiolucency*	4	2	2	Asymptomatic

ORIF= open reduction and internal fixation.

#According to Sirveaux et al.¹³

*According to Sanchez-Sotelo et al.¹⁴

DISCUSSION

There were two main findings in our study. First, although RSA in the elderly with PHF was generally associated with favorable clinical outcomes and high satisfaction rates, both postoperative range of motion and functional scores were significantly better in patients with anatomical union of the tuberosities than in those without it. Secondly, regarding complications and reoperations, no significant differences were found between the groups analyzed.

In the last decade, RSA has become the first surgical option for the treatment of complex PHF.⁷ RSA surgery for PHF increased 406% between 2005 and 2012 and, in 2013, surpassed hemiarthroplasty in patients >65 years of age.^{15,16} While hemiarthroplasty and open reduction and internal fixation of fractures are based on the activation of the coupling of force and compression of the concavity through the rotator cuff attachments on the tuberosities, RSA uses the deltoid as the driving force, bypassing the rotator cuff to some extent.^{17,18} However, some studies have shown better results in postoperative rotation when anatomic reduction of the tuberosities was achieved, as the compression of the concavity provided by the rotator cuff optimized the function of the larger muscle groups around the shoulder, added to the action of the rotator cuff as an internal and external rotator itself.^{19,20}

In our study, the majority of patients obtained favorable postoperative clinical outcomes. The mean postoperative VAS score was 1.7, and the mean postoperative ASES and Constant-Murley scores were 76 and 62, respectively. In addition, 85% reported being satisfied with the procedure. However, anterior elevation, external rotation, and mean endpoint ASES and Constant-Murley functional scores were significantly better in the tuberosity union group than in the group without union. The clinical advantages of tuberosity consolidation in this type of patient have also been published by other authors.^{10,11}

In a 2019 meta-analysis, Jain et al. compared the clinical and functional outcomes of RSA in PHF with and without union of the tuberosities.¹¹ The authors evaluated seven studies including 381 patients and found that patients with consolidated tuberosities had significantly better active anterior elevation (134° vs. 112°), abduction (114° vs. 95°), external rotation (27° vs. at 7°) and Constant-Murley score (63 vs. 56) ($p < 0.05$) than those with unconsolidated tuberosities.¹¹ In a more recent similar meta-analysis, O'Sullivan et al. evaluated 21 studies with 873 patients and compared the results in patients with and without union of the tuberosities.¹⁰ Patients with healed tuberosities had 18° greater active anterior elevation ($p = 0.008$) and 16° greater external rotation ($p < 0.001$) than those with unhealed tuberosities.

In a recent meta-analysis of the literature, complications associated with the treatment of PHF with RSA were analyzed. The authors reported a complication rate of 5.5% and 9.7% with uncemented and cemented reverse shoulder prostheses, respectively.²¹ In our study, the complication rate was 11.5% and did not vary between the two groups (11% and 12%). We believe it is important to highlight that RSA for the management of PHFs has a long learning curve that implies performing at least 20 procedures.²² Therefore, we believe that this type of surgery should be performed by surgeons with experience in trauma and shoulder joint reconstruction to achieve optimal results.

This study has some limitations that should be mentioned. First, all patients received the same implant. This has the advantage that the series evaluated is more homogeneous, but the results obtained with this implant cannot be generalized to all the reverse prosthesis designs available on the market. Thus, it was not possible to assess the implications of variations between different types of reverse prostheses, such as stem tilt angle, fracture-specific stem designs, and lateralized glenospheres compared to medialized glenospheres. Second, although the aim of the study was to assess short-term outcomes, it is important to note that the number of complications and revisions could increase with a longer follow-up period. Finally, it is important to highlight that the group without anatomical consolidation included patients with reabsorbed tuberosities, consolidated in a non-anatomical position and with pseudarthrosis. It is possible that a subanalysis of all these categories shows differences between the subgroups, which was not possible in our study due to the low number of each of these subtypes.

CONCLUSION

Postoperative range of motion and functional scores were significantly better in patients >65 years of age with PHF treated by RSA and with anatomical union of the tuberosities than in those without union.

Conflict of interest: The authors declare no conflicts of interest.

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Belangero-Livani Technique (MIPO) in the Treatment of Humeral Shaft Fractures. A Latin American Experience in Three Medical Centers

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ABSTRACT

Objective: To determine the demographic data of the patients in relation to age, sex, profession, affected side, single or multiple lesions, type of material used, bone healing time and possible complications of the treatment of diaphyseal fractures of the humerus treated using the MIPO technique in a series of patients from three hospital units in Ecuador, Paraguay, and Brazil. **Materials and Methods:** A retrospective, longitudinal, observational study of data from 133 patients collected in 3 services in Quito, Ecuador; Asunción, Paraguay; and Passo Fundo, Brazil. The distributions between different services were compared using Pearson's chi-square test. **Results:** The age of the patients ranged from 17 to 76 years, with a mean of 36 years. The median time to union, which occurred in 126 of the 132 patients, was 11 weeks. Most of the patients were male (70.45%), the right side was the most affected (55.3%), most of the fractures were single (85.61%), consolidation occurred in 95.45 % of cases, complications occurred only in 9.09% of patients, 6.82% of them were severe. In relation to complications, they were divided according to the absence (87.12%) or presence of the following: post-surgical neuropraxia (0.76%), infection (3.03%), and pseudarthrosis (4.55%). **Conclusion:** The MIPO technique for the treatment of diaphyseal fractures of the humerus presents low rates of complications and morbidity, demonstrating good rates of consolidation.

Keywords: Humeral shaft fracture; internal fixation; MIPO technique.

Level of Evidence: IV

Técnica de Livani-Belangero (MIPO) en el tratamiento de las fracturas diafisarias de húmero. Experiencia latinoamericana en tres centros hospitalarios

RESUMEN

Objetivo: Evaluar los datos demográficos, como edad, sexo, profesión, lado afectado, lesión única o múltiple, tipo de material utilizado, tiempo de cicatrización ósea y posibles complicaciones de los pacientes con fracturas diafisarias de húmero tratados mediante la técnica MIPO en tres Servicios hospitalarios de Ecuador, Paraguay y Brasil. **Materiales y Métodos:** Estudio retrospectivo, longitudinal, observacional de los datos de 133 pacientes recolectados en tres Servicios en Quito (Ecuador), Asunción (Paraguay) y Passo Fundo (Brasil). Se compararon las distribuciones entre diferentes Servicios mediante la prueba χ^2 de Pearson. **Resultados:** La edad de los pacientes varió entre 17 y 76 años, con una media de 36 años. El tiempo promedio hasta la consolidación fue de 11 semanas (126 de 132 pacientes). Predominó el sexo masculino (70,45%), el lado derecho era el más afectado (55,3%), la mayoría de las fracturas eran únicas (85,61%), se logró la consolidación en el 95,45%. Solo el 9,09% tuvo complicaciones y el 6,82% fueron severas. El 87,12% no tuvo complicaciones; el 0,76% sufrió neuropraxia posquirúrgica; el 3,03%, infección y el 4,55%, pseudoartrosis. **Conclusión:** Con la técnica MIPO para el tratamiento de las fracturas diafisarias de húmero, se logran bajas tasas de complicaciones y de morbilidad, y buenas tasas de consolidación.

Palabras clave: Fractura diafisaria de húmero; fijación interna; técnica MIPO.

Nivel de Evidencia: IV

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INTRODUCTION

Currently, there are several treatment methods for humeral shaft fractures, either through surgical or non-surgical procedures. Conventional surgical methods to resolve humeral shaft fractures are not exempt from complications during and after the procedure.^{1,2,3} Most of these complications are related to the technique and others to the risks of surgical exposure.² On the other hand, there is a growing interest in publications on minimally invasive plate osteosynthesis (MIPO) in humerus fractures, in order to reduce complications and improve the rate of union.^{1,2,3,4}

The method of choice for the current treatment of closed humerus fractures remains controversial. Thus, the non-surgical approach results in non-union rates of 12%. The use of the conservative method requires a prolonged period of immobilization, which generates tissue atrophy, and, in some cases, leads to prolonged physiotherapy treatment.

On the other hand, conventional surgical treatment has the apparent advantage of providing the patient with early range of motion, which reduces the risk of non-union and allows a quicker return to activities.^{2,4,5-6} Among the advantages offered by this method, a higher degree of functionality of the elbow and shoulder joints can be mentioned. Regarding the disadvantages, the most problematic is the extensive deperiostization that alters the microcirculation and increases the risk of non-union, also associated with an increased risk of iatrogenic injury to the radial nerve.^{7,8,11}

The objective of this study is to communicate the experience obtained in the treatment of humeral shaft fractures using the MIPO technique, with a focus on determining the average times to obtain radiologically visible consolidation and the possible complications that may arise during the procedure and after it.

MATERIALS AND METHODS

An observational, longitudinal, retrospective study was carried out. The data were collected in three services: one from Quito, Ecuador; another from Asunción, Paraguay; and the third from Passo Fundo, Rio Grande do Sul, Brazil.

Sampling by trial was carried out by the main authors, strictly adhering to the following inclusion criteria: patients with a humeral shaft fracture, treated using the MIPO technique in the participating hospitals, and with closed type 12A, 12B, or 12C (AO/OTA classification) fractures confirmed by radiographic evaluation, whose treatment had started up to 20 days after trauma.

We included skeletally mature patients aged 18 to 70 years with closed or open humeral shaft fracture who had undergone the MIPO technique performed by the researchers between 2016 and 2020, and whose minimum follow-up was 6 months and had complete health records.

Patients with a diaphyseal fracture with joint extension, a pathological fracture, previous surgery in the ipsilateral segment, a fracture whose treatment had started three or more weeks after trauma, or concomitant associated fractures in the ipsilateral limb were excluded. Those with disabling neurological or psychiatric disorders or who had not completed a follow-up of at least 6 months were also excluded.

Surgical technique

The patient is placed in the supine position under general anesthesia with a plexus block. Antibiotic prophylaxis with 1 g of intravenous cefazolin is administered shortly after anesthetic induction.

The surgical technique used follows that described by Livani and Belangero.¹⁴ Proximal access was made 5 cm between the lateral border of the biceps brachii muscle and the deltoid tendon, thus exposing the proximal humeral diaphysis. In sequence, the distal access is also made 5 cm on the anterior aspect of the distal arm, 3 cm from the elbow crease. After the skin incision, the biceps brachii is retracted medially, exposing the brachialis muscle which is bluntly retracted (Figure 1).¹²



Figure 1. Sequence of steps to measure and place the plate on the anterior aspect of the humerus using the MIPO technique.

After making an extraperiosteal tunnel between the two incisions with a blunt dissection instrument, the plate is slid percutaneously from distal to proximal, and reduction is carried out aided by radioscopy.¹²

Narrow 4.5 mm dynamic compression plates with 12 to 14 holes are used. The plate is placed on the anterior surface of the humerus. (Figure 2).

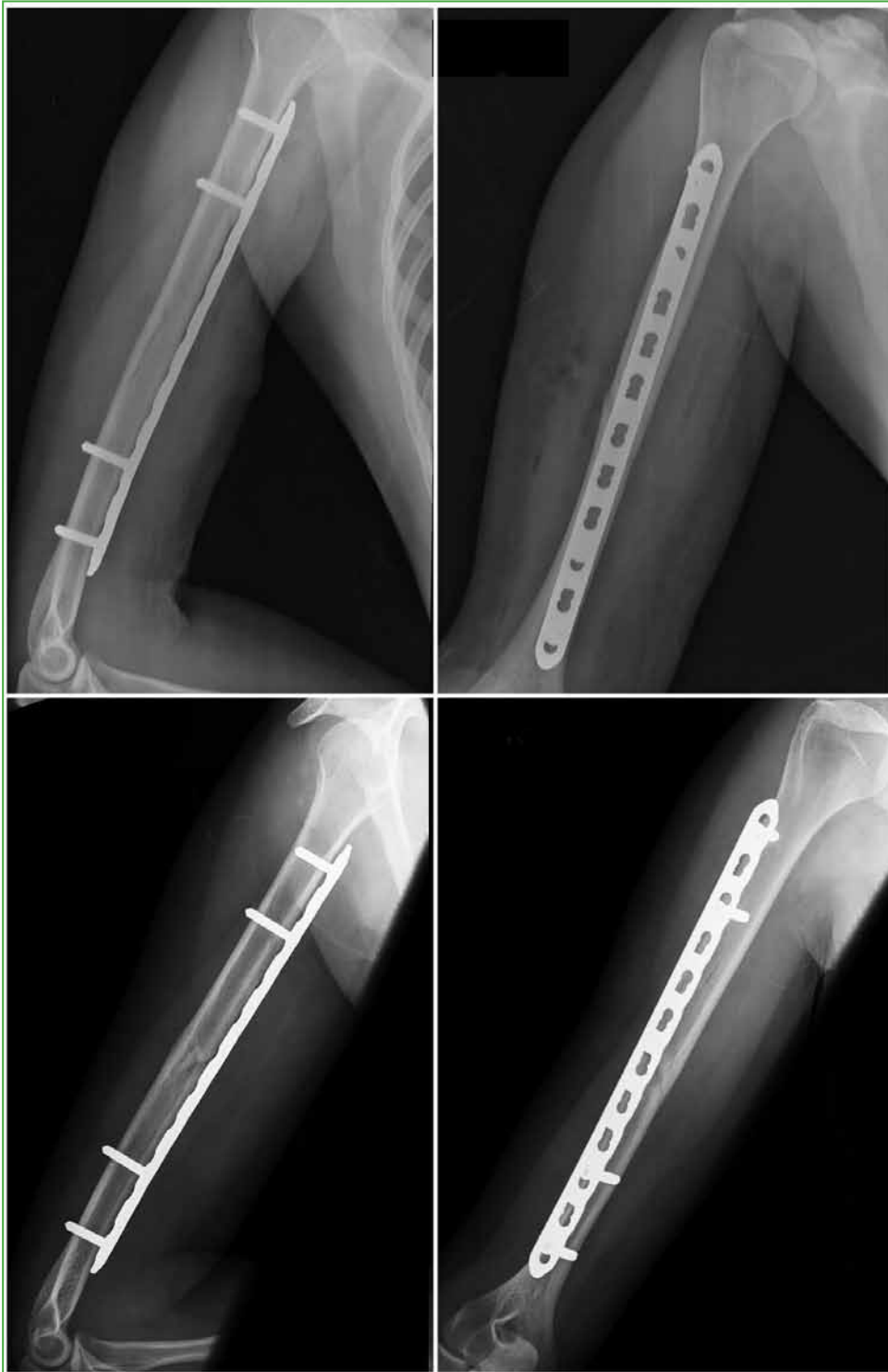


Figure 2. Post-surgical fixation with tolerable reduction. At follow-up, complete consolidation is seen.

Statistical analysis

Numerical variables are described with measures of central tendency, and categorical variables with absolute frequency. The distributions of sex, dominance, fracture type, implant type, success rate (i.e. union without complications), and complications were compared between different Services using Fisher's exact test. Age was compared between the different Services using the one-way analysis of variance (ANOVA). Factors potentially associated with success and complications were evaluated using two binary logistic regression models.

The information was collected through independent Excel spreadsheets for each hospital center with the chosen variables. This information was handled solely by the authors, preserving data confidentiality.

Postoperative management

The use of a sling was indicated for two weeks, and its removal was allowed three times a day for passive elbow range of motion. At the end of the second week, the removal of the sling was authorized and passive motion was indicated, with an increase in active motion in the third week and progressive gain of the motion arcs. Strengthening work was indicated after three months. The return to work depended a lot on the activity of the patients, it was early in the case of office workers (a month and a half) or late in the case of manual workers (2 or 3 months depending on whether there was consolidation). The return to sports was allowed once complete consolidation was achieved and after at least three months of convalescence (Figure 3).

The radiographic evaluation was carried out by the shoulder and elbow fellowship team made up of three medical specialists. Cortices with bone callus formation were considered to determine consolidation or resorption of the edges without consecutive advancement for non-union.



Figure 3. Clinical images of functional outcomes at the end of follow-up.

RESULTS

The age of the patients ranged between 17 and 76 years, with a mean of 36 years. The mean time to union (126 of 132 patients) was 11 weeks (range 6-36). (Table 1).

Table 1. Measures of central tendency and dispersion of numerical variables

Variable	Minimum	Median	Mean	Maximum	Standard deviation
Age (years)	17	35	36.23	76	13.67
Time to union (weeks)	6	11	11.45	36	3.67

Most of the patients were male (70.45%), the right side was the most affected (55.3%), most of the fractures were single (85.61%), and consolidation occurred in 95.45% of cases. Only 9.85% suffered complications and the most commonly used material was the dynamic compression plate (61.36%). Most of the patients were from Paraguay (80.3%) and success, that is, consolidation without serious complications (a complication requiring a new surgical procedure), was achieved in 91.67% of the patients. (Table 2).

In Table 3, it is observed that the majority of those who had some type of complication were men (66.67%), the percentage of the affected side was the same (50%) and the majority were single fractures (66.67%). Regarding the material used, 50% were dynamic compression plates; 41.67%, dynamic compression plates with limited contact and 8.33%, locking compression plates. Mild complications were defined as those that did not require a new procedure and serious complications were those that did require a new procedure.

The distributions of sex, dominance (laterality), type of fracture, type of implant, success and complications were compared between the different Services using Fisher's exact test. This test was chosen because, according to Giolo,¹³ Fisher's exact test for RxC tables is more appropriate when the sample size is not large enough and there may be one or more values <5 in the contingency table.

In Fisher's exact test, if the p-value is less than a significance level (0.05), it leads to the rejection of the null hypothesis H0: the proportion of characteristic "X" is the same in all categories of variable Y.

In Table 4, it can be seen that there are significant differences in the proportion of the type of fracture (p 0.016) and type of material used (p <0.001) in the different Services.

The age of the patients was compared between the different Services using the one-way analysis of variance (ANOVA). The mean age was not significantly different (p 0.5613).

Factors potentially associated with success and complications were evaluated using binary logistic regression models. Logistic regression fitting effects were verified with the help of the simulated envelope and normal probability plot of the HNP library of R.

Table 2. Absolute frequency of categorical variables

Variable	Absolute frequency	Relative frequency - Brazil	Relative frequency - Ecuador	Relative frequency - Paraguay
Sex				
Female	39 (29.55%)	3 (2.27%)	4 (3.03%)	32 (24.24%)
Male	93 (70.45%)	11 (8.33%)	8 (6.06%)	74 (56.06%)
Side				
Right	73 (55.3%)	7 (5.3%)	9 (6.82%)	57 (43.18%)
Left	59 (44.7%)	7 (5.3%)	3 (2.27%)	49 (37.12%)
Type of fracture				
Multiple	19 (14.39%)	5 (3.79%)	3 (2.27%)	11 (8.33%)
Single	113 (85.61%)	9 (6.82%)	9 (6.82%)	95 (71.97%)
Consolidation				
No	6 (4.55%)	0 (0%)	1 (0.76%)	5 (3.79%)
Yes	126 (95.45%)	14 (10.61%)	11 (8.33%)	101 (76.52%)
Complication				
Severe	9 (6.82%)	0 (0%)	1 (0.76%)	8 (6.06%)
Mild	3 (2.27%)	0 (0%)	0 (0%)	3 (2.27%)
No	120 (90.91%)	14 (10.61%)	11 (8.33%)	95 (71.97%)
Type of material				
Dynamic compression plate	81 (61.36%)	14 (10.61%)	5 (3.79%)	62 (46.97%)
Limited Contact Dynamic Compression Plate	41 (31.06%)	0 (0%)	2 (1.52%)	39 (29.55%)
Locking Compression Plate	10 (7.58%)	0 (0%)	5 (3.79%)	5 (3.79%)
Success				
No	10 (7.58%)	0 (0%)	1 (0.76%)	9 (6.82%)
Yes	122 (92.42%)	14 (10.61%)	11 (8.33%)	97 (73.48%)

Table 3. Absolute frequency of categorical variables of patients with complications

Variable	Frequency	Percentage
Sex		
Female	4	33.33%
Male	8	66.67%
Side		
Right	6	50%
Left	6	50%
Type of fracture		
Multiple	4	33.33%
Single	8	66.67%
Consolidation		
No	5	41.67%
Yes	7	58.33%
Complication		
Severe	9	75%
Mild	3	25%
No	0	0%
Type of material		
Dynamic compression plate	6	50%
Limited Contact Dynamic Compression Plate	5	41.67%
Locking Compression Plate	1	8.33%
Service		
Brazil	0	0%
Ecuador	1	8.33%
Paraguay	11	91.67%
Success		
No	9	75%
Yes	3	25%

Table 4. Fisher exact test

Variable	p
Sex	0.82783640485
Side	0.39619935801
Type of fracture	0.01648996506
Complication	0.56003456881
Type of material	0.00005054684
Success	0.71174965658

DISCUSSION

The treatment of diaphyseal fractures includes several options, and surgery is usually indicated in the setting of significant displacement, neurovascular injury, open fractures, and multiple fractures.

In the last decade, global interest in minimally invasive osteosynthesis has increased with the use of bridge plates, whose fixation site can vary, most of them through the anterior safe zone, avoiding direct contact with the radial nerve.^{14,15}

Several studies suggest that the MIPO technique achieves favorable results compared to other surgical techniques in terms of healing time and postoperative complications. According to the meta-analysis by Bin-feng Yu et al., one of its advantages is the reduction in the risk of radial nerve damage, a trend that was also observed in our study.^{3,11,14,9,15,21,22,17}

One of the main issues to be studied is the reduction of the risk of radial nerve damage. In some cases treated with the conventional open technique, its mere identification and nerve protection can cause postsurgical neuropraxia. We believe that this is one of the main advantages of this technique, in which a muscle flap protects the aforementioned structure.^{3,11}

To avoid the neurological damage associated with the MIPO technique, Benegas et al.²⁴ recommend adequate handling of the soft tissues and gentle retraction during the distal approach, in addition to avoiding lever-type retractors, placing the plate in an anterior position, keeping the forearm in a semi-flexed position, and inserting the plate from proximal to distal.^{20,14} The incidence of neurological injury with this technique is low (around 2.8%);^{1,14,16} however, when it occurs, it leads to poor functional outcomes and the need for additional procedures.

Based on our experience in this study, we believe that the MIPO technique approach works in a safe zone in relation to neurological structures by not manipulating nerve structures during the fixation pathway, which, in itself, may be a factor that contributes to reducing the injuries.^{5,6,23,14}

The neurological damage verified before surgery was not a contraindication to perform this procedure, which can be deduced from the experience published by Shao et al., who recognized an 88.1% general recovery, with a spontaneous recovery of 70.7%. No differences were found between the groups treated initially with early exploration and with expectant management, suggesting that carrying out a procedure to explore the radial nerve does not have an impact on the degree of nerve recovery. In our series, most patients were treated with this approach and a low rate of neurological injury was achieved.⁶

Most cases of neuropathy are due to a distraction injury, which tends to improve. We would suggest open exploration in which a wide approach and surgical exploration of the radial nerve is performed and its possible repair only in cases of worsening or lack of improvement during patient follow-up.⁴

The nonunion rate after plate fixation can reach 5.8%²⁰ and the time to union, in some studies, ranges between 12 and 32 weeks, with a mean of 16.2 weeks.^{9,12,16,20} This finding coincides with that of our study, in which the rate of nonunion was 4.5%.

The pooled data reflect consistently favorable outcomes, such as a nonunion rate of 2.6%, an infection rate of 1.5%, and an iatrogenic radial nerve injury rate of 2.8%. This compares very favorably with the reported complication rate for open reduction and internal fixation or intramedullary nailing, whose risk of iatrogenic radial nerve injury may be as high as 10-20%.^{6,10}

We believe that an important factor that can directly influence the speed of union, its quality and the reduction of complications, such as nonunion, is an adequate reduction of the fracture, which also influences the healing of fractures by open techniques and is a factor that can act as a possible distractor. This fact makes comparisons difficult and we believe should be taken into account in future studies.

It is difficult to obtain data regarding follow-up and degree of consolidation in the public health system, which may prevent us from knowing the exact date on which consolidation occurred. This implies a limitation to our study, because clinical consolidation could possibly occur without a radiological image.

Regarding the type of plates used, they were mostly 12-hole dynamic compression plates (124 dynamic compression plates, 8 locking compression plates); locking plates were used only in some cases. We consider that this may be a factor that alters the biomechanics of fixation. The technique was originally described by Livani et al.,^{2,5} with this implant, since the dynamic compression plate is an inexpensive, easily accessible and widely used implant that can effectively resolve this type of fracture, reproducible in the most centers.^{1,2,5,19}

In our study, four screws were used to fix the plate, two proximal and two distal, distributed along the edges of the plate, which apparently provides adequate stability and flexibility to the plate to stimulate consolidation due to its relative stability. We believe that comparative biomechanical studies are needed to address this and contrast it with different screw configurations and different work areas.

Studies have been published on fractures treated with the MIPO technique with a locking compression plate,^{1,6} we believe that this could offer benefits for elderly patients or patients with osteoporotic bone; however, more comparative biomechanical studies are needed to determine the best type of implant for this technique. Therefore, based on our experience, dynamic compression plating is recommended using the original technique described by Livani et al. whereas locking compression plating is recommended in patients with osteoporotic bone.^{1,2,5,16}

As a disadvantage of this technique, we could mention that it requires the use of an image intensifier, which means extra resources, in addition to exposure to radiation.^{1,2,5}

The MIPO technique also does not increase the risk of complications in general, according to the study by Bin-feng Yu et al., which is advantageous, because the comparison was made with the conventional plate fixation technique, considered the gold standard.^{3,12,17}

In relation to the methodology of the study, we were struck by the disparity of cases within one Center (Paraguay). In the general statistics, this implies a dilution of the results of the other two Centers, which subtracts statistical power from our work. Thus it is mentioned that variables such as complications have mostly taken place in Paraguay, which could not be fully representative of the technique.

CONCLUSIONS

The MIPO technique for the treatment of humeral shaft fractures causes low rates of complications and morbidity, and good rates of union.

Conflict of interest: The authors declare no conflicts of interest.

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Suprapectoral Biceps Tenodesis. Clinical Outcomes

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ABSTRACT

Objective: To evaluate and compare outcomes in a case series of SLAP injuries and complete tears of the long head of the biceps treated with suprapectoral tenodesis using a mini-open approach. **Materials and Methods:** Patients aged over 18, treated between 2019 and 2020, with a minimum 1-year follow-up were included. The demographic characteristics, indication for surgery, return to activities considered usual by the patient, and complications were recorded. The American Shoulder and Elbow Surgeons (ASES) score for the shoulder was used, and the active range of motion of the affected shoulder was measured. In addition, the patients were asked if they were able to return to their daily activities. We recorded the diagnosis that led the patients to surgery and whether they had undergone a traumatic event coinciding with the onset of symptoms. **Results:** 8 patients were evaluated, the median age was 42.5, and the follow-up was 17 months (IQR 13.5 – 21.5). Six patients (75.0%) had a type II SLAP injury, and two (25.0%) had a complete LHB tear. Six patients (75.0%) associated the symptoms with a traumatic event. The final range of motion of the shoulder (median) was: flexion 180° (IQR 170°-180), internal rotation 65° (IQR 60° - 75°), and external rotation 70° (IQR 65° - 87.5°). **Conclusion:** Suprapectoral tenodesis with a prior arthroscopic tenotomy for SLAP II cases or in cases of complete tears of the long head of the biceps is a safe technique for achieving functional outcomes.

Keywords: Biceps; suprapectoral tenodesis; tenodesis; SLAP, proximal biceps; LHB.

Level of Evidence: IV case series

Tenodesis suprapectoral del bíceps. Resultados clínicos

RESUMEN

Objetivo: Evaluar los resultados de la tenodesis suprapectoral mediante un miniabordaje en una serie de pacientes con lesión SLAP y desgarros completos de la porción larga del bíceps, y compararlos con los valores prequirúrgicos. **Materiales y Métodos:** Se incluyeron pacientes adultos tratados con dicha técnica entre 2019 y 2020, y un seguimiento mínimo de un año. Se registraron las características demográficas, la indicación de cirugía, el retorno a las actividades consideradas habituales por el paciente y las complicaciones. Se utilizó el puntaje ASES para hombro, y se midió la movilidad activa del hombro afectado. Además, se le preguntó al paciente si retomó la actividad que consideraba habitual, con opciones "sí" o "no". Se consignó si los pacientes reconocían un evento traumático con el inicio de los síntomas y se registró el diagnóstico con el que se llegó a la cirugía. **Resultados:** Se evaluó a 8 pacientes (7 hombres), con una mediana de la edad de 42.5 años. El seguimiento fue de 17 meses (RIC 13.5-21.5). Seis (75%) tenían diagnóstico de lesión SLAP tipo II y dos (25%), de desgarramiento completo. Seis pacientes (75%) asociaron los síntomas con un evento traumático. Las medianas de los rangos de movilidad finales fueron: flexión 180° (RIC 170°-180°), rotación interna 65° (RIC 60°-75°) y rotación externa 70° (RIC 5°- 87,5°). **Conclusión:** La tenodesis suprapectoral tras una tenotomía artroscópica para casos de lesión SLAP II o de desgarramientos completos de la porción larga del bíceps resultó una técnica segura y con resultados funcionales.

Palabras clave: Bíceps; tenodesis suprapectoral; tenodesis; SLAP; tendón del bíceps proximal.

Nivel de Evidencia: IV serie de casos

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INTRODUCTION

The pathology of the long head of the biceps includes a wide spectrum of clinical scenarios, such as complete tears, tenosynovitis, instability, and SLAP (superior labrum anterior posterior) injuries. With its different technical options, biceps tenodesis is usually the first option when there are complete tears and instability of the articular portion. In recent years, tenodesis has gained popularity as an alternative to repairs for SLAP injuries.¹⁻⁴

Tenodesis of the long head of the suprapectoral biceps performed entirely by arthroscopy and subpectoral tenodesis through a mini-open approach have been proposed. There is evidence and comparative studies between these techniques, but there is little evidence and information on suprapectoral tenodesis using a mini-open approach after arthroscopic tenotomy.⁵⁻⁹ We have not found published series reporting results with this technique.

The objective of this study was to evaluate the outcomes in a series of patients undergoing suprapectoral tenodesis using a mini-open approach, and compare them with preoperative values.

MATERIALS AND METHODS

A retrospective, descriptive and analytical research was carried out. We included adult patients who had undergone tenodesis using a mini suprapectoral approach for proximal biceps pathology between 2019 and 2020, with a minimum follow-up of one year. Patients who were lost to follow-up and those in whom the tenodesis was secondary to other procedures were excluded. In our database, 13 patients were retrospectively identified, one was excluded because he had been lost to follow-up and four because the tenodesis had been secondary to cuff repairs (in the same surgery). All were operated on by the same surgeon.

Demographic characteristics, reason for indicating surgery, return to activities considered normal, and complications were recorded. The range of motion of the affected shoulder was evaluated in anterior flexion, and external and internal rotations at 90° of abduction.

The indication for surgery in cases of SLAP lesions was due to pain that prevented the patient from performing the usual tasks, with at least three months of medical treatment and rehabilitation without remission of symptoms (pain, dislocations, positive O'Brien test). Medical treatment did not include injections. In two cases, it was indicated for the treatment of a complete tear of the long head of the biceps (Figure 1).

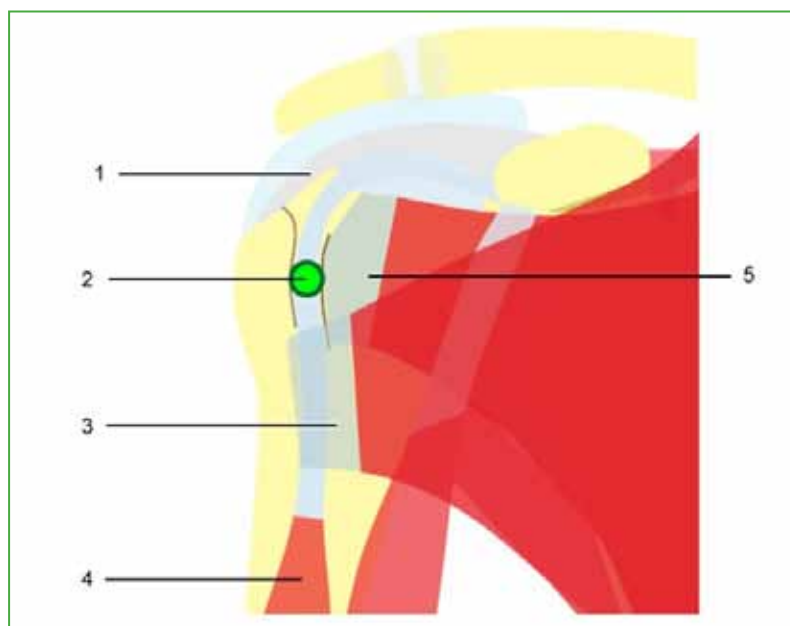


Figure 1. Scheme of the suprapectoral tenodesis site. 1. Supraspinatus. 2. Level of the suprapectoral tenodesis. 3. Pectoralis major. 4. Biceps. 5. Subscapularis.

The Snyder classification for SLAP injuries and the *American Shoulder and Elbow Surgeons* (ASES) score for the shoulder were used. The active range of motion of the affected shoulder was measured: forward flexion, external rotation with the arm in 90° abduction, internal rotation with the arm in the same position. All measurements and scores were recorded before surgery and postoperatively. In addition, the patient was asked if he was able to resume the activities he considered usual, with options “yes” or “no”. The diagnosis that led to surgery was recorded.

The biceps was evaluated by clinical inspection in the supinated and extended arm position looking for signs of detachment or re-tear (Table 1).

Table 1. Demographic, clinical and follow-up characteristics

Characteristics	Patients (n = 8)
Sex, n (%)	
Female	1 (12.5%)
Male	7 (87.5%)
Age, median (IQR)	42.5 (37.0-46.5)
Diagnosis, n (%)	
SLAP II	6 (75%)
Tear	2 (25%)
Side, n (%)	
Right	5 (62.5%)
Left	3 (37.5%)
Months of follow-up, median (IQR)	17 (13.5-21.5)

IQR = interquartile range. SLAP = superior labrum anterior posterior

Surgical technique

In all cases, general anesthesia with block was administered for postoperative pain management. Surgery is performed with the patient in the lateral decubitus position under traction in cases of SLAP injury. First, a glenohumeral arthroscopy is performed. A posterior and an anterior portal are used. Once the pathology has been evaluated and the indication defined (unstable SLAP lesion plus degenerative signs and pathology of the joint tendon such as thickening and instability), the tenotomy of the long head of the biceps with radiofrequency through the anterior portal is performed. Then, in the same position, an anterior longitudinal approach is performed in the most distal deltopectoral section, usually 5 cm distal to the anterolateral end of the acromion. The dissection is performed through the deltopectoral interval. Once that interval has been dissected, the deltoid is retracted laterally with a Hohmann lever to visualize the anterior aspect of the humerus. The bicipital groove is identified, it is incised and recovered by tractioning the end of the previously tenotomized biceps tendon. The bone surface is then roughened. After determining the reinsertion and fixation point, the end of the biceps is regularized and prepared according to the fixation method, which may consist of conventional anchors or those designed for tenodesis, bone fixation or biotenodesis screws. It is important to keep the elbow in extension to achieve adequate tension. In this case, the upper limb is under tension. If anchors are used, the fixation to the pectoralis major can be strengthened with sutures. Finally, it is sutured in planes. In cases of biceps rupture, the described mini-open approach is performed directly with the patient in a beach chair position. The patient is then immobilized in a sling for four weeks. Passive range of motion exercises are indicated at three weeks; then, physical therapy begins (Figures 2-4).

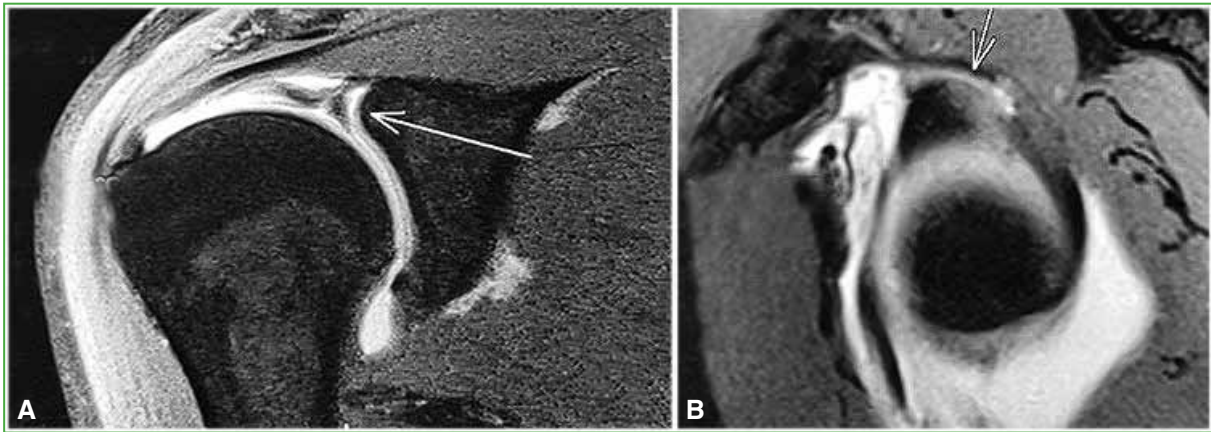


Figure 2. Magnetic resonance imaging of the shoulder. **A.** Anteroposterior section. The arrow shows a type II SLAP lesion. **B.** Sagittal section. The arrow shows an anteroposterior type II SLAP lesion.



Figure 3. Lateral decubitus position under traction used in SLAP cases. **A and B.** The anterior portal used for the tenotomy and the mini-open approach for the suprapectoral tenodesis are marked, approximately 5 cm distal to the acromion. **C.** Clinical appearance of the incisions before suturing.

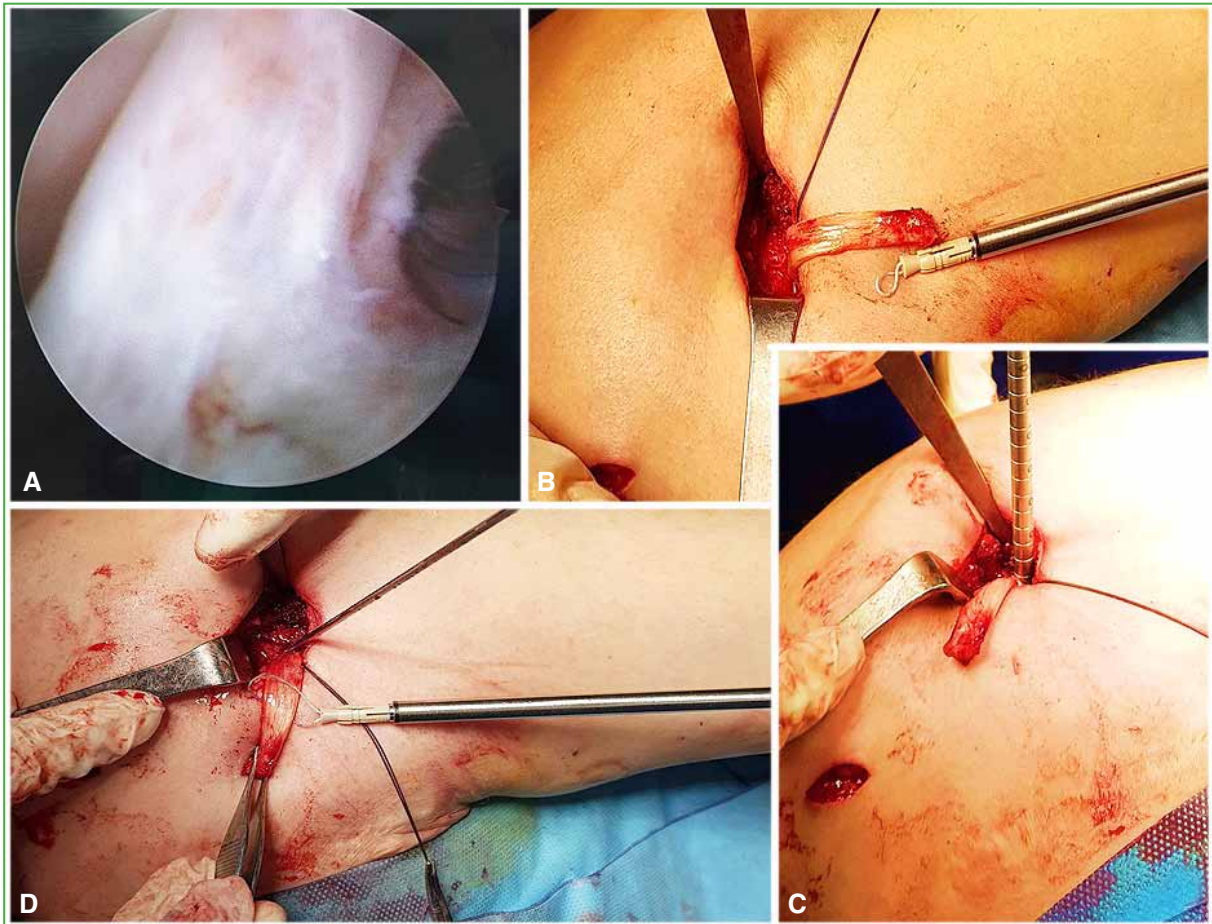


Figure 4. **A.** Posterior arthroscopic view of a SLAP II injury and biceps with tenosynovitis. **B.** The biceps was recovered through the suprapectoral approach. The detail of the anchorage used for the tenodesis can be observed. **C.** Carving of the bone tunnel in the humerus before placement of the guide (cannulated wick). **D.** Detail of the tendon looping technique to ensure its introduction into the humerus before tenodesis.

Statistical analysis

A descriptive analysis was made. Data are expressed as median and interquartile range (IQR) for numerical variables and as absolute values with their percentages for categorical data. To compare the results of surgery with preoperative values, the Wilcoxon signed rank test was used. A p value <0.05 was considered significant. The data were analyzed with the STATA/MP version 14 package.

RESULTS

The study group included eight patients, seven (87.5%) were men. The patients were active, practiced recreational sports and overhead activities, but had not been treated for work accidents or by a Work Risk Insurer. The median age was 42.5 years (IQR 37.0-46.5). The median follow-up was 17 months (IQR 13.5-21.5). Six of the patients (75%) had a preoperative diagnosis of type II SLAP injury and two (25%) of complete tear. In six cases (75%), surgery was performed with a diagnosis of magnetic resonance imaging compatible with a SLAP lesion. The two patients with complete tears were 42 and 56 years old. The mean age of patients with SLAP lesions was 39 years.

In four cases (50%), tenodesis was performed with a 5-mm double suture PEEK (polyetheretherketone) anchor, and in four (50%) with a TenoLok tenodesis anchor (ConMed, Largo FL, USA).

Six patients (75%) returned to their previous activity, two (25%) reported not being able to fully perform their activities.

The median pre-surgical ranges of motion were: flexion 165° (IQR 155°-175°), internal rotation 47.5° (IQR 30°-70°) and external rotation 60° (IQR 42.5°-75, 0°). The median final ranges of motion were: flexion 180° (IQR 170°-180°), internal rotation 65° (IQR 60°-75°), and external rotation 70° (IQR 65°-87.5°) (Table 2).

Table 2. Pre- and postoperative ranges of motion and ASES score

	Preoperative	Postoperative	p
Flexion, median (IQR)	165 (155-175)	180 (170-180)	0.031
Internal rotation, median (IQR)	47.5 (30-70)	65 (60-75)	0.078
External rotation, median (IQR)	60 (42.5-75)	70 (65-87.5)	0.039
ASES, median (IQR)	68 (42.5-79)	90 (75-95)	0.007

IQR = interquartile range.

A statistically significant difference was observed in pre- and postoperative ranges of motion, specifically in flexion ($p = 0.031$) and external rotation ($p = 0.039$), but not in internal rotation ($p = 0.078$).

The median pre-intervention ASES score was 68 (IQR 42.5-79) and the median final ASES score was 90 (IQR 75-95). A statistically significant difference was obtained between the ASES score before the intervention and after ($p < 0.01$).

No general complications, such as infections, or related to the surgical technique were recorded. No disinsertions of the tenodesis (Popeye's sign) were observed (Figure 5).



Figure 5. Clinical image of the contour of the biceps after tenodesis.

DISCUSSION

We present a series of cases treated with suprapectoral tenodesis using a mini-open approach in which ASES scores and functional range of motion were compared before and after surgery.

Different options have been proposed for proximal biceps tenodesis. The main controversy in the literature is whether to perform tenodesis entirely arthroscopically or through a mini-open approach after arthroscopic tenotomy. Another point of discussion is where to perform the tenodesis. The suprapectoral location has been reported in the bicipital groove¹ and the subpectoral groove.²³

Although the site of suprapectoral tenodesis is the one originally proposed for reattachments after a complete tear,⁴ in recent years, arthroscopic suprapectoral and subpectoral tenodeses using a mini-open approach have been reported in multiple studies, but we did not identify recent publications with this technique. The exceptions are an anatomical study in which the proximity to nerve structures is evaluated and another that reports the use of an Endobutton® device.^{5,6}

In a level III epidemiological study on the trend between these two options, it was found that the general indication for tenodesis tends to increase. Of 8,547 patients treated with long head biceps tenodesis, 43.5% were performed by open technique and 56.5% by arthroscopy. In that review, open techniques were more frequent when performed as the only procedure and arthroscopic methods when there were concomitant procedures. Furthermore, the authors concluded that complications are extremely rare and that there are no differences between techniques.⁷

We consider that the theoretical advantages of suprapectoral tenodesis include that the technique may be less demanding than that of tenodesis performed entirely arthroscopically and, on the other hand, the location immediately above the pectoral would avoid reported complications in subpectoral tenodesis, such as neurological injuries of the musculocutaneous nerve and fractures, as it is a more robust region of the humerus.^{8,9} In addition, good muscle coverage can be obtained, avoiding the regional pain reported as a complication in arthroscopic tenodeses in the superior groove.¹⁰

In a cadaveric anatomical study, the distances to the axillary, radial and musculocutaneous nerves were measured, with fixation techniques in which it is necessary to go through the posterior cortical bone of the humerus, and it was found that, in the suprapectoral position, the axillary nerve has greater proximity risk.⁵ In this series, we did not transfix the posterior cortex with the techniques used for anchor fixation and biceps tenodesis.

Regarding the cases of SLAP II injury, the alternative to tenodesis is its repair with arthroscopic anchors, with which satisfactory outcomes are achieved,¹¹ but in our series, the SLAP injury was associated with degenerative characteristics of the articular portion of the biceps and injury instability. Therefore, we indicated tenotomy and tenodesis. These pathological characteristics of the tendon are related to the chronicity of the symptoms.

According to some authors, the primary indication for the treatment of SLAP lesions is repair, mainly in patients <35 years of age; however, in recent years, variable results have been published. On the other hand, worse results were obtained with repairs in series of SLAP type II lesions, which suggests better results with tenodesis. In these studies, they focus the analysis on the age of the patients and the return to normal activity.

Boileau et al.¹² compared a small series of tenodesis repairs and reported that 40% of repair patients were satisfied, only 20% returned to their previous activity level; in the tenodesis group, 93% were satisfied and 87% returned to their previous level of activity. In a comparative retrospective study of 15 tenodeses with 15 repairs, Ek et al.¹³ found no differences in the ASES score, patient satisfaction and return to sports (76% vs. 60%). As in our series, tenodesis was indicated, mostly, for patients >35 years of age and due to a degenerative labrum. Instead, repairs were indicated when healthy tissue was present and in patients <35 years of age. There was one case of tenodesis failure and two cases of repair stiffness, all resolved with non-surgical treatment.

Denard et al.¹⁴ compared both techniques (22 repairs and 15 tenodeses) in patients >35 years of age. The treatment decision was based on patient factors such as age, activity, and work compensation. The authors reported that in patients >35 years of age with a SLAP II injury as a single injury, greater satisfaction, more predictable function, and a higher rate of return to activity may be obtained with biceps tenodesis compared with repairs. In 2021, Hurley et al.¹⁵ compared the results of 29 cases of subpectoral tenodesis and 74 arthroscopic repairs in patients <30 years of age (SLAP II and IV lesion). They found no difference in function and return to sport. They reviewed nine repairs (11.5%) and no tenodesis. They found no differences in visual analog scale, ASES score, patient satisfaction, and biceps girth.¹⁶

It should be noted that, in this series, the indication for tenodesis was defined at surgery in patients with SLAP II injury and biceps with a degenerative appearance. In all these cases, the preoperative evolution was long-standing with multiple previous non-surgical treatments, one of the patients had been operated on 20 years earlier for anterior instability using an open Bankart technique. The two cases without SLAP injury involved complete tear of the long head of the biceps, so suprapectoral tenodesis was performed directly.

The position of the biceps was clinically evaluated and no signs of detachment, re-tearing or tension alterations (Popeye's sign) were observed. According to a cadaveric anatomical study, the ideal position to achieve adequate biceps tension would be immediately proximal to the pectoralis major (suprapectoral), in addition to being safe in relation to the nearby neurovascular structures.¹⁷

We found no reports on the results of suprapectoral tenodesis using a mini-open approach, so comparison with other experiences is difficult. We obtained a final average ASES score of 90. On the other hand, numerous series comparing subpectoral tenodesis have been published. Mazzocca et al.² reported a series of 41 patients with subpectoral tenodesis and the average ASES score obtained was 89. Along the same lines, in another study of 20 active patients <45 years old with SLAP II injury undergoing subpectoral tenodesis, the authors suggested that excellent outcomes related to patient satisfaction and return to the same sporting level can be obtained.¹⁸

In a study of subpectoral tenodesis as a primary indication in cases of SLAP II injury, tenosynovitis, and other chronic pathologies of the long head of the biceps, Provencher et al. obtained high functional and return to activities rates, with a low rate of complications.¹⁹ Comparisons between suprapectoral and subpectoral tenodesis have not shown substantial differences in terms of scores, satisfaction, return to sports activities, or complications.^{7,15,16} Another option to tenodesis is tenotomy as a standalone procedure, but it is reserved for pathology of the proximal biceps in elderly patients with low functional demand, sedentary, obese, and without aesthetic problems, all situations that lead to low demand for strength. With this technique without tenodesis, a 13-50% incidence of Popeye's sign has been reported postoperatively. Likewise, a decrease in flexion and supination strength has been reported.^{20,21} In our series, there were two cases of complete tear in which reinsertion by tenodesis was decided after exposing the options and the possible evolution to the patients.

No specific complications related to the technique used were detected. Some authors consider complications or failures when the return to full activity or low scores on the scales are not achieved.¹⁹ Therefore, we believe that it constitutes a valid option for the treatment of SLAP injury—when repair is not an option—and for the reattachment of the long head of the biceps in complete tears. The weaknesses of this study are its retrospective design and the small number of patients. Likewise, it is a heterogeneous sample with different fixation methods. But, on the other hand, it is a technique with little evidence in the literature and a pre- and postoperative clinical evaluation.

CONCLUSION

Suprapectoral tenodesis by a mini-open approach after arthroscopic tenotomy for SLAP II injuries or complete tears of the long head of the biceps was a safe technique and achieved functional outcomes.

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Reduction of Acute Anterior Inferior Glenohumeral Joint Dislocation in the Argentine Health Care System. A National Perspective

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ABSTRACT

Objective: To know the methods used for the initial treatment of the first episode of acute anterior inferior glenohumeral dislocation and to compare the behaviors of physicians between the different levels of specialization. Our hypothesis was that there is great variability in the methods used in Argentina. **Materials and Methods:** A survey was conducted using the Google forms platform. It was disseminated through the morbidity and mortality committee of the AAOT and the Argentinian Association of Shoulder and Elbow Surgery. The questionnaire consisted of 13 questions with multiple choice answers that included the degree of specialization, work environment, maneuvers, anesthesia, complications, position, and immobilization time. **Results:** 429 complete answers were obtained. 52.2% use the Kocher maneuver as their first choice, followed by the Hippocratic method (15.9%). 72% do not use anesthesia to perform the reduction, there is a statistically significant difference between the use of anesthesia and the different levels of specialization ($P = 0.046$). 85.8% of the 120 surgeons who use anesthesia for the reduction, use general anesthesia or sedation. 74.8% immobilize the patient in adduction and internal rotation. 13.8% reported having complications related to the reduction. **Conclusions:** There is a great variability regarding the methods used to reduce a first episode of LGHAI in the emergency services in Argentina. We believe it is important to reconsider the use of anesthesia, proposing intra-articular anesthesia as the first option, if needed.

Keywords: Anterior inferior glenohumeral dislocation; reduction; anesthesia; complications.

Level of Evidence: IIC

Reducción de la luxación glenohumeral anteroinferior aguda en el sistema de salud de la Argentina. Perspectiva nacional

RESUMEN

Objetivo: Conocer los métodos utilizados para el tratamiento inicial del primer episodio de luxación glenohumeral anteroinferior aguda y comparar las conductas entre los diferentes niveles de especialización. Nuestra hipótesis es que los métodos utilizados en la Argentina presentan una gran variabilidad. **Materiales y Métodos:** Se realizó una encuesta mediante formularios de Google, que se difundió a través del Comité de Morbimortalidad de la Asociación Argentina de Ortopedia y Traumatología y la Asociación Argentina de Cirugía de Hombro y Codo. El cuestionario consta de 13 preguntas con respuesta de opción múltiple que incluyen: grado de especialización, ámbito laboral, maniobras utilizadas, empleo de anestesia, complicaciones, posición y tiempo de inmovilización. **Resultados:** Se obtuvieron 429 respuestas completas. El 52,2% utiliza la maniobra de Kocher como primera elección, seguida del método hipocrático (15,9%). El 72% no utiliza anestesia inicialmente para la reducción; se halló una diferencia estadísticamente significativa entre el uso de anestesia y los diferentes niveles de especialización ($p = 0,046$). De los 120 médicos que sí la emplean, el 85,8% recurre a la anestesia general o la sedación. El 74,8% inmoviliza al paciente en aducción y rotación interna. El 13,8% de los participantes refiere haber tenido alguna complicación relacionada con la reducción. **Conclusiones:** Existe una gran variabilidad en los métodos utilizados para la reducción de un primer episodio de luxación glenohumeral anteroinferior en los servicios de emergencia de la Argentina. Consideramos oportuno replantear el uso de la anestesia, y proponer la anestesia intrarticular como primera opción.

Palabras clave: Luxación glenohumeral anteroinferior; reducción; inmovilización; anestesia; complicaciones.

Nivel de Evidencia: IIC

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INTRODUCTION

Glenohumeral joint dislocation is a frequent condition, it represents approximately 50% of all dislocations,¹⁻⁴ and it has an incidence of between 8 to 48 cases per 100,000 inhabitants per year.^{5,6}

The anterior inferior variant is the most frequent and represents between 90% and 97% of all cases.¹ The usual mechanism of injury is a combination of abduction, external rotation, and extension.⁷

Numerous techniques and reduction maneuvers have been described and widely used for the treatment of these dislocations, among the most widespread in our field, we can mention: Kocher,⁷⁻⁹ Stimson,¹⁰ Hippocratic method,¹⁰ Spaso,⁷ Milch,^{10,11} FARES,^{10,11} traction/countertraction.¹¹

Prompt reduction and a correct maneuver are essential to prevent vascular and neurological complications or fractures.

Currently, there is no consensus or national protocol for the management of anterior inferior glenohumeral dislocation (AIGHD) in the emergency services. Nor have we found any bibliographic data on the reduction techniques and methods chosen by doctors in the emergency services of Argentina.

The main objective of this study was to know the most commonly used methods for the initial treatment of the first episode of acute AIGHD in the emergency services of Argentina. The secondary objective was to analyze the information obtained and compare the behaviors between the different levels of specialization. Our hypothesis was that there is great variability in the methods used to reduce a first episode of AIGHD in emergency services in Argentina.

MATERIALS AND METHODS

We carried out an analytical, observational and cross-sectional study between June and November 2021 to determine the treatment used for the reduction of a first episode of AIGHD.

For this purpose, we designed and carried out a survey using the Google forms platform (Mountain View, California, USA) After a pilot test with 40 participants, it was approved by and disseminated through the Morbidity and Mortality Committee of the *Asociación Argentina de Ortopedia y Traumatología* (Argentine Association of Orthopedics and Traumatology) and the *Asociación Argentina de Cirugía de Hombro y Codo* (Argentine Association of Shoulder and Elbow Surgery). The survey is aimed at traumatologists and residents/concurrent traumatologists who work directly or indirectly in the emergency services of Argentina. The questionnaire consists of 13 questions with multiple choice answers that include the degree of specialization, the work environment, the reduction maneuvers used, the use of anesthesia, complications, position and time of immobilization ([Annex](#)).

Considering that the *Asociación Argentina de Ortopedia y Traumatología* has 5,900 members, the sample size necessary to achieve a confidence level of 95% and a margin of error of 5% is 362.

Statistical analysis

Categorical variables are presented as frequency and percentage. The chi-square test for independent samples or Fisher's exact test was used to compare categorical variables. For all statistical conclusions, a significance level of 5% was used. The analysis was performed with the statistical program IBM SPSS Statistics for Windows, version 26 (IBM Corp., Armonk, NY, USA).

RESULTS

429 complete responses were obtained, of which 33 (7.7%) correspond to residents; 329 (76.7%), to specialists in traumatology; and 67 (15.6%), to subspecialists in shoulder and elbow surgery. 13.1% of those surveyed worked in the public sector; 38.9%, in the private sector; and 48%, in both.

Faced with a first episode of AIGHD, 52.2% (224 respondents) stated that the Kocher maneuver was the first choice for reduction. [Figure 1](#) details the percentages of the different maneuvers. No significant differences were found between the first reduction maneuver and the work environment. In both the private and public sectors, the most commonly used maneuver is the Kocher maneuver (54.5% in private and 46.4% in public hospitals, $p = 0.262$).

72% do not initially administer anesthesia for glenohumeral reduction. Of the 120 physicians who do use it, 85.8% (103 respondents) use general anesthesia or sedation and 14.2%, intra-articular local anesthesia.

When comparing the use of anesthesia with the degree of specialization, it was observed that 12.1% of residents, 28% of traumatologists, and 35.8% of specialists use anesthesia for the first reduction attempt, with a statistically significant difference between them ($p = 0.046$).

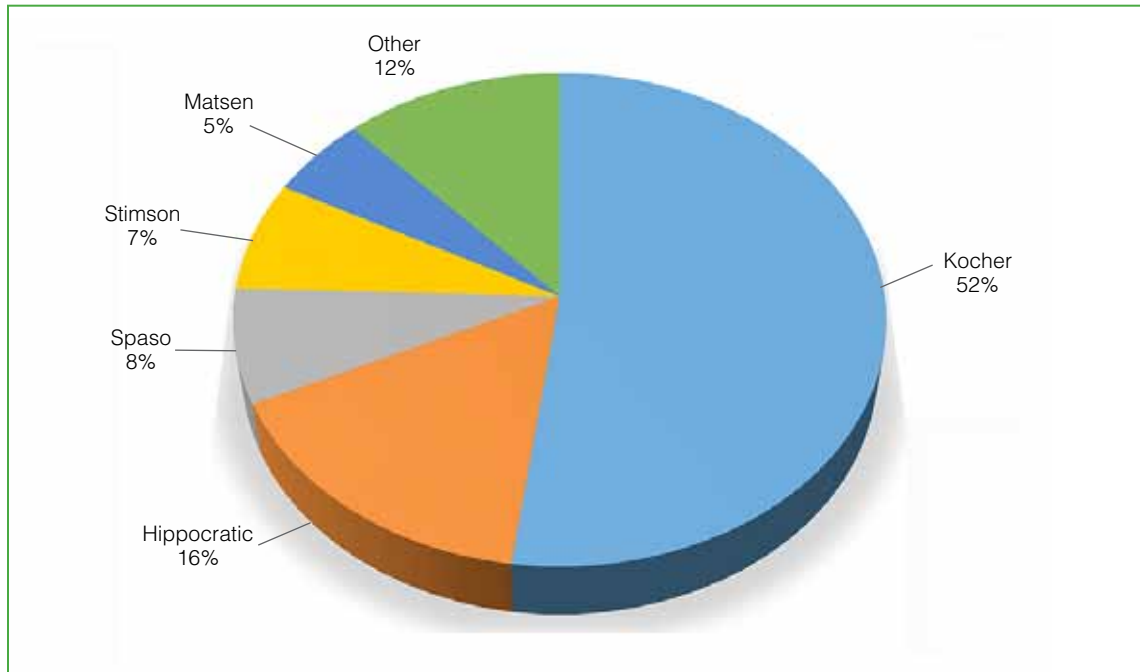


Figure 1. Maneuvers used in a first episode of anterior inferior glenohumeral dislocation. The most used maneuver was Kocher's (52.2%).

No statistically significant differences were found between the use of anesthesia and the work environment. 30.5% of those who work in the private sector and 26.8% of those in the public sector use it ($p = 0.594$).

Faced with a failure in the initial reduction, 20.8% would repeat the initial maneuver, 49.3% would use another reduction maneuver, 29.5% would administer anesthesia if it had not been used previously, and 0.4% would perform an open reduction for the second reduction attempt.

Among those who would use another maneuver for the second attempt, 34.3% would use the Kocher maneuver; 19.6%, the Hippocratic method; 13.7%, Stimson; 10.8% Milch; 7.8%, the Spaso maneuver; 6%, traction/counter-traction and, in lower percentages, the FARES, Mothes, and other techniques.

13.8% of the participants reported having had complications related to the reduction of an AIGHD. Complications are detailed in [Figure 2](#). 44.1% mentioned that they occurred with the Hippocratic maneuver; 39%, with the Kocher maneuver; 10.2%, with the Milch maneuver and 6.8%, with other methods. There was no statistically significant difference between the type of complications reported and the maneuvers performed ($p = 0.835$).

Regarding the position chosen for immobilization after reducing an AIGHD, 74.8% immobilized the patient in adduction and internal rotation; 23.3%, in adduction and neutral rotation, while 4.4% used another unspecified position.

[Figure 3](#) shows the immobilization time indicated by the respondents. No statistically significant differences were found between the degree of specialization and the immobilization position or the indicated immobilization times ($p = 0.227$ and $p = 0.873$, respectively).

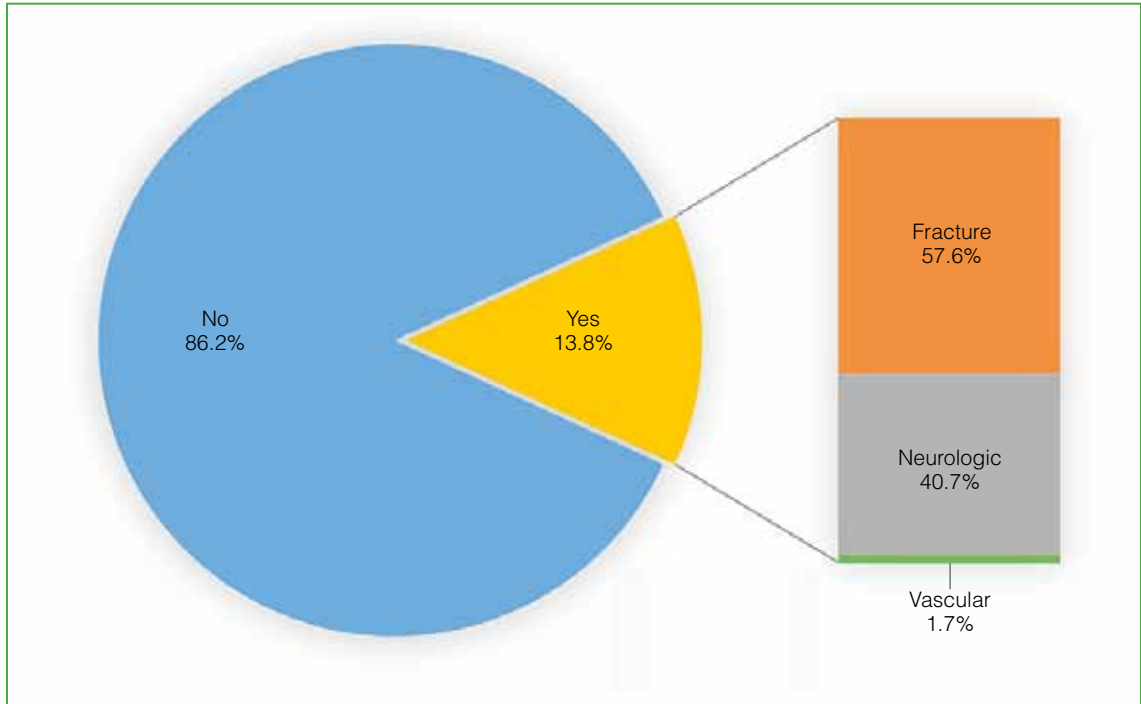


Figure 2. Percentage of respondents using anesthesia and type of anesthesia administered.

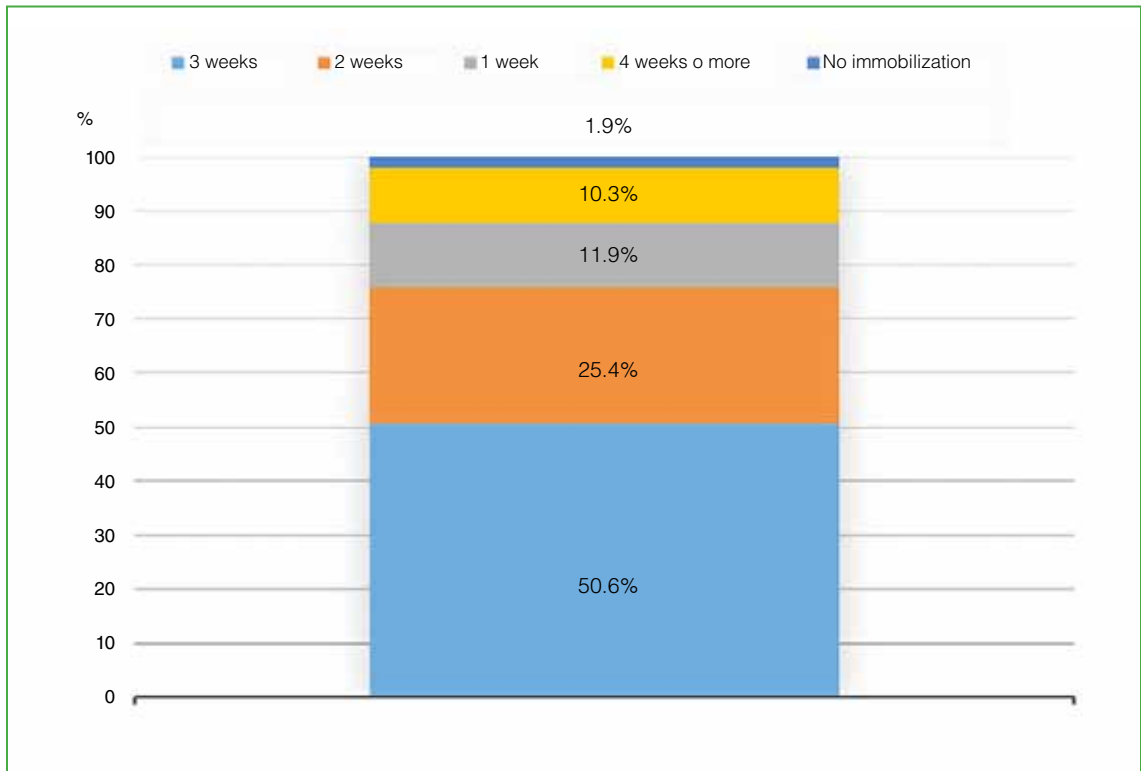


Figure 3. Use of anesthesia according to the degree of specialization. The differences between the groups were statistically significant ($p = 0.046$).

DISCUSSION

The survey revealed that, among traumatologists/residents of the Argentine health system, the maneuvers used to reduce an AIGHD are very varied. Most of those surveyed initially resorted to the Kocher maneuver, probably because they considered that it had the highest success rate. Numerous articles have been published on the effectiveness and efficiency of the different maneuvers.^{10,12-15}

In 2017, Alkaduhimi et al. published a systematic review comparing pain, hospital stay, and success rate of classic maneuvers. The reduction success rate was 28% with the Stimson maneuver, 80% with the Milch maneuver, 85% with the Kocher maneuver, 92% with the Spaso and FARES techniques, 95% with traction/counter-traction, and 97% with scapular manipulation. The authors concluded that the scapular manipulation maneuver should be used as the first choice followed by the FARES technique.¹⁶

Position and immobilization time after reduction remain controversial. Even the need to immobilize has been questioned. The immobilization position used by 76.3% of those surveyed is in adduction and internal rotation. An immobilization time of three weeks was chosen by the majority.

Based on a study with 226 patients, Kiviluoto et al. reported that, after the first episode of AIGHD, the rate of a new dislocation was higher in patients immobilized for one week, compared with those immobilized for three weeks.¹⁷ In contrast, Hovellius et al. published a prospective multicenter study in which they evaluated 247 patients immobilized in internal rotation, and found no correlation between immobilization time and recurrence after a 10-year follow-up.¹⁸

Heidari et al. reported that abduction and external rotation reduced the risk of redislocation when compared to internal rotation; however, compliance rates were significantly lower in the external rotation group, due to more difficulty going through doors, sleeping, and risk of trauma.¹⁹

Based on a literature review available up to 2007, Itoi et al. concluded that immobilization in external rotation reduces the risk of AIGHD recurrence compared to immobilization in internal rotation.²⁰ These results were confirmed by Murray et al. in 2018, who maintain that immobilization in external rotation significantly improved the healing of soft tissue injuries (Bankart injury).²¹ In contrast, Gutkowska et al. stated that immobilization in external rotation at 10-20° vs. adduction and internal rotation is not superior to pure internal rotation.²²

In a prospective, randomized study of 30 patients in 1995, Matthews et al. determined that intra-articular anesthesia with lidocaine is a safe and effective method, contributing to successful positioning with less pain and fewer side effects than sedation (respiratory depression, nausea and vomiting).²³ These results were confirmed by Kosnik et al.,⁵ and Meyer et al.²⁴

79.2% of the physicians surveyed do not initially use anesthesia for the first closed reduction attempt, and only 29.5% use anesthesia for a second attempt when reduction is not achieved with the initial maneuver.

There is a significant difference in the application of anesthesia ($p = 0.046$) between residents and specialists. Only 12.1% of the resident doctors use anesthesia to perform the reduction, while 43.3% of the group of specialists in shoulder surgery do administer anesthesia for the first reduction attempt. Contrary to the evidence available to date, if they choose to use anesthesia for reduction, 78% of the sample choose sedation or general anesthesia instead of an intra-articular local anesthetic. The latter option has similar efficacy, lower cost, a lower complication rate, and requires a shorter hospital stay.^{5,23-25}

The main limitations of this study are: not knowing the number of traumatologists and residents who work in emergency services and the low number of responses by resident doctors.

To our knowledge, this is the first epidemiological study related to the behavior adopted in the initial treatment of a first episode of AIGHD in Argentina.

CONCLUSIONS

The methods used for the reduction of the first episode of AIGHD are highly variable. There is a relationship between the level of specialization and the use of anesthesia. We highlight the importance of reconsidering the use of anesthesia, and we suggest intra-articular anesthesia as the first option. We propose to modify behavior and use intra-articular local anesthesia, because the complication rate and costs are lower, and the hospital stay is shorter than with sedation and general anesthesia.

As a future line of research, we propose to carry out a prospective study to compare the efficiency, economic cost, and complications of AIGHD reduction between intra-articular anesthesia and sedation and general anesthesia.

This study provides a framework for establishing guidelines aimed at reducing first-episode AIGHD, and outlines areas that lack consensus and require further study.

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Appendix

ORIGINAL SURVEY

Choice for the reduction of an Anterior Inferior Glenohumeral Joint Dislocation (AIGHD).

This questionnaire is anonymous.

Estimated duration: 3 minutes.

Aimed at traumatologists and residents/interns of traumatology and orthopedics who practice in Argentina.

1. You are a... * (Check only one.)

- Resident/Intern Physician
- Traumatologist

2. When did you complete your medical degree? * (Check only one.)

- Less than 5 years ago
- Between 5 and 15 years ago
- More than 15 years ago

3. In what field do you work? * (Check only one.)

- Public
- Private
- Both

4. Facing a first episode of AIGHD. What is the maneuver you usually use for reduction? *

(Check only one.)

- Kocher
- Stimson
- Hippocratic
- Spaso
- Milch
- FARES
- Scapular manipulation
- Other

5. Do you use anesthesia to perform this maneuver? * (Check only one.)

- YES (Skip to question 7)
- NO (Skip to question 8)

6. What type of anesthesia do you use? * (Check only one.)

- Intra-articular local anesthesia
- Sedation or general anesthesia

7. Given the failure of the first attempt to achieve the reduction, what would be your second option? (Check only one.)

- Repeat the previous maneuver (Skip to question 10.)
- Choose another maneuver (Skip to question 9.)
- Use anesthesia if I have not used it previously (Skip to question 10.)
- Open reduction (Skip to question 10.)

8. The second choice maneuver is: * (Check only one.)

- Kocher
- Stimson
- Hippocratic
- Spaso
- Milch
- FARES
- Scapular manipulation
- Other:

9. Have you ever had any complications related to the reduction of an AIGHD? * (Check only one.)

- Yes (Skip to question 11.)
- No (Skip to question 13.)

10. With which of the maneuvers have you had any complications? * (Select all that apply.)

- Kocher
- Stimson
- Hippocratic
- Spaso
- Milch
- FARES
- Scapular manipulation
- Other:

11. What type of complication have you had? * (Check only one.)

- Neurological
- Vascular
- Fracture
- Other:

12. What position for immobilization do you typically choose after reduction of an anterior inferior glenohumeral joint dislocation? * (Check only one.)

- Adduction and internal rotation
- Adduction and neutral rotation
- Other

13. After reduction. How long do you immobilize the patient? * (Check only one.)

- 1 week
- 2 weeks
- 3 weeks
- 4 weeks or more
- I do not immobilize

Thank you!

Nerve Transfers for Elbow Flexion in Traumatic Brachial Plexus Injuries

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ABSTRACT

Objective: To evaluate the results of different nerve transfers used for elbow flexion in patients with traumatic brachial plexus injury. **Materials and Methods:** Between April 2012 and January 2019, 13 patients (12 men) with traumatic brachial plexus injury underwent surgery. 5 patients had total paralysis and did not recover, 4 had total paralysis and partially recovered the lower trunk, and 4 had high paralysis. The nerve transfers performed for elbow flexion were: 3 intercostal nerves with a sural graft to the musculocutaneous nerve or its motor branch(es) (4 patients), 3 intercostal nerves to the musculocutaneous nerve without graft (3 patients), the accessory spinal nerve to motor branches of the musculocutaneous nerve with sural graft (2 patients), fascicles of the ulnar nerve to the motor branch of the biceps (3 patients) and fascicles of the ulnar nerve and fascicles of the median nerve to the motor branches of the biceps and anterior brachialis (3 patients). We assessed elbow flexion strength (M0-M5), pain on the visual analog scale, and DASH score. The average follow-up was 50 months. **Results:** Elbow flexion strength was M5 (1 patient), M4 (7 patients), M3 (1 patient), M2 (1 patient), and M1 (2 patients). The mean DASH score was 54.1 before surgery and 29.5 postoperatively. The preoperative pain score was 7 and 0.9 postoperatively. There were no complications. **Conclusions:** Nerve transfers achieved satisfactory outcomes for active elbow flexion reconstruction in patients with brachial plexus injury.

Keywords: Nerve transfers; elbow flexion; brachial plexus injury.

Level of Evidence: IV. Case report

Neurotizaciones para la flexión de codo en lesiones traumáticas del plexo braquial

RESUMEN

Objetivo: Evaluar los resultados de diferentes neurotizaciones utilizadas para la flexión del codo en pacientes con lesión traumática del plexo braquial. **Materiales y Métodos:** Entre abril de 2012 y enero de 2019, se operaron 13 pacientes (12 hombres) con lesión traumática del plexo braquial, 5 con parálisis totales sin recuperación, 4 con parálisis totales que recuperaron el tronco inferior parcialmente y 4 con parálisis altas. Las neurotizaciones para la flexión del codo fueron: 3 nervios intercostales con injerto sural a nervio musculocutáneo o su(s) rama(s) motora(s) (4 pacientes), 3 nervios intercostales a nervio musculocutáneo sin injerto (3 pacientes), nervio espinal accesorio a ramas motoras del nervio musculocutáneo con injerto sural (2 pacientes), fascículos del nervio cubital a rama motora del bíceps (3 pacientes) y fascículos del nervio cubital y fascículos del nervio mediano a ramas motoras del bíceps y braquial anterior (3 pacientes). Se evaluaron la fuerza de flexión del codo (M0-M5), el dolor con la escala analógica visual y se utilizó el puntaje DASH. El seguimiento promedio fue de 50 meses. **Resultados:** La fuerza de flexión del codo fue M5 (1 paciente), M4 (7 pacientes), M3 (1 paciente), M2 (1 paciente) y M1 (2 pacientes). El puntaje DASH promedio fue de 54,1 antes de la cirugía y 29,5 en el posoperatorio. El puntaje de dolor preoperatorio fue de 7 y de 0,9 posoperatorio. No hubo complicaciones. **Conclusiones:** Las neurotizaciones lograron resultados satisfactorios en la reconstrucción de la flexión activa del codo en pacientes con lesión del plexo braquial.

Palabras clave: Neurotizaciones; flexión codo; lesión plexo braquial.

Nivel de Evidencia: IV Serie de casos

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INTRODUCTION

Traumatic brachial plexus injuries are rare, but severely disabling. In adults, recovery from elbow flexion paralysis is the first goal of treatment, followed by functional recovery of the shoulder.¹⁻⁴

Multiple reconstruction methods are available, such as microsurgical procedures—which are preferred in early stages—tendon transfers, vascularized and reinnervated free muscle transfers, arthrodesis, osteotomies, tenodesis, and arthrolysis, among others, for which there is no time limit. Microsurgical techniques include neurolysis, neuroorrhaphy with or without graft, and nerve transfer. In nerve transfers, a redundant or “sacrificeable” donor nerve is sectioned and its proximal end is transferred to the distal end of an injured nerve, as close as possible to the muscle to be innervated (Figure 1). It is a nerve transfer from a functioning nerve to a more important denervated nerve, as long as the time elapsed since the injury does not exceed 12-16 months, since it is known that the best outcomes are obtained with procedures performed within the first five months.⁵ This is due to the fact that a muscle that does not receive its nervous stimulation, over time, suffers the degeneration and atrophy of its neuromuscular plates, which prevents its subsequent reinnervation.

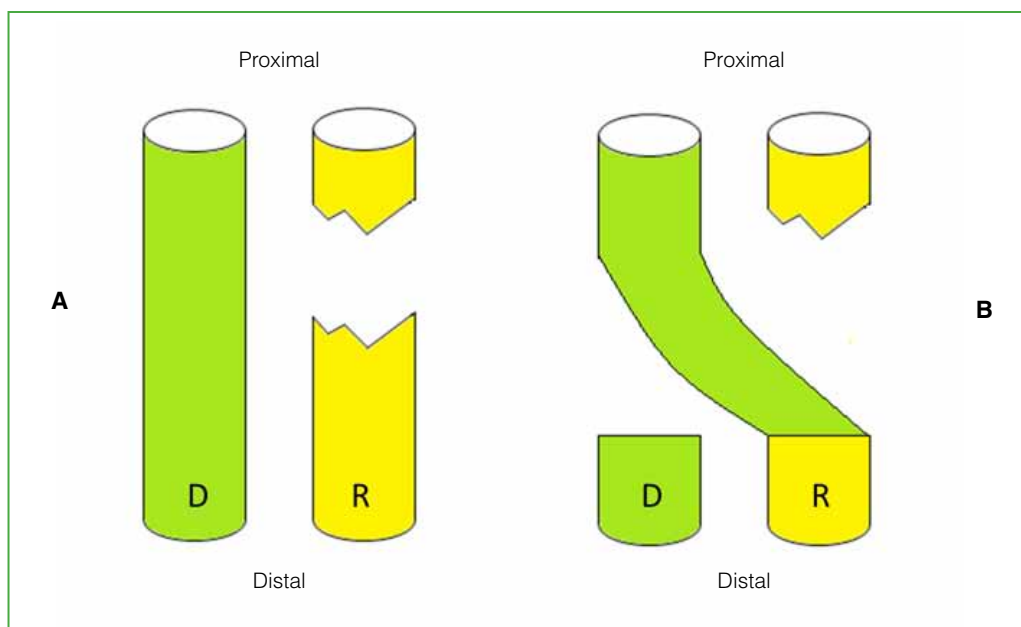


Figure 1. Diagram of a nerve transfer. **A.** Traumatic axonotmesis of the receptor nerve (R). **B.** Nerve transfer with donor nerve (D).

There are multiple possible nerve transfers for the shoulder, elbow or hand in the context of a brachial plexus injury. They can be categorized as extraplexus or intraplexus, depending on the donor nerve.

Extraplexus neurotizations include the transfer of a nerve outside the brachial plexus; the most commonly used are the intercostal, spinal accessory, and phrenic nerves. Intraplexus neurotizations are transfers of a functioning nerve component belonging to the brachial plexus. The transfer of fascicles of the ulnar or median nerve to motor branches of the musculocutaneous muscle for the biceps and anterior brachialis in high plexus injuries is widely used today. Another donor nerve used is the radial branch for the medial portion of the triceps for the axillary nerve.

The objective of this study was to evaluate the results of different neurotizations used to recover active elbow flexion in patients treated for traumatic brachial plexus injury.

MATERIALS AND METHODS

Between April 2012 and January 2019, 13 patients with traumatic brachial plexus injury underwent nerve transfers for elbow flexion, performed by the same surgeon, at three Centers. The patients were 12 men and a 10-year-old girl, and the average age at surgery was 26 years (range 10-44). The affected limb was the left in eight cases and the right in five patients (dominant limb in 38.4%). The palsies treated included five total brachial palsies that did not recover, four total palsies that partially recovered the lower trunk, and four upper palsies, two of them with partial recovery of the shoulder. The mechanism of the trauma was a traffic accident in 12 patients: motorcycle (10 patients), bicycle (1 patient), and car (1 patient). One patient had sustained direct trauma from falling on his shoulder into a eucalyptus tree trunk. The average time elapsed between trauma and surgery was 8.7 months (range 4-13). In 11 patients (85%), important associated traumatic pathologies were diagnosed (Table 1).

Table 1. Number of cases

Case	Age	Sex	Dominance	Limb	Type of paralysis	Associated injuries
1	25	M	Right-handed	Left	Total with partial recovery of finger flexion	Ipsilateral rib and clavicle fractures
2	21	M	Right-handed	Left	High	TBI with loss of consciousness
3	23	M	Right-handed	Left	Total	Nonunion of the clavicle and forearm (ulna and radius), ipsilateral leg <i>steppage</i>
4	28	M	Right-handed	Left	Total	Ipsilateral foot amputation
5	19	M	Right-handed	Left	Total	Open fracture of the ipsilateral humerus
6	23	M	Right-handed	Left	Total	TBI with loss of consciousness, seizures, mild cognitive sequela
7	33	M	Right-handed	Right	Total with full recovery of wrist and finger flexion	No
8	38	M	Right-handed	Right	Total with partial recovery of the ulnar, median and radial nerve	Fractures of the humerus and scapula, metacarpophalangeal dislocation (3, 4 and 5), fracture of the third ipsilateral metacarpal
9	21	M	Right-handed	Right	Total	TBI with loss of consciousness, fracture of the 1 st ipsilateral rib
10	44	M	Right-handed	Left	High	No
11	28	M	Right-handed	Left	Total with recovery of the ulnar nerve	Fractures of 4 ribs, scapula, open fracture dislocation of the ipsilateral elbow, contralateral brachial plexus palsy with spontaneous recovery in 3 months
12	10	F	Right-handed	Right	Total with partial recovery, shoulder abduction	Supracondylar fracture of the ipsilateral elbow
13	26	M	Right-handed	Right	Discharge with partial recovery, shoulder abduction	TBI with loss of consciousness, fracture of nasal bones and forearm bones

M = male, F = female, TBI = traumatic brain injury.

The nerve transfers used for the microsurgical reconstruction of elbow flexion were: three intercostal nerves with sural graft to the musculocutaneous nerve or its motor branch(es) for each case (4 patients), three intercostal nerves to the musculocutaneous nerve without graft interposition (1 patient), spinal accessory nerve to motor branches of the musculocutaneous nerve with sural graft (2 patients), motor fascicles of the ulnar nerve to motor branch of the biceps (simple Oberlin) (3 patients) and motor fascicles of the ulnar nerve and motor fascicles of the median nerve to motor branches of the biceps and anterior brachialis (double Oberlin) (3 patients). The fascicles of the ulnar nerve are used for the flexor carpi ulnaris muscle, whereas the median nerve fascicles are used for the palmaris longus. During surgery, the fascicles are electrostimulated to determine which ones predominantly innervate these muscles. The reconstruction techniques used were chosen individually, taking into account the different lesions of the patients, with different donor nerves available and also considering their associated conditions. As an example, three cases are shown, with different surgical techniques (Figures 2-4).

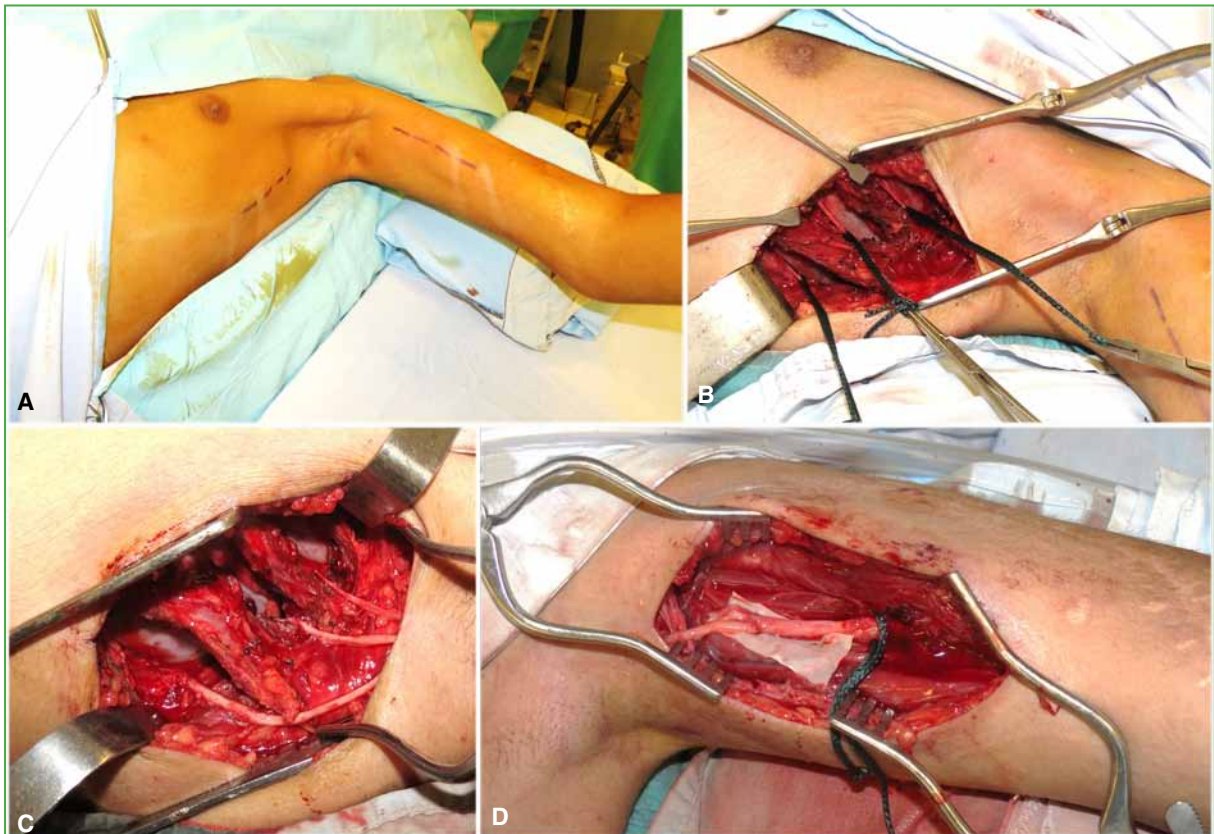


Figure 2. Nerve transfer of the motor branch of the biceps with three intercostal nerves with a sural graft. (Case 5). **A.** Presurgical markings and fields. **B.** Dissection of three intercostal nerves in the thorax. **C.** x3 Intercostal-sural neurorrhaphies. **D.** Neurorrhaphy of sural grafts to the motor branch of the biceps on the inner side of the arm.

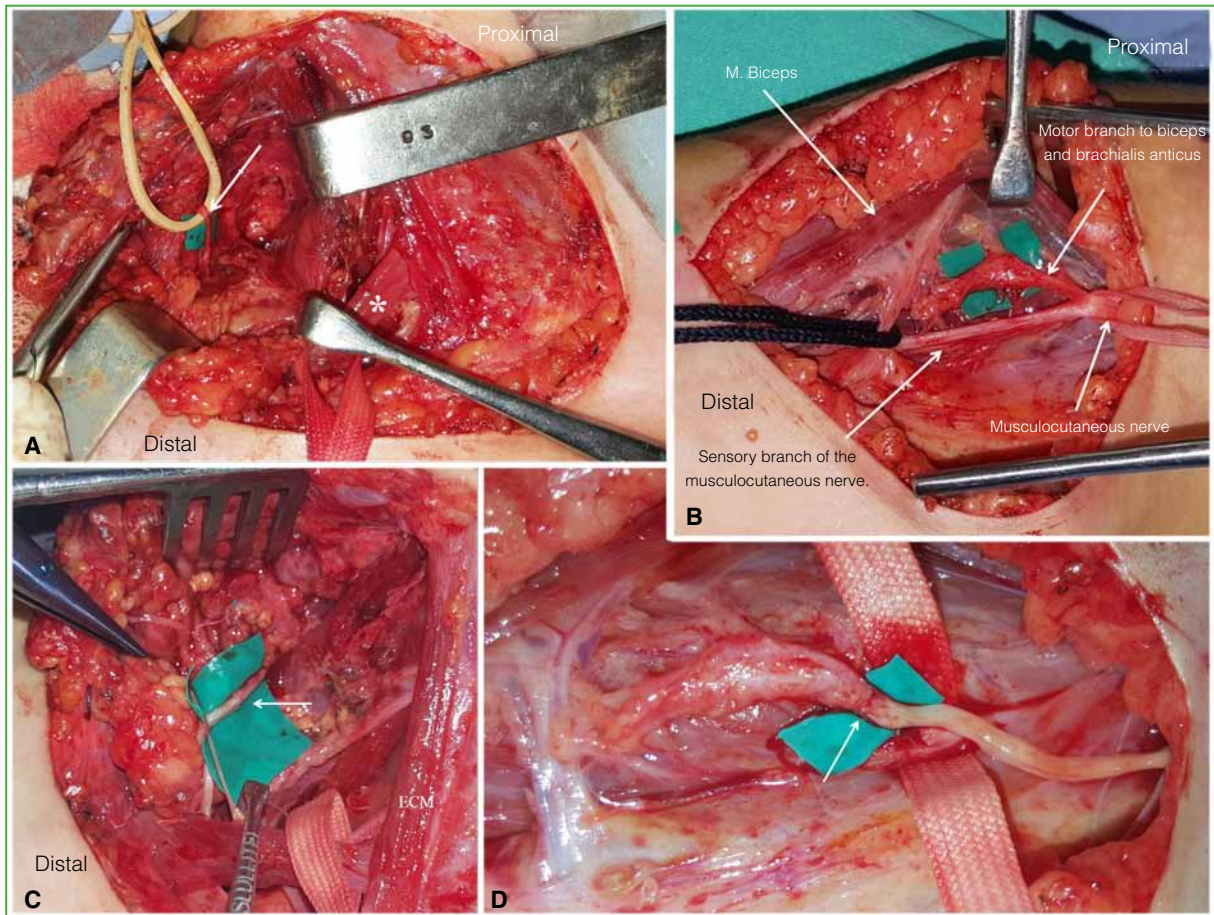


Figure 3. Neurotization of the motor branches of the musculocutaneous nerve with the spinal accessory nerve with a long sural graft (Case 12). **A.** Supraclavicular approach and dissection of the spinal accessory nerve (arrow). **B.** Dissection of the motor branches of the musculocutaneous nerve on the inner aspect of the arm. **C.** Neurotization of the spinal accessory-sural nerve (arrow) in the supraclavicular fossa. **D.** Sural graft neurotization to the motor branch of the biceps and anterior brachialis (arrow) on the inner aspect of the arm. *omohyoid muscle. SCM = sternocleidomastoid muscle.

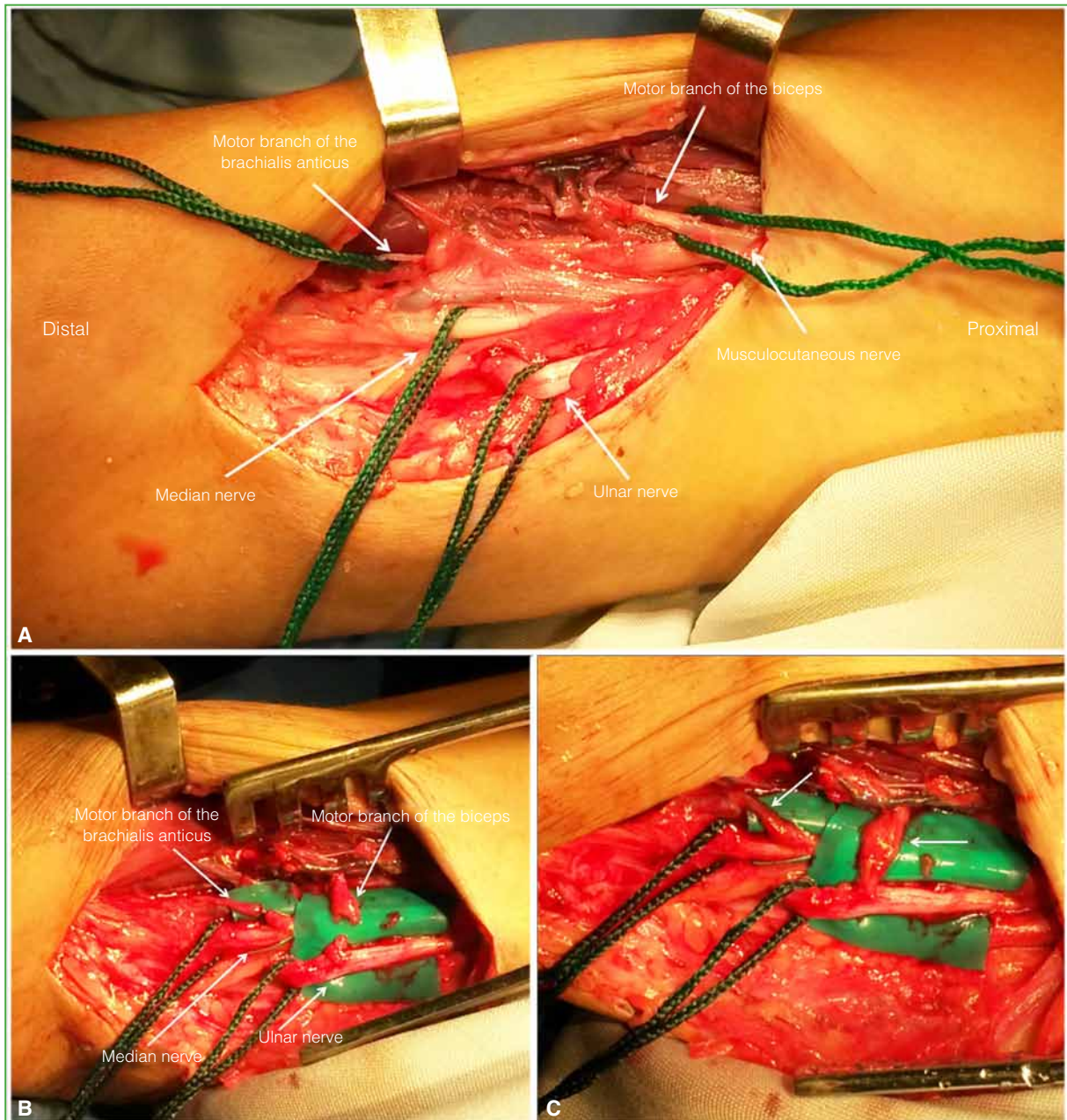


Figure 4. Neurotization of the motor branches of the biceps and anterior brachialis with motor fascicles of the ulnar and median nerves (Case 7). **A.** Approach to the inner aspect of the arm. **B.** Dissection of the motor fascicles of the ulnar and median nerves, and section of the motor branches of the biceps and anterior brachialis. **C.** Nerve transfers performed (arrows).

Although it is not the reason for this study, it is clarified that, for the shoulder, a supraclavicular neurolysis of the brachial plexus and a neurotization of the suprascapular nerve with an accessory spinal nerve were performed in seven patients.

The patients underwent rehabilitation protocols with physical therapy or occupational therapy according to their condition and the surgical technique used. In the first four weeks, movements that put the nerve sutures at risk were avoided, but the remaining joints were mobilized and treatment for pain, edema, and scarring was administered. After the first month, full passive range of motion was allowed and strengthening of the muscle group correspond-

ing to the transferred nerve(s) started, e.g. sit-ups and inspiratory exercises to strengthen the intercostal muscles. When observing the first sign of reinnervation of the elbow flexors, the muscle re-education phase began. This muscle strengthening is associated with active assisted flexion of the elbow, taking into account that the contraction of the reinnervated muscle begins with the contraction of the muscle corresponding to the donor nerve. In the case of neurotization using motor fascicles of the ulnar nerve for the biceps, the contraction of this muscle will be activated by flexing the wrist in ulnar deviation. As months go by, the loads and the repetitions of the exercises are increased and the cortical neuroplasticity of the patients will be able to make the flexion of the elbow independent of the contraction of the muscle corresponding to the donor nerve. That is, in the example above, the patient will be able to actively flex their elbow without needing to flex their wrist.

All patients underwent a subjective evaluation with the DASH score. (*Disabilities of the Arm, Shoulder and Hand*)⁶ and the visual analog scale (VAS) for pain before surgery and at the last control. Elbow flexion strength was assessed using the British *Medical Research Council* M0-M5 scale.⁷ Case 10 was excluded from the study, because the follow-up was shorter than one year, due to the loss of contact due to living in another province and lack of connectivity. The average follow-up of the remaining cases was 50 months.

RESULTS

In the last evaluation, the elbow flexion strength showed that the 10-year-old girl obtained an M5 value; seven patients had an M4 value; one patient, M3; one patient, M2; and two patients, M1. We consider satisfactory values to be those \geq M3, that is, those that manage to flex the elbow against the force of gravity, as has been established internationally.⁸ Nine patients (75%) obtained this result. The mean DASH score was 54.1 preoperatively and 29.5 postoperatively. The VAS score was 7 before the intervention and 0.9 at the last control. The reconstruction method used and its individual functional evaluation are shown in [Table 2](#).

The only complication occurred in the patient with nerve transfer of the intercostal musculocutaneous nerve without grafts, who suffered dehiscence of the wound in the armpit and was adequately treated with Irujol[®] ointment.

There were no pleural lesions during intercostal graft harvesting, nor neural pain or motor or sensory complications related to donor nerve territories.

DISCUSSION

Traditionally, in brachial plexus reconstruction, direct nerve repair with or without nerve grafts led to poor outcomes due to the long distances that axonal regeneration must travel after neurorrhaphy, which implies a longer time than the reinnervation potential of muscle motor plates, which is estimated at 12-18 months.⁹ Under these circumstances, neurotizations allow the regeneration distance between viable proximal motor axons and distal motor endplates to be reduced, thus achieving faster reinnervation and, in most cases, better functional outcomes.

In addition, it is very common for brachial plexus injuries to be directly irreparable, from a technical point of view. Such is the case of root avulsions in which there is no proximal nerve ending that can be sutured.

Another possible scenario is patients who could not undergo direct neurorrhaphy within the indicated time, due to delays in the specialized consultation or other injuries, and functional recovery is no longer possible. In our field, it is common for patients to consult with delay for the resolution of their paralysis, as they have already been evaluated in one or several Centers that do not have the technical possibility of microsurgical treatment and the referral is often late. In the case series presented, 54% (7 patients) underwent surgery after 10 or more months of evolution.

Direct repair at sites adverse to nerve regeneration, such as areas with loss of skin coverage, infection, or vascular injury, will also not be successful.

There is another advantage of nerve transfers. When the goal is to recover motor function, neurotization of pure motor axons to a motor nerve is more likely to achieve the desired function than coaptation of a mixed (motor-sensory) nerve to the mixed distal end. In addition, in neurotizations, nerve grafts are less frequently needed than in traditional neurorrhaphy.

In summary, the basic indication for nerve transfers is injuries in which direct repair is not possible or in which it is, but functional recovery with direct repair or nerve grafting is unlikely.⁹

Table 2. Technique used and outcomes

Case	Elbow reconstruction	Trauma-surgery time (months)	Flexion strength of the elbow	DASH Preoperative period:	final DASH	VAS (preoperative)	VAS (final)	Follow-up (months)
1	3 intercostals with sural graft	10	4	52.5	28.3	4	1	111
2	Ulnar fascicles to biceps branch	11	4	40.8	15	6	0	103
3	3 intercostal nerves without graft to musculocutaneous	11	1	57.8	30.8	7	0	19
4	3 intercostals with sural graft	10	4	53.3	32.5	10	2	25
5	3 intercostals with sural graft	13	4	52.4	29.1	9	0	93
6	Accessory spinal nerve with sural graft	13	3	46.7	23.8	2	0	36
7	Fascicles from the ulnar to the biceps branch and from the median to the anterior brachial branch	6	4	71.7	36.7	9	0	17
8	Ulnar fascicles to biceps branch and median nerve to anterior brachial branch	6	1	63.9	43.3	8	4	58
9	3 intercostals with sural nerve grafts	4	2	61.7	32.3	10	2	40
10	Ulnar fascicles to biceps branch	6	No	No	No	No	No	Insufficient
11	Ulnar fascicles to biceps branch	10	4	55.7	29.1	6	0	47
12	Accessory spinal nerve with sural graft	6	5	38.6	26.8	9	0	28
13	Median nerve fascicles to biceps branch and ulnar fascicles to anterior brachialis branch	8	4	55	27.2	5	2	27

DASH = *Disabilities of the Arm, Shoulder and Hand*, VAS = *Visual Analog Scale*

The results obtained in our series to achieve elbow flexion with nerve transfers were adequate and within what was expected, according to the literature. In the meta-analysis by Merrell et al.,⁸ 71% of M3 strength or more was observed with neurotizations for elbow flexion, regardless of the donor nerve; the two most used nerves were the intercostal nerves and the spinal accessory nerve. Better outcomes can be expected with intraplexus neurotization with motor fascicles of the ulnar nerve (Oberlin), with which 97% of M3 strength or more is achieved.^{10,11} The functional recovery time of the biceps is shorter than with any other neurotization. This is its biggest advantage. This is because the transfer is carried out very close to the muscle to be reinnervated and without graft interposition. Therefore, the procedure is especially useful for patients who, for whatever reason, are being treated more than six months post-injury.

In 2002, Humphreys and Mackinnon¹² described a double fascicular transfer technique for elbow flexion. It involves the nerve transfer of the motor branches of the biceps and the anterior brachialis with redundant fascicles of the ulnar and median nerves, without the need to interpose a nerve graft. In this way, the brachialis anterior adds to the flexion force provided by the biceps. Regarding the outcomes, there are authors¹³⁻¹⁵ who ratify the superiority of double nerve transfer compared to single transfer of the motor branch of the biceps; however, others find no functional difference between the two techniques.^{16,17}

The limitations of this study are its retrospective design, with a modest number of patients, given that a rare pathology is being evaluated. For this reason, it is not possible to perform a statistical analysis with sufficient power to establish definitive treatment guidelines.

CONCLUSION

In our series, nerve transfers were valid and reliable options in the reconstruction of active elbow flexion in patients with traumatic injury to the brachial plexus, with a low rate of complications.

Conflict of interest: The authors declare no conflicts of interest.

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Osteosynthesis of Complex Fractures of the Distal Humerus. Our Experience

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ABSTRACT

Objective: To describe the results obtained in the treatment of distal humerus fractures by open reduction and internal fixation (ORIF) and to reflect whether the approach used had an impact on the functional outcome. **Materials and Methods:** We carried out a retrospective case study of 19 patients with a diagnosis of complex distal humerus fracture who were treated with ORIF from 2015 to 2021. Periodic radiographic controls were performed and the functional outcome was evaluated using internationally known scales such as the DASH and Mayo Elbow performance Score (MEPS), then the variables obtained were extrapolated using statistical software. **Results:** A 100% consolidation rate was achieved; in 7 patients (37%), the Alonso Llamas approach was used and in 12 cases (63%), we performed an olecranon osteotomy. The average DASH was 11.31, which determined mild disabilities. The MEPS obtained was excellent in 1 patient (5.26%), good in 10 (52.6%), fair in 7 (36.84%), and poor in 1 (5.26%). When comparing the results obtained through the different approaches a $P = 0.4197$ was obtained in the ANOVA test and $P = 0.4723$ in the Mann-Whitney/Wilcoxon Two sample Test. **Conclusions:** We conclude that ORIF is effective in the treatment of complex fractures of the distal humerus, allowing the surgeon to obtain good post-surgical results. In this series, the average DASH was 11.31, with excellent and good results in 57% of the patients. We found no statistically significant difference regarding the choice of one approach or the other.

Key words: Osteosynthesis; distal humerus fracture; Alonso Llamas; olecranon osteotomy.

Level of Evidence: IV

Osteosíntesis de fracturas complejas de húmero distal. Nuestra experiencia

RESUMEN

Objetivo: Describir los resultados obtenidos en el tratamiento de las fracturas de húmero distal mediante reducción abierta y fijación interna y reflejar si el abordaje empleado tuvo impacto en el resultado funcional. **Materiales y Métodos:** Se llevó a cabo un estudio retrospectivo de presentación de casos. Se evaluó a 19 pacientes con diagnóstico de fractura de húmero distal compleja tratados con reducción abierta y fijación interna entre 2015 y 2021. Se realizó un control radiográfico periódico y se evaluó el resultado funcional mediante escalas internacionales, como DASH y MEPS. Luego se procedió a extrapolar las variables obtenidas utilizando un programa estadístico. **Resultados:** Se logró la consolidación de todas las fracturas. Se empleó el abordaje de Alonso Llamas en 7 pacientes (37%) y la osteotomía de olécranon en 12 casos (63%). El puntaje DASH promedio fue de 11,31, lo que determinó discapacidades leves. El puntaje MEPS obtenido fue excelente en un paciente (5,26%), bueno en 10 (52,6%), regular en 7 (36,84%) y pobre en 1 (5,26%). **Conclusiones:** La reducción abierta y la fijación interna son eficaces para tratar las fracturas complejas de húmero distal, permiten lograr buenos resultados posquirúrgicos. En esta serie, el 57% de los pacientes obtuvo resultados excelentes o buenos. No se halló una diferencia estadísticamente significativa con respecto a la elección de un abordaje u otro.

Palabras clave: Osteosíntesis; fracturas de húmero distal, Alonso Llamas; osteotomía de olécranon.

Nivel de Evidencia: IV

INTRODUCTION

Distal humerus fractures are infrequent injuries in our field, with a prevalence of 0.5% to 7%,^{1,2} and they represent 30% of elbow fractures. In young people, these injuries are usually due to high-energy trauma.^{1,2} In the elderly, often women, these injuries are considered low-energy and are generally due to a fall from their own height.

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96% of these fractures are of the CAO type,^{1,2} which translates into intraarticular compromise and disabling sequelae, even with adequate treatment. The complex local anatomy, bony comminution, osteoporotic bone, and lack of bone stock present the surgeon with multiple challenges in treating these fractures.

Anatomical reduction of the joint surfaces, restoration of the anatomical limb axes, and stable fixation allow for early range of motion, which is key to good surgical outcomes. Early range of motion is very important after open reduction and internal fixation, because the elbow joint capsule is very prone to scarring and prolonged immobilization is associated with poor outcomes.³

The objective of this study is to communicate the functional outcomes obtained with two approaches of choice to treat distal humerus fractures, evaluated with standardized scales, such as Disabilities of the Arm, Shoulder and Hand (DASH)⁴ and Mayo Elbow Performance Score (MEPS),⁵ and reflect whether the approach used had an impact on the postoperative functional outcome.

MATERIALS AND METHODS

A retrospective case report study was conducted. Between 2015 and 2021, 23 patients with a diagnosis of distal humerus fracture were treated in our Service through open reduction and internal fixation; three patients were lost to follow-up. Patients >18 years of age with a follow-up of >1 year and a diagnosis of type B and C distal humerus fracture were included. Patients <18 years old, with open fractures, history of surgery and malunions were excluded.

Records of 20 patients (6 women and 14 men, average age 44 years) were found. The injuries had been caused by traffic accidents and falls from their own height. Eight fractures involved the left elbow and 12 the right elbow. According to the AO/ASIF classification system, 18 were type C and two were type B. Before the injury, they all carried out their daily activities normally. One case in which the Kocher approach was used was not considered; therefore, the sample contained 19 patients (Table 1).

A Chevron olecranon osteotomy approach (Figure 1) was performed for fractures with intra-articular involvement and an Alonso Llamas triceps approach (Figure 2) for supracondylar fractures with minimal intra-articular involvement. The ulnar nerve was released and transposed, and plates were placed in both columns in an orthogonal and parallel arrangement, respecting the O'Driscoll criteria.⁶ All patients were treated by the same surgical team. In type C fractures, after nailing and reduction of the fragments, and once the intra-articular facet was restored, transverse cannulated screws were placed. For fixation of the olecranon osteotomy, different means of fixation were used (tension band, cannulated screws, Kirschner pins).

Description of the approaches used

Alonso Llamas: The patient is placed in the prone or lateral decubitus position. The injured arm is placed on a support that allows at least 90° of elbow flexion. A posterior midline incision is made between the medial and lateral brachial cutaneous nerves, curving laterally around the olecranon. The incision continues 5-8 cm distal to the tip of the olecranon. The fascia overlying the triceps brachii is identified, divided in the midline, and elevated with the dermis and subcutaneous tissue, creating two fasciocutaneous flaps. The dissection continues to the lateral and medial borders of the triceps at their respective interfaces with the posterior aspects of the intermuscular septa. In this way, the triceps muscle is separated from the posterior surface of the intermuscular septa. On the lateral aspect, the radial nerve and its concomitant vessels are identified passing from the posterior to the anterior compartment through the intermuscular septum approximately 10 cm proximal to the elbow.

The posterolateral humeral shaft is approached by elevating the triceps muscle from the posterior periosteum and retracting it medially. Distally and laterally, the dissection can be continued anterolaterally to the anconeus muscle, thus preserving its innervation and blood supply. Medially, the ulnar nerve is identified and exposed proximally in the posterior compartment. When a more proximal exposure of the humerus is required, the ulnar nerve can be followed further until it traverses the intermuscular septum from the anterior compartment.

Table 1. Study population data

Patient	Age	AO/ASIF Classification	Approach	DASH	MEPS
1	42	13C3.1	Olecranon osteotomy	9.16	Good
2	41	13C1.1	Olecranon osteotomy	3.33	Excellent
3	45	13C2.1	Olecranon osteotomy	4.54	Good
4	50	13C2.1	Olecranon osteotomy	13.33	Fair
5	23	13C2.1	Alonso Llamas	5.10	Good
6	48	13C3.3	Olecranon osteotomy	15	Fair
7	48	13C3.3	Olecranon osteotomy	10	Fair
8	38	13C2.1	Olecranon osteotomy	4	Good
9	36	13C2.2	Alonso Llamas	18.33	Fair
10	35	13C1.1	Alonso Llamas	4	Good
11	63	13C1.1	Olecranon osteotomy	1	Fair
12	86	13C1.1	Alonso Llamas	6.10	Good
13	28	13C1.1	Alonso Llamas	5.5	Good
14	50	13C2.3	Olecranon osteotomy	11	Fair
15	40	13C2.3	Olecranon osteotomy	76.6	Poor
16	40	13C1.1	Alonso Llamas	7	Good
17	36	13B3.1	Alonso Llamas	4.40	Good
18	54	13C3.3	Olecranon osteotomy	10.33	Fair
19	50	13C3.2	Olecranon osteotomy	6.33	Good

DASH = Disabilities of the Arm, Shoulder and Hand, MEPS = Mayo Elbow Performance Score.

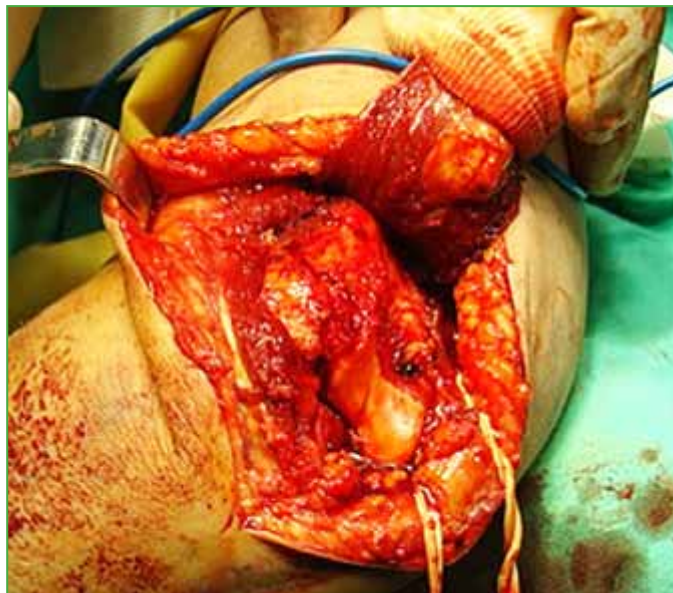


Figure 1. Approach with olecranon osteotomy.

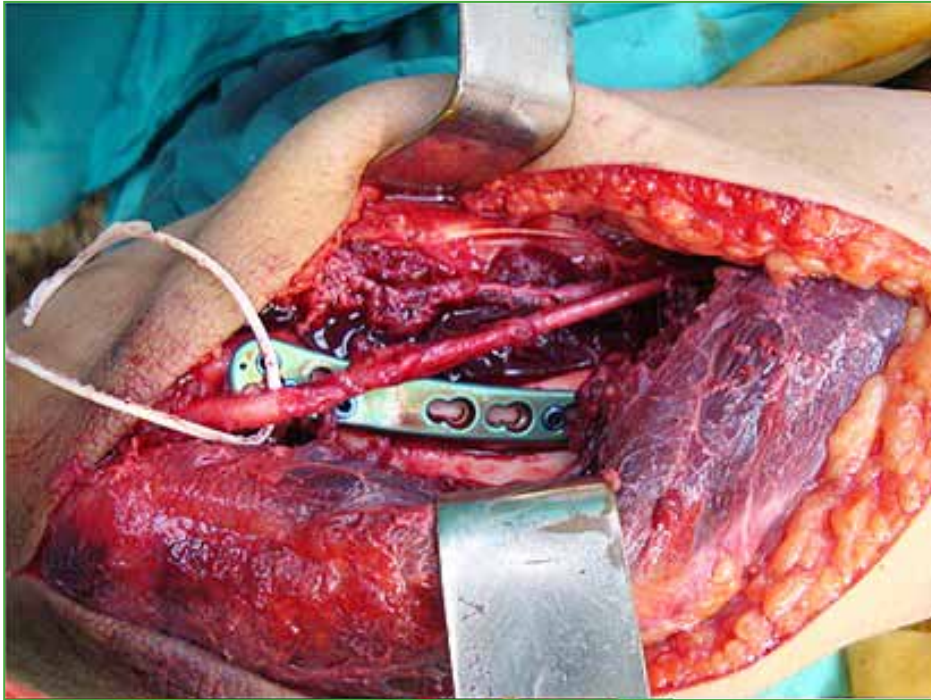


Figure 2. Alonso Llamas approach.

Olecranon osteotomy: It is carried out with the patient in ventral decubitus, with a bloodless field, through a “V” osteotomy of the olecranon, in its middle third. The posterior capsule is transected and the olecranon with the triceps muscle and posterior periosteum are lifted proximally, exposing the entire posterior aspect and the distal end joint of the humerus. Prior to olecranon osteotomy or medial column work, the ulnar nerve must be released, mobilized, and protected; once osteosynthesis is completed, the nerve returns to its anatomical position⁷ or is transposed.

A long arm cast is placed, with the elbow flexed at 90°, for the first five days after surgery. Then, the cast is removed to begin physical rehabilitation consisting of assisted passive range of motion exercises until the third week; assisted active range of motion exercises until the sixth week; active range of motion without restriction and without weight-bearing from the sixth to the eighth week; and strengthening and weight-bearing exercises from the eighth week (Figures 3 and 4).

Statistical analysis

Continuous variables are presented as median and interquartile range, and categorical variables are presented as proportions. The ANOVA test (parametric test for inequity in population medians) and the Mann-Whitney/Wilcoxon two-sample test were used to compare continuous variables. A p-value < 0.05 was considered statistically significant. The EPI Info program, version 7.2.5.0, was used for the statistical analysis.



Figure 3. Clinical case. Pre-surgical tomographic images showing a dislocated complex fracture of the distal humerus.



Figure 4. Clinical case. Post-surgical anteroposterior and lateral control radiographs. Reduction and osteosynthesis of a fracture of the distal humerus.

RESULTS

Of the 19 patients who followed treatment, 100% consolidation of fractures and osteotomies was achieved, without implant failure or material migration. The average consolidation time was 3.5 months, anatomical reduction was achieved in 8 patients; 9 were satisfactory and 2 were poor. In 7 patients (37%), the Alonso Llamas approach was used and, in 12 cases (63%), olecranon osteotomy.

The mean DASH⁴ score was 11.31 (range 1-76), indicating mild disabilities; the average DASH score of the patients with olecranon osteotomy was 13.7 and that of those with the Alonso Llamas approach, 7.20 (Table 2). The MEPS⁵ obtained was excellent in one patient (5.26%), good in 10 (52.6%), fair in seven (36.84%) and poor in one (5.26%) (Table 3). The average arc of extension and flexion was 21° (range 0-40°) to 125° (range 100-140°), pronation and supination were 75° (range 60-85°) and 68° (range 60-85°). 60°-80°), respectively.

After extrapolating the data obtained in the DASH functional scale, the statistical analysis of the variables was carried out using the EPI info tool of the CDC. When comparing the results obtained through the different approaches, a value of $P = 0.4197$ was obtained in the Anova test and a value of $P = 0.4723$ in the Mann-Whitney/Wilcoxon Two Sample Test. (Tables 4 and 5)

Table 2. Postoperative assessment with the DASH scale

	DASH mean \pm SD	Average
Alonso Llamas	5.50 \pm 5.00	7.204
Olecranon osteotomy:	9.58 \pm 20.25	13.718
Total	6.33 \pm 16.41	11.318

DASH = Disabilities of the Arm, Shoulder and Hand, SD = standard deviation.

Table 3. Postoperative assessment with the MEPS scale

MEPS	Frequency	Percentage
Excellent	1	5.26%
Good	10	52.63%
Fair	7	36.84%
Poor	1	5.26%

MEPS = Mayo Elbow Performance Score.

Table 4. ANOVA, parametric test for inequity in population median

VARIATION	SC	gl	MC	F-statistic
Between	187.5977	1	187.5977	0.6480
Within	4662.8275	17	274.2840	
Total	4850.4253	18		
p	0.4197			

Table 5. Mann-Whitney/Wilcoxon two-sample test (Kruskal-Wallis test for two groups)

Kruskal-Wallis H	0.5165
Degrees of freedom	1
p	0.4723

One patient had a late post-surgical infection with osteomyelitis that required the removal of the osteosynthesis material and infectious treatment, for which the consolidation and rehabilitation time was prolonged; this case had the worst post-surgical evolution with a DASH score of 76.6% and a poor MEPS.

Another patient presented signs compatible with neuropraxia of the ulnar nerve, but did not require other interventions, and evolved favorably, with complete restoration (Figure 5).

**Figure 5.** Clinical Case. Arc of motion 6 months post surgical treatment.

DISCUSSION

The goal of treatment of distal humerus fractures is to achieve anatomic reduction, with a stable and painless elbow. The surgeon must restore the complex local anatomy to achieve early and complete rehabilitation. The lack of bone stock and the osteoporotic bone make it technically difficult to achieve the objective.

The approach of choice for the resolution of complex fractures of the distal humerus is still a matter of controversy. Currently, there are multiple well-described approaches available to the surgeon, some of the most widely used are: Bryan Morrey, Alonso Llamas and olecranon osteotomy.³ In cadaveric studies, the percentage of exposed joint surface has been quantified and the olecranon osteotomy was found to be superior, most authors advocate the transolecranon approach in AO type C fractures.^{1,2,8,9,10} However, the functional outcomes associated with each approach remain uncertain.

In the systematic review by Ljungquist KL et al.,³ functional outcomes were reviewed in 133 published complex fractures of the humerus. The authors reported more complications and reinterventions associated with olecranon osteotomy, and concluded that, in the absence of a reference pattern of elbow functional outcomes and in the absence of studies, it is very difficult to recommend one technique over another, since no significant differences were found between one approach and the other.

In our series, the choice of the approach route focused on the involvement of the facet joint. Cases with intra-articular involvement were approached through an olecranon osteotomy, whereas patients with minimal involvement of the facet joint were approached through the paratricipital approach. More complications occurred in the olecranon osteotomy group related to ulnar union, but functional outcomes were satisfactory in most patients.

The management of the ulnar nerve is a subject of controversy, since many authors prefer transposition. In the meta-analysis by Shearin et al., it was concluded that ulnar transposition increased the risk of neuropraxia and the authors proposed in situ decompression as a routine method,¹¹ advising not to use medial plates when it is mechanically possible. In our series, there was only one case of ulnar neuropraxia that healed spontaneously, we routinely transposed the ulnar nerve.

Reduction and osteosynthesis with double plate is currently the most widely used method, some series report good to excellent outcomes in 65-100% of patients. The traditional method was to apply the plates perpendicular to each other at 90°, this has been challenged by the introduction of parallel column plates that use a medial and lateral configuration, and allow long screws to interdigitate distally, maximizing the stability of the columns.^{1,6,8,12,13} In the systematic meta-analysis by Xiaohan et al., it is argued that, although the orthogonal and parallel methods are effective in the treatment of distal humerus fractures, the times of fracture healing are better with the parallel method.¹

CONCLUSIONS

Technical advances and technological developments in materials such as new implant designs allow the surgeon to achieve good surgical outcomes in the treatment of distal humerus fractures.

The different approaches used have not had statistically significant differences in the functional outcome of the patients. We have noticed a longer healing time in patients treated with olecranon osteotomy, which we infer has to do with the healing of the ulna. This approach allowed the best exposure and visualization of the articular facet of the distal humerus, and although the Alonso Llames approach respects the extensor apparatus, it would be the choice in those fractures that do not compromise the joint.

The surgeon has multiple approaches to treat this pathology. According to our experience, the choice of approach should be the one he or she considers best for the resolution of the fracture. We conclude that the transolecranon approach should be the choice in those fracture lines that present compromise of the articular facet, relegating the tricipital approach to cases without joint compromise.

Conflict of interest: The authors declare no conflicts of interest.

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Olecranon Fracture. A New Therapeutic Alternative

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ABSTRACT

Objective: Displaced olecranon fractures mostly require surgical fixation. The most commonly used techniques are tension band wiring and plate fixation, but they are associated with high rates of discomfort due to soft tissue irritation. An alternative surgical option is fixation with high-strength sutures with intramedullary screws. The aim of this study is to evaluate the range of motion, bone healing and complications using this technique. **Materials and Methods:** Six patients with type IIA fractures with an average age of 43 years (range 24-60 years) treated with high strength suture and intramedullary screw between January 2020 - April 2021 were included. Post-operative range of motion, bone healing and complications were evaluated. All were evaluated up to 6 months postoperatively. **Results:** At the 6th postoperative month, the average flexion was 143° (range 90°-160°), average extension 19° (0°-55°), there was bone healing in 5 patients, and 1 nonunion with joint stiffness (complication 16.6%). There were no second surgeries. **Conclusion:** Simple displaced olecranon fractures treated with high-strength suture with intramedullary screws is a simple, reproducible and economical technique since it does not require a second surgery, as is the case with traditional fixation methods for this pathology. **Keywords:** Olecranon fracture; high strength suture; intramedullary screw.

Level of Evidence: IV

Fractura de olécranon. Nueva alternativa terapéutica

RESUMEN


Introducción: Las fracturas de olécranon desplazadas mayoritariamente requieren de fijación quirúrgica. Las técnicas más usadas son las clavijas con alambre en 8 y las placas anatómicas, pero están asociadas a altas tasas de insatisfacción por irritación de las partes blandas. Una nueva opción quirúrgica es la fijación con suturas de alta resistencia y tornillo canulado. El objetivo de este estudio fue evaluar los rangos de movilidad, la consolidación ósea y las complicaciones utilizando esta técnica. **Materiales y Métodos:** Se presenta a 6 pacientes con fracturas tipo IIA y un promedio de la edad de 43 años (rango 24-60) tratados con suturas de alta resistencia y tornillo canulado intramedular entre enero de 2020 y abril de 2021. Se evaluó el rango de movilidad posoperatorio, la consolidación ósea y las complicaciones. Todos fueron evaluados hasta el mes 6 posoperatorio. **Resultados:** A los 6 meses de la cirugía, el promedio de flexión fue de 143° (rango 90°-160°) y la extensión promedio, de 19° (0°-55°). Se logró la consolidación ósea en 5 pacientes y hubo un retraso de la consolidación con rigidez articular (complicación 16,6%). No hubo segunda intervenciones. **Conclusión:** La fijación con suturas de alta resistencia y tornillo canulado para las fracturas simples desplazadas de olécranon es una técnica simple, reproducible y económica, ya que no necesitaría de segunda intervenciones, como sí sucede con las fijaciones tradicionales.

Palabras clave: Fractura; olécranon; sutura de alta resistencia; tornillo canulado intramedular.

Nivel de Evidencia: IV

INTRODUCTION

Olecranon fractures represent 10% of upper limb fractures, and the most frequent is type IIA of the Mayo Classification.^{1,2} These occur as a result of a direct (impact on the dorsal aspect of the olecranon) or indirect traumatic mechanism (impact of the humeral trochlea in the greater sigmoid cavity of the ulna during a fall with the elbow in extension added to triceps traction).³ Although there are grounds for conservative treatment in elderly patients with low demand, these fractures are typically surgically resolved.⁴ Multiple surgical options have been described

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for the treatment of olecranon fractures (tension band wiring, anatomical plates, cannulated intramedullary screws alone or with wire, intramedullary nails, and tension band with sutures only).⁵⁻⁷ All of these fixation methods result in anatomic reduction, restoration of the range of motion, and fracture union.

Tension band wiring and anatomical plates are the most widely used therapeutic options for simple displaced type IIA fractures.² Tension band wiring converts triceps distraction forces into compression at the articular surface (tension band principle), with excellent functional outcomes similar to those achieved by absolute reduction with anatomical plates. However, both methods are associated with several complications (prominence of the material, discomfort, pin or wire discomfort, pain, bursitis, infection) which raises the reoperation rate to 46-65%.⁸ The skin and subcutaneous tissue are thin at the proximal end of the ulna and cause soft tissue irritation, requiring implant removal in 68-82% of patients.⁹⁻¹¹ So, it is imperative to reduce these complications. Biomechanically, polyester and polyethylene sutures have similar strength to wire,¹² and cannulated screws are generally used for olecranon osteotomies.^{13,14} Therefore, the combined use of high-strength sutures with an intramedullary screw provides satisfactory stability without soft tissue irritation, greatly reducing the reoperation rate. These combined methods were only reported in cadaveric studies¹² and in olecranon osteotomies for distal humerus fractures.¹⁵

The objective of this case series study was to evaluate functionality, bone consolidation and complications in type IIA olecranon fractures treated with this new technique of high-strength sutures and cannulated screw.

MATERIALS AND METHODS

A retrospective study was carried out that included patients with non-comminuted displaced olecranon fractures type IIA of the Mayo Classification, between January 2020 and April 2021. Diagnosis was made with anteroposterior and lateral radiographs. Patients with extra-articular fractures, fractures combined with a forearm fracture, comminuted fractures, fractures treated conservatively, and fractures treated with tension band wiring or anatomical plates were excluded. Considering these inclusion criteria, six patients with type IIA fracture were identified who were treated with high-strength sutures plus intramedullary partial-thread cannulated screw with a 6.5-mm washer. All were operated on by the same surgeon.

Surgical technique

The patient is under general anesthesia in the supine position with a hemostatic cuff. A posterior approach is used for open reduction and internal fixation (incision 3 cm superior from the proximal end of the olecranon to approximately 4 cm distal to the fracture). The curettage of the fracture focus and its reduction with instruments are performed. The intramedullary guide pin is placed in the proximal ulna, then intramedullary reaming is performed with a 4.5-mm cannulated drill (from the superior aspect of the transtricipital olecranon toward the medullary canal, approximately 8-10 cm). Next, 4 cm distal to the fracture site, a hole is made with a 2.0 mm wick or pin in the posterior cortex of the ulna, from side to side, in a transverse trajectory. The high-strength sutures are inserted through said hole and a figure-of-eight suture is made at the level of the fracture, passing the sutures proximally below the triceps at its distal insertion. The fracture is again reduced with instruments to tie the closure and tension knots with the high-strength sutures. Subsequently, the 6.5 mm partially threaded cannulated screw with a washer is placed to increase the compression of the fracture site. Its length will be decided taking into account that all the threads of the cannulated screw must pass the fracture line and the width of the medullary canal from the proximal ulna distally to the fracture site (about 80-100 mm) to achieve a stable fixation. Finally, the end of the cannulated screw with its washer is covered with soft tissue to prevent future irritation of the subcutaneous cellular tissue. The entire procedure is carried out and controlled by radioscopy (Figure 1). (Video ►)

Patients begin functional rehabilitation early, without immobilization of the elbow in the immediate postoperative period. They are allowed passive and active functional motion, but without load or force until week 6 after surgery. Clinical follow-up is carried out at weeks 2, 6 and 10, evaluating the postoperative range of motion, bone consolidation by means of radiographs, and the presence of complications.

The data were collected in Numbers version 11.1. All the patients signed the informed consent which clarified that the surgical procedures could be used for study or academic purposes.

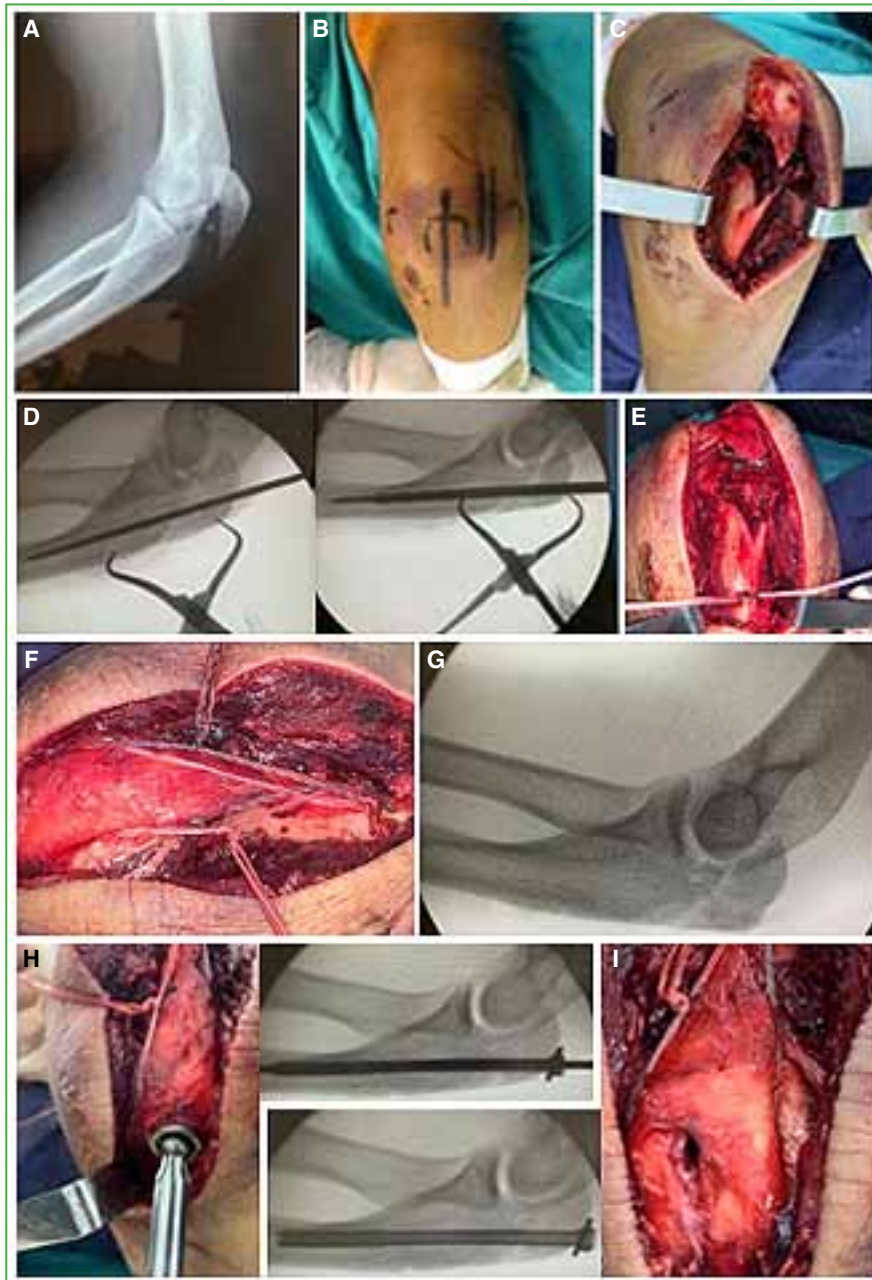


Figure 1. A. Radiograph of a type IIA fracture. B. Approach. C. Fracture focus. D. Reduction and intramedullary reaming. E. Posterior cortical hole for sutures. F. Figure-of-eight suture. G. Figure-of-eight suture reduction. H. Placement of the cannulated screw. I. Final reduction.

RESULTS

Six patients with simple displaced type IIA fracture of the olecranon were identified and were treated with high-strength sutures and an intramedullary partial-thread cannulated screw with a 6.5 mm washer. Four patients were men and two were women, and the average age was 43 years (range 24-60). Immediate postoperative radiographic controls were performed, and at weeks 2, 6 and 10 (Figure 2).



Figure 2. A. Anteroposterior and lateral radiographs of a fracture. B. Immediate postoperative period. C. Consolidated fracture at week 10.

Bone consolidation was confirmed in all patients, except for one who developed elbow joint stiffness due to poor follow-up with delayed consolidation (16.6%). He continued with occupational therapy and achieved bone consolidation and recovery of the range of motion. There were no wound complications nor revision surgeries. The average flexion was 143° (range 160°-90°) and the average extension was 19° (range 0°-55°). All reached full pronosupination (Figure 3 and Table).



Figure 3. Postoperative range of motion - 6 weeks.

DISCUSSION

Tension band wiring and anatomical plates are the most widely used therapeutic options to treat simple displaced olecranon fractures. This new alternative with high-strength sutures and a 6.5 mm partially threaded cannulated screw with a washer is a reasonable surgical option according to the results presented. Multiple studies show that tension band wiring and anatomical plates achieve similar bone union and functional outcomes,¹⁶⁻¹⁸ but with a high reoperation rate (mainly removal of material due to discomfort) ranging between 30% and 80%,^{8,9,19-21} Clearly, this detail increases costs and patient morbidity.⁹

Lallis and Branstetter²² compared three sutures (Ethibon® No. 2, No 5 and high-strength suture) to cerclage wire. They showed that high-strength sutures obtain results similar to those of wire when subjected to distraction forces; therefore, it becomes an alternative for the fixation of these fractures.

Carofino et al.¹² compared high-strength sutures with wire, using pins or cannulated screws that were tested under active motion, and found no differences in fixation, either with pins or cannulated screws.

Bosman et al.²³ treated 15 patients with simple olecranon fractures with cannulated screws alone and achieved an adequate range of motion (average flexion 145°, extension 11°), excellent bone consolidation results, and a lower rate of complications than with traditional treatments.

Nazifi et al.⁷ carried out a systematic review of studies with level IV evidence on the use of strong sutures and anchors for olecranon fractures. They only found nine published articles, and concluded that the use of sutures is a cost-effective alternative to wire, since it greatly reduces the rate of reoperation.

The therapeutic option described in this case series, which uses low-profile implants (which do not need to be removed) with acceptable functional outcomes is the strength of this technique. Patients benefited from early range of motion. One patient developed joint stiffness due to poor follow-up, with delayed union. With occupational therapy, his range of motion increased and he did not require surgical intervention.

This study has severe limitations: its retrospective design, the lack of a control group and the small number of patients that determine that the results do not have a statistical impact.

However, publications of this technique have only been on cadavers¹² and Chevron osteotomies in distal humerus fractures.¹⁵ There have been no publications on its use for simple fractures.

Future studies should increase the number of patients and follow-up time, compare this technique with other fixation options, and study other possible indications for its use.

Table. Patient characteristics

Age	Flexion	Extension	Bone union	Complications
28	150	10	Yes	No
24	160	5	Yes	No
60	140	25	Yes	No
57	90	55	Delay	Stiffness
35	155	20	Yes	No
56	160	0	Yes	No

CONCLUSION

High-strength suture with a cannulated screw is a simple, reproducible, and cost-effective technique from an economic point of view, since it would avoid second interventions (removal of the implant) and would reduce costs compared to traditional techniques. It offers adequate stability, with bone consolidation and acceptable ranges of motion.

Conflict of interest: The authors declare no conflicts of interest.

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Severe Apraxia due to Entrapment of the Radial Nerve in the Arm: “Lotem Syndrome”. Case Report

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ABSTRACT

We present the case of a 57-year-old male patient who consulted for high radial nerve palsy, with pain and positive Tinel test on the lateral side of the dominant arm, of sudden onset after great repetitive muscular efforts, without clinical improvement after three months of evolution. A decompressive surgical treatment was performed, presenting a rapid recovery since the 7th day and full recovery after 25 postoperative days. **Conclusion:** The entrapment of the radial nerve in the arm is a rare pathology and its clinical presentation may vary. We consider that in the face of no remission or favorable evolution of paralysis within the first three months of conservative treatment, surgery should be performed.

Keywords: Radial nerve; Lotem syndrome; nerve apraxia; nerve entrapment.

Level of Evidence: IV

Apraxia severa por atrapamiento del nervio radial en el brazo: “síndrome de Lotem”: Presentación de un caso

RESUMEN

Se presenta el caso de un hombre de 57 años que consulta por parálisis alta del nervio radial, con dolor y prueba de Tinel positiva en la cara lateral del brazo dominante, de inicio súbito, luego de grandes esfuerzos musculares repetitivos, sin mejoría clínica al tercer mes de evolución. Se realizó un tratamiento quirúrgico descompresivo. El paciente tuvo una rápida recuperación a partir del séptimo día, y remisión completa a los 25 días de la cirugía. **Conclusión:** El atrapamiento del nervio radial en el brazo es un cuadro poco frecuente. Según los estudios publicados, la evolución clínica es variada, pero si no hay remisión o la evolución de la parálisis no es favorable en 3 meses, creemos que la cirugía es el tratamiento de elección.

Palabras clave: Nervio radial; síndrome de Lotem; apraxia; atrapamiento nervioso.

Nivel de Evidencia: IV

INTRODUCTION

High radial nerve palsy due to entrapment after repeated muscular efforts is an unusual condition and there is little published evidence on its treatment and evolution.

The radial nerve enters the arm through the triangular space to form part of the contents of the radial sulcus in close relation to the posterior face of the humeral diaphysis. Between 11 and 13 cm proximal to the lateral epicondyle, the nerve crosses the external intermuscular septum from posterior to anterior, in the direction of the lateral parabolic groove.¹⁻³ The orifice that allows the passage of the nerve from the posterior to the anterior muscle compartment of the arm corresponds to a possible site of compression or distraction of the nerve.^{1,3} Lotem⁴ syndrome is known as compressive neuropathy of the radial nerve at said level. Depending on the severity of the compression, this affection produces paralysis of the wrist extensors and the five fingers of the hand, generating severe apraxia and a significant inability to carry out activities of daily living.^{3,4}

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The objective of this article is to report the case of a patient with severe apraxia of the radial nerve due to entrapment in the arm, who had a rapid recovery after surgical treatment.

CLINICAL CASE

A 57-year-old man consulted our institution for pain (8 points on the visual analog scale) in the lateral aspect of the middle third of the arm, of sudden onset after performing masonry work with repeated efforts, of three months' evolution. Physical examination revealed signs of motor paralysis of the dorsal compartment of the forearm, with extension impairment of the wrist and fingers corresponding to grade M0 of the *Medical Research Council* (MRC) scale for muscle strength, without compromise of elbow extension. The passive range of motion of the elbow, wrist, and hand was complete. In addition, he had hypoesthesia in the dorsum of the forearm and the hand in the territory of the radial nerve. Tinel's test was positive to percussion of the lateral region of the arm, mainly at a point located approximately 11 cm proximal to the lateral epicondyle. The QuickDASH questionnaire (*Disabilities of the Arm, Shoulder and Hand*) in the first visit yielded a score of 77.3 (Figure 1).



Figure 1. Clinical image in the immediate preoperative period. Flexion of the wrist and fingers is observed due to motor apraxia of the radial nerve.

Initially, while awaiting the results of imaging studies and electromyography, conservative treatment was indicated, consisting of rest with a thermoplastic splint in wrist extension and nonsteroidal anti-inflammatory drugs, in addition to occupational therapy to maintain full passive range of motion of the wrist and fingers, and physical therapy with weekly electrostimulation sessions.

The electromyogram three months after the onset of symptoms reported a severe injury to the radial nerve with possible axonotmesis.

Masses of surrounding tissue that could compress the radial nerve in its path were ruled out by means of radiography and magnetic resonance imaging, which confirmed an intact radial nerve.

With the requested studies and no evidence of clinical signs of motor or sensory recovery, surgical exploration was indicated.

A 6-cm longitudinal lateral arm approach centered on the high point was performed. It was followed by a deep dissection along the lateral intermuscular septum. The radial nerve was then identified at the exit of the radial sulcus. It was observed to be compressed between the external intermuscular septum and the muscle fibers dependent on the vastus lateralis of the triceps muscle. The vessels of the radial perineurium appeared to be congested without evidence of neuroma formation. In addition, the signs of compression increased dynamically, after flexion of the elbow and pronation of the forearm. The nerve was released after excising the surrounding tissue. Finally, a neurolysis (under magnification) was performed 3 cm proximal and distal to the decompression area (Figure 2).

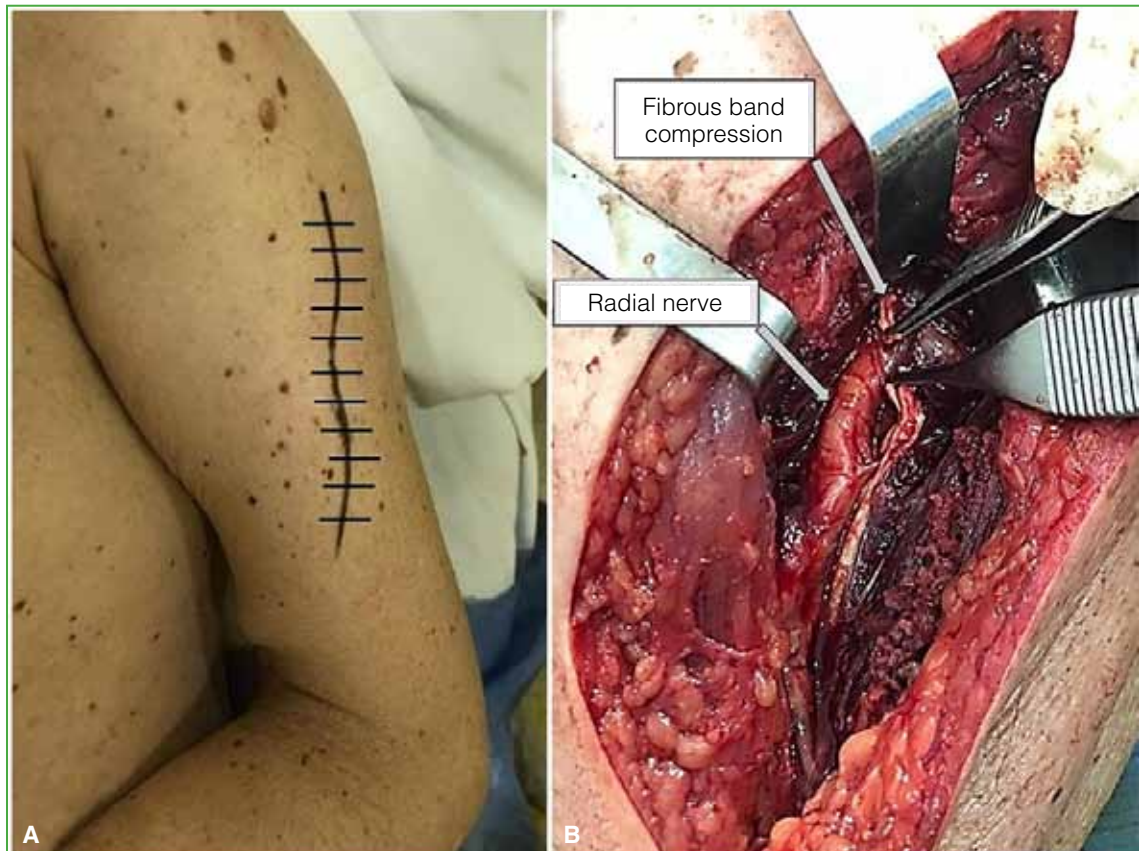


Figure 2. **A.** Marking of the lateral approach of the left arm. **B.** Intraoperative image. The compression of the radial nerve by a fibrous arch dependent on the lateral intermuscular septum can be observed. The radial nerve is congested.

In the first control 48 hours after surgery, no complications were detected. In the second control, on day 7, a weak extension of the wrist and fingers was observed (MRC scale = M2). On postoperative day 25, recovery of range of motion and strength of the wrist and fingers were complete (MRC = M5).

At the 12-month follow-up, no functional limitations were detected (MRC = M5), elbow and wrist ranges of motion were complete, sensory recovery was complete, and the QuickDASH score was 0 (Figure 3).

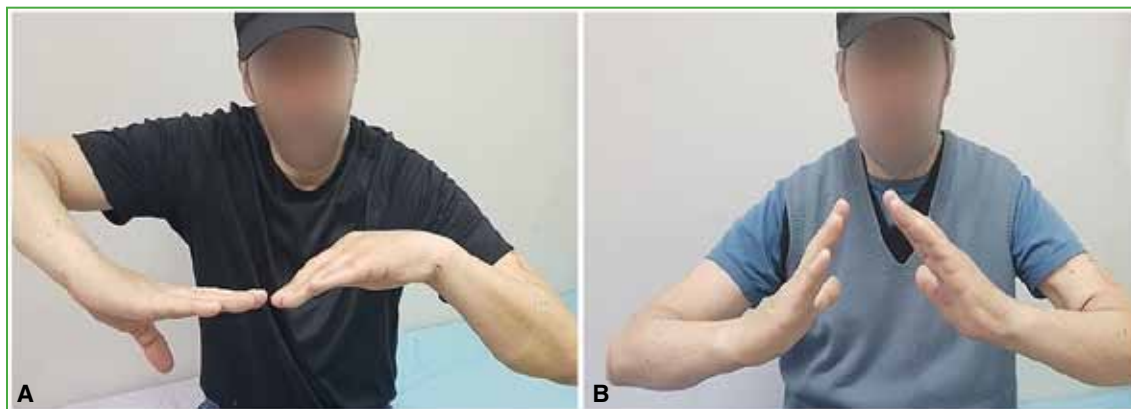


Figure 3. **A.** Partial recovery of wrist and finger extension. **B.** Full extension of the wrist and fingers 25 days after surgery.

DISCUSSION

Currently, there are few publications on severe apraxia due to compressive nerve injuries of the radial nerve in the lateral aspect of the arm. In comparison with these reports and with other patients treated in our Service, in the present case, a complete and early clinical recovery was obtained after surgical decompression.

In 1971, Lotem et al.⁴ defined atraumatic compression of the radial nerve in the arm by publishing a series of three patients with transient radial nerve paralysis after repeated muscle exertion. They attributed its etiology to blockage in nerve conduction produced by a fibrous arch over the radial nerve at the lower end of the spiral groove, which was demonstrated by subsequent cadaveric dissections. They also found that this arch gave rise to accessory muscle fibers from the outer portion of the triceps. The authors associated post-exertional muscle edema with nerve compression at that level and proposed that people with large muscle mass were prone to this condition. Unlike our case, the three patients in this study had a progressive spontaneous recovery from the third day after the onset of symptoms.

In 1985, Sunderland⁵ suggested an additional mechanism; he considered that the distal end of the radial sulcus can act as a fixation point in the course of the nerve, exerting excessive internal traction at that level in the event of a sudden and forced extension of the elbow. This clinical presentation has also been correlated with other potentially compressive pathologies, such as humeral exostoses, sequelae of humerus fractures, or tumors of the surrounding soft tissues.⁶ These diagnoses were ruled out in our patient by interpreting the radiographs and magnetic resonance images.

It is believed that in these conduction blocks, complete recovery inevitably occurs after the cessation of the stimulus favoring nerve compression, since axonal continuity is preserved and the cause is naturally reversible. However, recovery may be delayed for several months or the condition may be irreversible.⁵

Mitsunaga and Nakano,⁷ Manske,⁸ Nakamichi, and Tachibana⁹ reported cases of patients who underwent surgery more than a year after the onset of symptoms and did not show any signs of subsequent recovery. However, Lubahn and Lister¹⁰ published a rare case: three of the five members of a family had spontaneously suffered high radial palsy (without a history of exertion). Among them, a 32-year-old woman consulted after progressing to progressive radial palsy over the course of 4 years. She was treated with surgical decompression and regained M4 to M5 motor strength after 6 months.

The evolution of this case coincides with Mackinon and Novak who recommend that “if there is no clinical evidence of recovery in 3 months, electrodiagnostic studies should be performed. If these show no evidence of reinnervation, we should consider the surgical release of the radial nerve.”¹¹

An oligosymptomatic form of presentation has been reported when the compressive mechanism is not of sufficient intensity to produce paresis/paralysis. In this case, the location and type of neuritic pain should guide the diagnosis. Adolfsson and Nettelblad,¹² in 1999, and Bowman et al.,¹³ in 2018, published case series with no history of trauma, with increased local sensitivity, tingling sensation, and pain that increased upon the percussion of the radial nerve (Tinel's sign) at the distal lateral end of the arm, but without clinical or subjective signs of muscle weakness. Finally, they were treated by surgical decompression of the radial nerve in the canal proximal to the lateral intermuscular septum, with successful results.

The singularity of the case should be highlighted, since the limited reports that required surgical decompression were palsies of a very long evolution in which a satisfactory result was not obtained or had mild symptoms without motor involvement.

Despite its low incidence, we must be familiar with this compression site to ensure early diagnosis and timely treatment, since delayed radial nerve release is associated with poor recovery of nerve function.¹⁴

We can conclude that, although Lotem's syndrome is an infrequent condition, it is one of the causes of high atraumatic paralysis associated with repeated efforts of the radial nerve. It is important to bear in mind that, given its natural evolution towards complete recovery within the first month from the onset of symptoms, the initial treatment of choice may be conservative. If symptoms persist for three months without improvement, surgery should be indicated for the decompression of the radial nerve at its exit from the radial sulcus, at the level of the lateral intermuscular septum. With this procedure it is feasible to achieve a recovery without sequelae of the radial nerve.

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Are Argentine Shoulder and Elbow Surgeons the Worst Treated in Ibero-America?

Comparison of Fees and Level of Satisfaction Between Members of the Asociación Argentina de Cirugía de Hombro y Codo and Colleagues From Ibero-America

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ABSTRACT

An adequate level of job satisfaction of the members of a health team is essential to guarantee the quality of the services provided, generate personal commitment, stimulate the desire to update, and promote retention within the system. We have not found any publication that specifically addresses this issue in the field of Orthopedics and Traumatology in our setting. The objective of this study is to know how the specialists who belong to the Argentine Association of Shoulder and Elbow Surgery perceive their working conditions, what their remuneration is and their degree of satisfaction, and to compare them with equivalents from other Ibero-American countries. The results of the survey showed low average levels of satisfaction in the Argentine professionals surveyed. There are statistically significant differences with professionals from other Ibero-American countries both in terms of remuneration and wellbeing indices. If there are no profound changes in the healthcare system, the remuneration and the working conditions, sooner or later consequences will appear that will affect not only professionals but also patients and the system in general.

Key words: Survey; shoulder; elbow; job satisfaction.

Level of Evidence: IV

¿Somos los cirujanos de hombro y codo argentinos los peor tratados de Iberoamérica? Comparación de los honorarios y el nivel de satisfacción entre los miembros de la Asociación Argentina de Cirugía de Hombro y Codo, y los colegas de Iberoamérica

RESUMEN

Un nivel de satisfacción laboral adecuado de los miembros del equipo de salud es esencial para garantizar una buena prestación de servicios, generar compromiso personal, estimular el deseo de actualización y fomentar la retención dentro del sistema. No hemos encontrado ninguna publicación que aborde específicamente este tema en el ámbito de la Ortopedia y Traumatología en nuestro medio. El objetivo de este estudio es conocer cómo perciben los especialistas que pertenecen a la Asociación Argentina de Cirugía de Hombro y Codo sus condiciones de trabajo, cuál es su remuneración y su grado de satisfacción y compararlos con equivalentes de otros países iberoamericanos.

Los resultados de la encuesta mostraron niveles promedio de satisfacción bajos en los profesionales argentinos encuestados. Existen diferencias estadísticamente significativas con profesionales de otros países de Iberoamérica tanto en lo relativo a la remuneración como en los índices de bienestar. Si no se producen profundos cambios en el sistema de atención, la remuneración y las condiciones de trabajo, tarde o temprano aparecerán consecuencias que afectarán no solo a los profesionales, sino también a los pacientes y al sistema en general.

Palabras clave: Encuesta; hombro; codo; satisfacción laboral.

Nivel de Evidencia: IV

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INTRODUCTION

An adequate level of job satisfaction of the members of the health team is essential to guarantee the quality of the services provided, generate personal commitment, stimulate the desire to update, and encourage retention within the system.¹ It has been stated that the quality of health services is directly related to the level of satisfaction of their professionals.²⁻⁶ This aspect of our profession is regularly evaluated in other countries.⁷⁻¹² In Argentina, on the other hand, the institutions are very interested in evaluating the degree of satisfaction of the patients (“clients”), but it is not common to find studies on the opinion of the professional (“provider”). In fact, we have not found any publication that specifically addresses this issue in the field of Orthopedics and Traumatology, in our setting.

Among colleagues, the deterioration of the image of the health professional, the underestimation of the medical act, the poor working conditions, professional fraud, and low remuneration generate concern. However, this has not been scientifically investigated.

Based on the hypothesis of being “the worst treated” in Ibero-America, the objective of this study was to research how the specialists who belong to the Asociación Argentina de Cirugía de Hombro y Codo (Argentine Association of Shoulder and Elbow Surgery) perceive their working conditions, what their remuneration and degree of satisfaction are, and to compare them with equivalents from other Ibero-American countries.

As a secondary objective, it was proposed to identify if there were differences in remuneration between surgeons in the Autonomous City of Buenos Aires (CABA), the Province of Buenos Aires (Buenos Aires) and the rest of the country (Interior).

MATERIALS AND METHODS

A semi-structured survey was carried out and sent to the specialists included in the database of the registry of members of the Asociación Argentina de Cirugía de Hombro y Codo. The Board of Directors of the Association gave its approval. The study also had the approval of the Bioethics Committee of the Universidad Católica Argentina.

Members of the registry who did not practice the profession in our country (foreign corresponding members and honorary members) and those who had abandoned the practice of medicine were not included.

The survey contained a series of questions related to medical activity and degree of satisfaction ([Annex](#)). The questions were based on previous studies and others were specially designed for our context. Informed consent was included on the survey platform explaining the characteristics and scope of the study. To start responding, the participant had to read and agree to the consent.

The questions were grouped into five areas: 1) Personal data, 2) Work environment, 3) Level of satisfaction, 4) Remuneration, 5) Improvement, teaching and research.

The survey and data collection were carried out using the Survey Monkey® platform. The responses were anonymous.

When appropriate, an ordinal analysis of the data was performed with values from 1 to 5. The open answers were coded independently by two researchers and a consensus was reached for their qualitative analysis.

The results obtained were compared with the experience of an equivalent group of specialists in shoulder and elbow surgery who represented the Ibero-American countries. An interview was previously conducted with them. This strategy was chosen to ensure that the objective of each question was clearly understood, in order to avoid interpretation errors generated by differences in nomenclature or the health system in each country. The inclusion criteria of these participants were: traumatologists dedicated to shoulder and elbow surgery, and being part of the scientific institutions of the subspecialty in their respective countries. They also received an informed consent.

The reference value used to express remuneration was the “stock market dollar”. The MEP dollar or “stock market dollar” is obtained with the purchase of a bond in pesos for its subsequent sale in dollars. The price was 195 Argentine pesos with 33 cents at the time of the study. The value of the informal dollar at the same time was 210 pesos.

Statistical Analysis

As they do not assume a normal distribution, the continuous variables of remuneration are reported as median and interquartile range 25-75 (IQR). Categorical variables are expressed as presentation number and percentage. To determine the distribution of the sample, the Shapiro-Wilk test was used.

To compare the remuneration between Argentine and Ibero-American surgeons, the Mann-Whitney test was used because the variables were not Gaussian. For the comparison of subgroups of surgeons from Argentina (Interior, Buenos Aires and CABA) the non-parametric one-way ANOVA test (Kruskall-Wallis) and a *post hoc* test (Dunn) were used. A p value <0.05 was considered significant. For the statistical study of the nominal qualitative variables, the χ^2 test was used.

Data were analyzed using the IBM SPSS Macintosh program, version 25.0 (IBM Corp., Armonk, NY, USA).

RESULTS

A total of 107 of the 157 members of the Asociación Argentina de Cirugía de Hombro y Codo answered the survey, which represents 68.15%. This is considered a high response rate as expected in this type of query. Eight surveys were incomplete, which could affect the statistical results; therefore, they were removed. The survey forms correctly answered were 99.

Only questions 33, 34 and 35 were allowed to be left unanswered, since not all members of the registry practice all surgical procedures. In these cases, when analyzing the answers, the size of the sample for each procedure was taken into account, and those who did not answer were discarded because they did not carry out a specific technique, which would have affected the average results.

In the case of Argentines, 34.3% work in CABA; 24.2%, in Buenos Aires and 41.4%, in the Interior.

The Ibero-American sample was made up of 16 colleagues who represented, in alphabetical order, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Spain, Guatemala, Mexico, Panama, Paraguay, Peru, Puerto Rico, the Dominican Republic, Uruguay and Venezuela.

Personal information

The average age of the 99 Argentine physicians was 45.3 years (range 32-78) and that of the group of Ibero-American colleagues, 48.4 years (range 37-58).

The Argentine group was made up of five (5%) women and 94 (95%) men. In the control group, all were men.

Both Argentines and Ibero-Americans reported treating patients in the private field. In the case of the former, the percentage was 67.6% and, in the latter, 93.7%. 44% of Argentines and 25% of Ibero-Americans work in public hospitals. The largest difference was related to health insurance, 59% of Argentines work for this system, while only 6.25% do so in the rest of the countries. In many cases, this health system does not exist abroad.

Work environment

Although 25% of Ibero-American colleagues work in state-run hospitals, none chose this work environment as the most comfortable. 44% of Argentines work in a state-run hospital and 29.5% of them reported being comfortable in that work environment, while 34% considered it the least comfortable. 75% of foreign colleagues who work in a public hospital considered it the least professionally comfortable place to work.

Work in the private sector was considered the most comfortable both professionally and humanly by 31% of Argentines, it was the most chosen option. In the case of Ibero-American colleagues, the most chosen option was also the private field, both professionally and humanly, it represented 56% of the preferences of the respondents in this group.

35% of Argentines reported doing active on-call work against 12% of Ibero-Americans. The geographical distribution showed that they are more frequent in CABA (41%) and Buenos Aires (45%) than in the interior (24.3%). On the other hand, colleagues from the Interior (46.3%) and Ibero-America (37.5%) have more passive on-call shifts than those from CABA (20.5%) and Buenos Aires (20.8%).

66.6% of Argentines considered that their workload is excessive compared to 37.5% of Ibero-Americans. The geographical area of our country in which this claim was most marked was in those who do not work in CABA or in Buenos Aires, 70.8%. In CABA, we obtained the lowest value (61.7%).

When asked if working conditions have improved, worsened or remain the same, 80.8% of Argentines consider that working conditions have worsened, with no significant differences due to the geographical location where they work. 68.7% of foreigners agree with this assessment. Only 9% of Argentines consider that working conditions have improved against 25% of Ibero-Americans.

70.7% of the Argentine doctors who responded to the survey stated that the risk of being legally sued influences their practice, with no significant differences depending on the jurisdiction in which they work. There were no significant differences in the response of foreign doctors (68.7%).

Satisfaction level

Respondents were asked about their degree of satisfaction with their choice of medical career, and in particular, orthopedics and traumatology. Responses included: if they felt very satisfied, somewhat satisfied, neither satisfied nor dissatisfied, somewhat dissatisfied or dissatisfied. 47% of Argentines responded that they were very satisfied with their choice of medical profession, the lowest rate was recorded in CABA (37.5%) and the highest in the Interior (53.6%). The rate of very satisfied in foreigners was 75%.

5% of Argentines expressed dissatisfaction regarding the choice of medical career, the highest rate was recorded in CABA (12%) and the lowest in the interior (0%). None of the Ibero-Americans stated that they were somewhat dissatisfied or dissatisfied with respect to their choice of profession.

37% of Argentines would choose medicine again. Among those who chose another profession, the most popular was engineering (11%), followed by law (3%), architecture (3%), economics (3%) and another great variety ranging from archeology to dentistry. 68.7% of Ibero-Americans would choose medicine again.

81.4% of Argentines and 100% of Ibero-Americans expressed being very satisfied with the choice of orthopedics and traumatology specialty. 40.5% of Argentines would choose orthopedics and traumatology again, against 62.5% of Ibero-Americans. Of those who chose another option, Argentines would choose: anesthesiology (20.2%), other surgical specialties (19%), plastic surgery was the most chosen (47% of surgical), clinical specialties were also mentioned (9%), and the rest did not respond or did not know.

Given the choice of another specialty, Ibero-Americans would choose surgical specialties as their first option, the most popular being plastic surgery. None chose anesthesiology.

Only 29.9% of Argentines would recommend their children to pursue a medical degree, unlike 69% of Ibero-Americans (Figure 1). The difference with Ibero-American colleagues was statistically significant ($p < 0.05$).

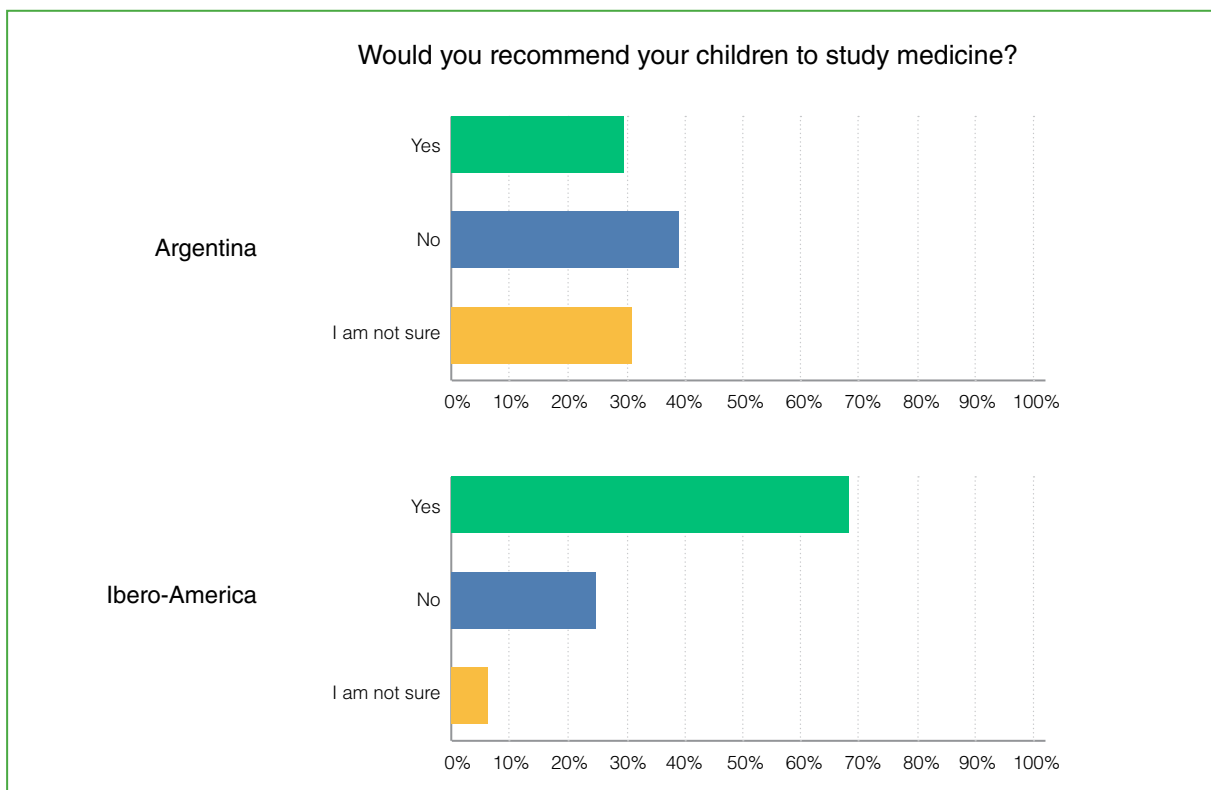


Figure 1. Graph showing the percentage of Argentine and Ibero-American doctors who would advise their children to pursue a career in Medicine.

79.3% of Argentines would consider working in another country if the conditions were met, against 50% of Ibero-Americans (Figure 2). Also, in this case, the difference was statistically significant ($p < 0.05$).

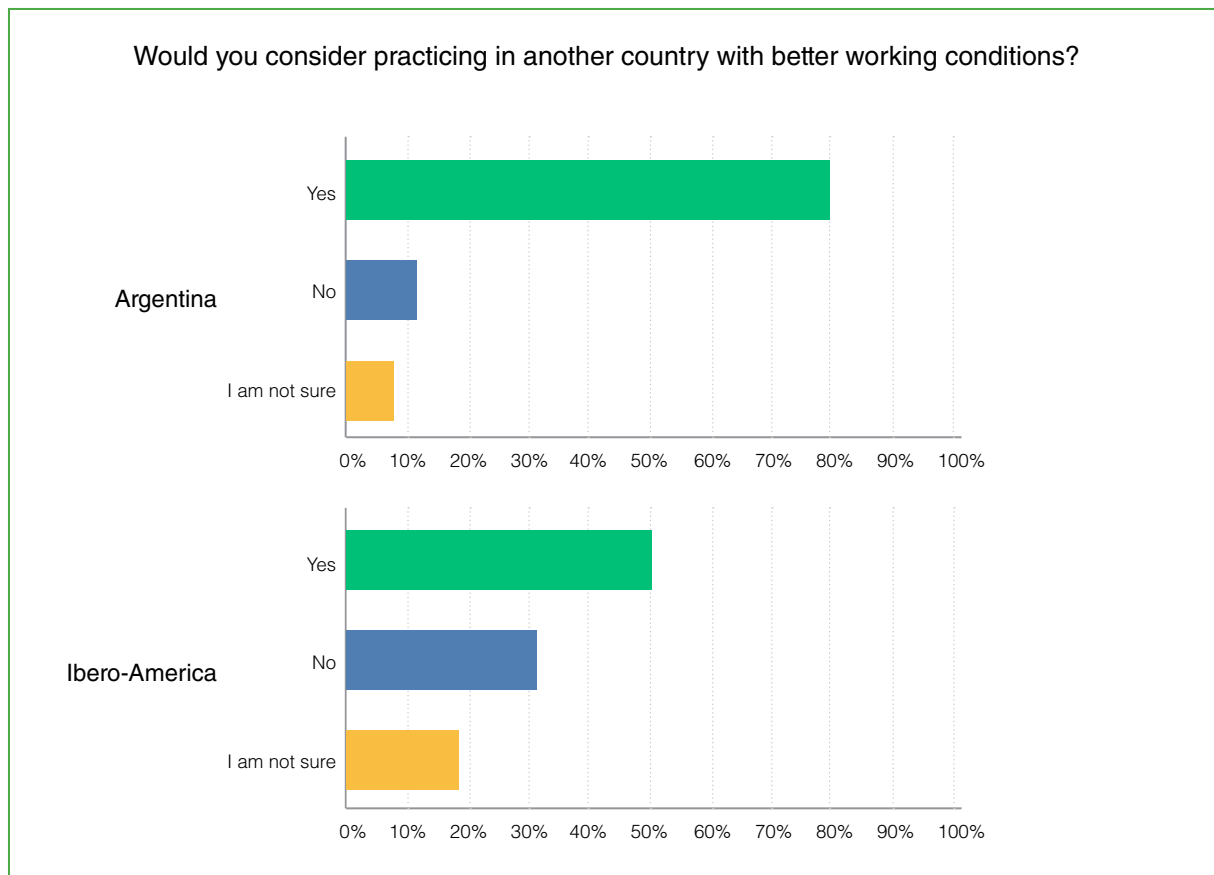


Figure 2. Comparison of the aspiration to work in another country, according to Argentine and Ibero-American doctors.

When asked if they would change something to feel professionally more comfortable in their workplace, 55.5% of the Argentine doctors referred to the value of the fees; 35.3%, to working conditions and 5%, to mistreatment of the professional. In some cases, there was more than one response. 12.5% of Argentines would not change anything. Among Ibero-American colleagues, 37.5% referred to fees; 37.5%, to working conditions and 12.5% complained of professional mistreatment.

When asked what they would change to feel better humanly in their workplace, 18.2% of Argentines referred to fees again; 23%, to working conditions and 7%, to safety and respect in the workplace. 51.8% did not propose changes. In the case of Ibero-American doctors, 6.25% mentioned changes in fees, 62.5% mentioned working conditions, and 31.3% did not propose changes.

Recognition

On a 5-star scale, Argentine doctors considered the prestige level of their profession to be 2.9 stars. In the case of Ibero-American doctors, the average was 3.6. The lowest value was in the Buenos Aires subgroup (2.7 out of 5).

The recognition of patients for their work was highlighted by 74% of Argentines and 75.6% of Ibero-Americans. Instead, the situation is the opposite when responding with respect to the recognition of the professional activity by health companies and employers. The response was negative in 76.2% of Argentines and 62.5% of Ibero-Americans.

95% of Argentines consider that the patient is not concerned about whether or not their doctor has a fair remuneration compared to 87.5% of Ibero-Americans.

Remuneration

Those who worked for a fixed salary because they were under a contract or in a Fellowship were left out. The values of those who carry out consultations and practices in an independent way were not incorporated.

Only 4% of the Argentines surveyed consider having a fair remuneration (CABA 0%, Buenos Aires 4.1%, Interior 7.32%). 31.2% of Ibero-Americans considered themselves to be well paid (Figure 3). The difference between Argentines and Ibero-Americans was statistically significant ($p < 0.05$).

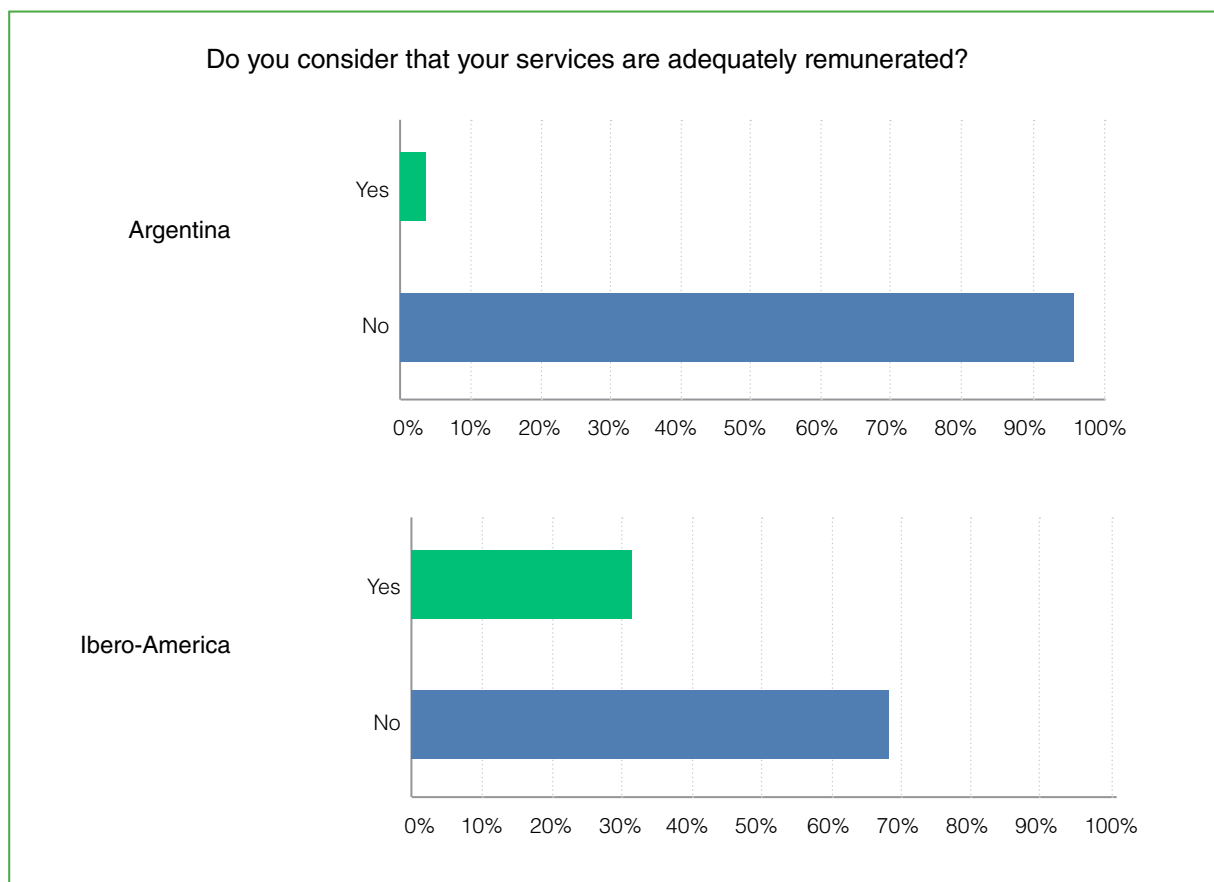


Figure 3. Graph of the evaluation of remuneration in Argentine and Ibero-American doctors.

21.2% cannot set their fees freely in any case; in Ibero-Americans this value corresponds to 18.75%. 67% of Argentines surveyed answered that they could set their fees in less than 10% of cases compared to 50% of foreigners.

The median of the minimum value declared by the Argentines for a consultation was 3 dollars (range 2-8), while for the Ibero-American control group it was 20 dollars (range 10.5-45). Regarding the maximum consultation values, the median of the Argentines was 9 dollars (range 5-15) and that of the Ibero-Americans, 57.5 dollars (range 31.25-100) (Figure 4). The difference in the value of minimum and maximum consultations between Argentine and foreign respondents was statistically significant ($p < 0.0001$).

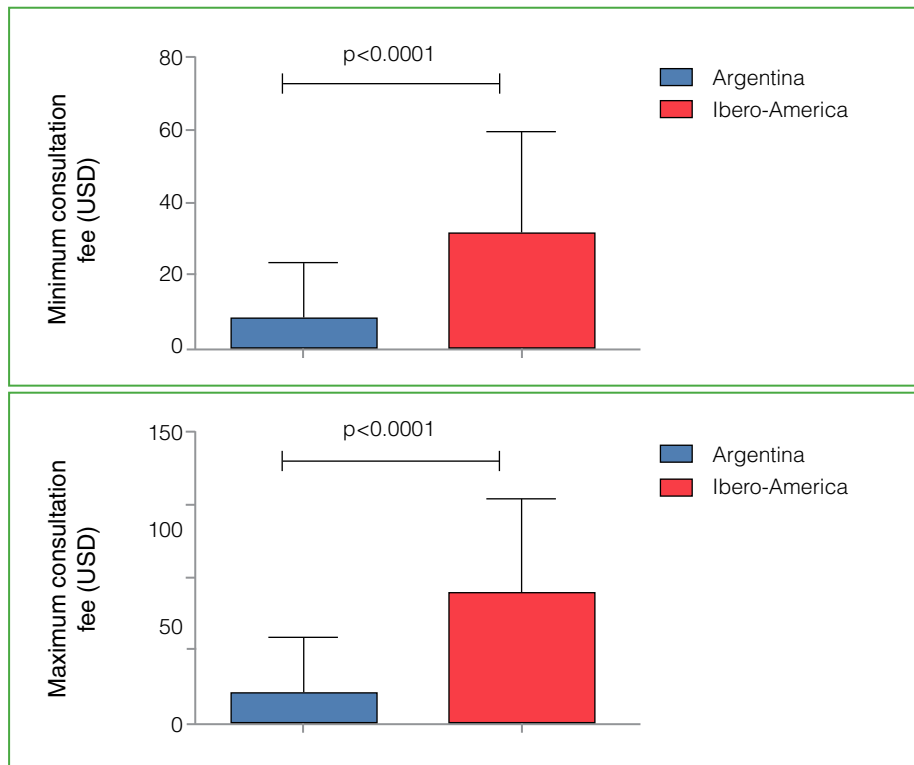


Figure 4. Minimum and maximum consultation fees for Argentine and Ibero-American doctors.

A response was also requested regarding the minimum and maximum values of different surgical techniques. For complex shoulder arthroscopy (rotator cuff repair and treatment of glenohumeral instability), the median minimum fee in Argentina was \$102 (range 61-189) in Argentina and \$681.5 (range 395-975) in Ibero-America. The maximum values for these procedures turned out to be 235 dollars (range 154-398) for Argentina and 1500 dollars (range 850-2450) for Ibero-America. The difference in the minimum and maximum remuneration for complex arthroscopy between Argentine and foreign respondents was statistically significant ($p < 0.0001$) (Figure 5).

Regarding the osteosynthesis of a fracture of the proximal end of the humerus, the median of the minimum value for Argentines was 77 dollars (range 41-165.3) and for Ibero-Americans, 560 dollars (range 412-1125). While the maximum median remuneration for this procedure was 179 dollars (range 102-324) for Argentines and 1400 dollars (range 650-1825) for Ibero-Americans. The difference in the minimum and maximum remuneration for a proximal humerus fracture between Argentine and foreign respondents was statistically significant ($p < 0.0001$) (Figure 5).

Finally, the comparison of minimum fees for total shoulder arthroplasties showed a median of 128 dollars (range 72-246) for Argentina, against 1000 dollars (range 515-1875) for Ibero-America. Regarding the maximum values in Argentina, the median was 256 dollars (range 179-511.5) and, in Ibero-America, 1800 dollars (range 900-2900). The difference in the minimum and maximum remuneration for total shoulder arthroplasty between Argentine and foreign respondents was statistically significant ($p < 0.0001$) (Figure 5).

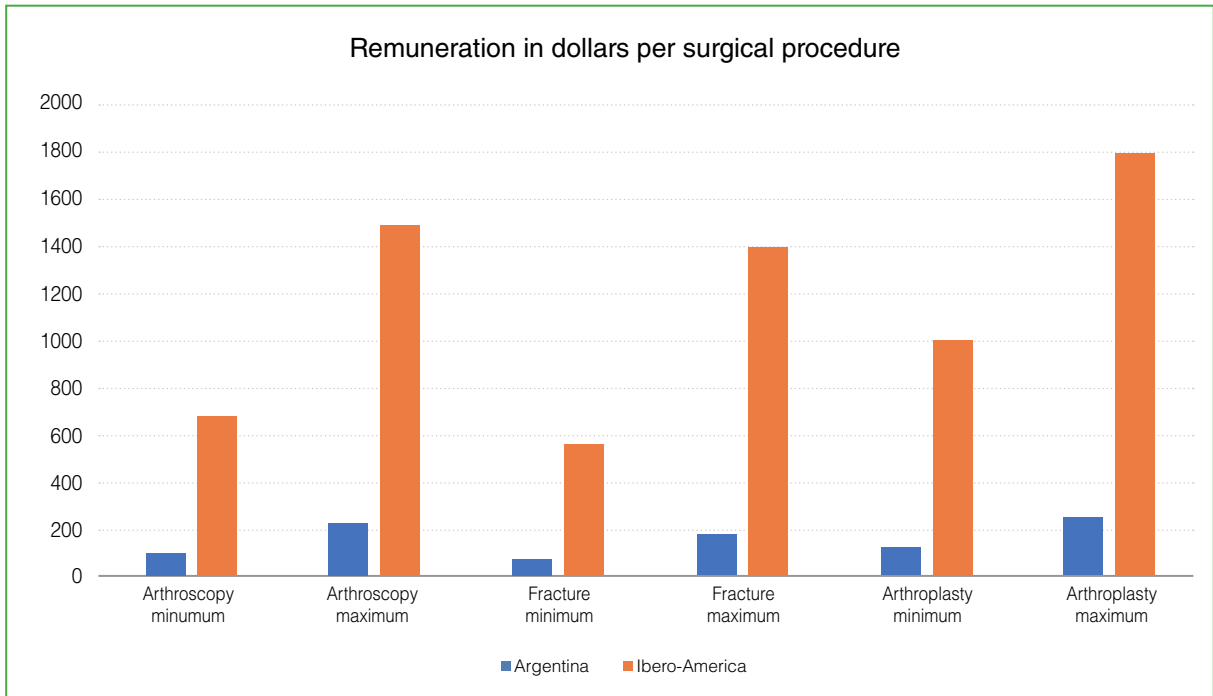


Figure 5. Comparison between the remuneration obtained in Argentina and Ibero-America for the aforementioned surgical procedures.

In all values evaluated, there is a relatively stable proportional difference in fees. Considering all the procedures and consultations, an Argentine earns, on average, 14.3% (range 12.7-15.6%) of what his or her colleagues in all of Ibero-America charge for the same work ($p < 0.001$) (Figure 6).

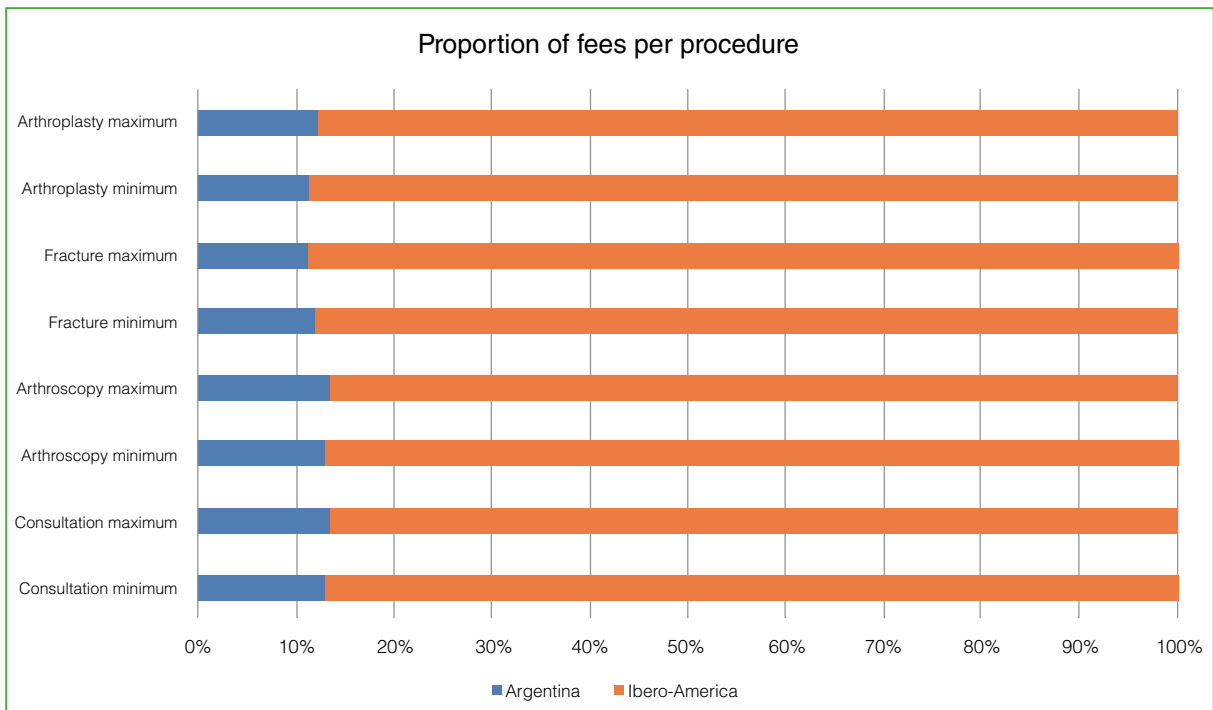


Figure 6. Proportional comparison of fees for surgical procedures between Argentine and Ibero-American surgeons.

Regarding the differences in fees between the different regions of Argentina, the values are reflected in the [Table](#) and [Figure 7](#). A constant tendency has been observed for the Interior to receive better fees in all procedures over CABA and Buenos Aires. This difference is significant in the values of minimum consultations (4 dollars in the interior and 2.5 dollars in Buenos Aires, $p < 0.001$). The maximum values for consultations were 10 dollars in the Interior, 9 dollars in Buenos Aires, and 5 dollars in CABA. In this respect, the doctors of CABA are significantly disadvantaged in the payments with respect to the Interior and Buenos Aires ($p < 0.0001$).

Table. Difference of medians with interquartile ranges 25-75 of remunerations per procedure in dollars between three regions of Argentina.

Practice	Autonomous City of Buenos Aires	Buenos Aires province	Rest of the country
Consultation - minimum	3 (2.5-4.5)	2.5 (2-3)	4 (2-10)
Consultation - maximum	5 (4-9.5)	9 (6-15)	10 (8-15)
Minimum - arthroscopy	102 (41-192.5)	94.5 (72-128)	125.5 (75-250)
Maximum - arthroscopy	230 (113-384)	205 (156-256)	256 (166-400)
Minimum - fracture	72 (26-102)	51 (38-148)	128 (61-256)
Maximum - fracture	128 (32-205)	154 (77-230)	230 (128-500)
Minimum - arthroplasty	146 (73-295)	120 (51-261)	154 (98-428)
Maximum - arthroplasty	256 (113-500)	205 (154-241)	361 (198-788)

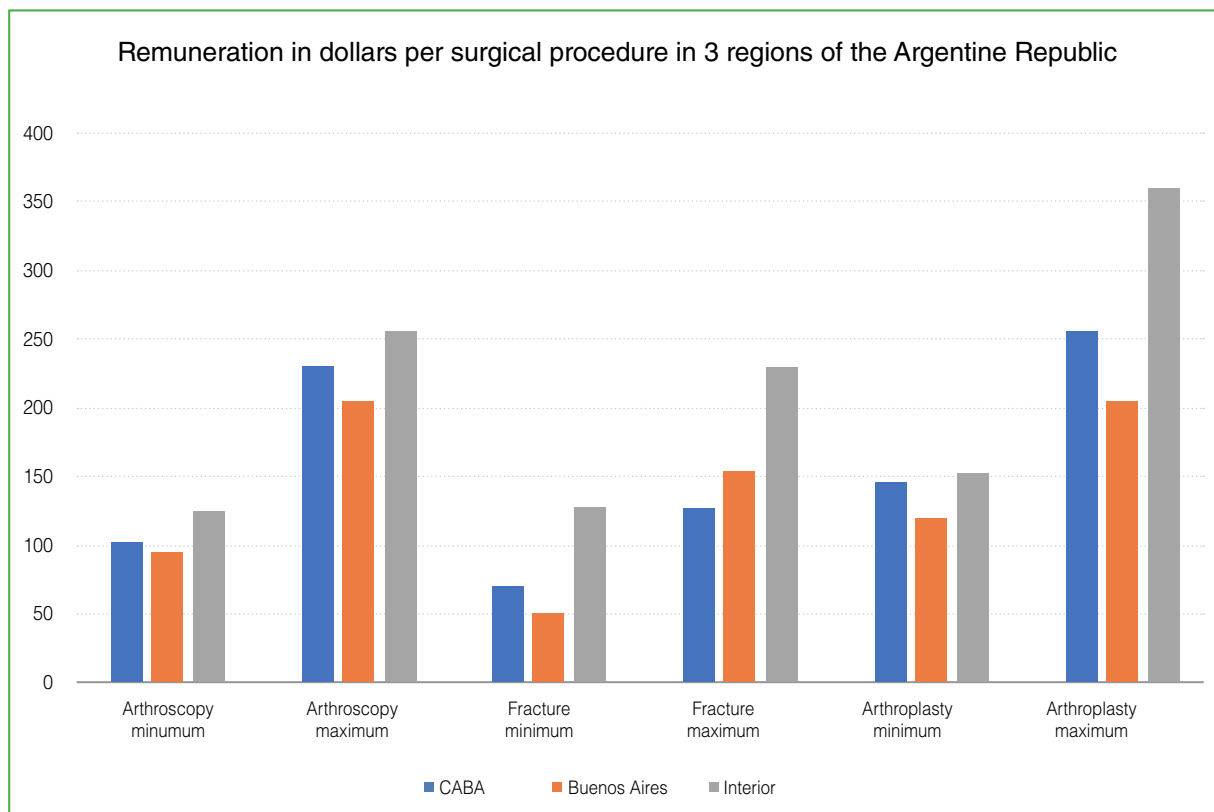


Figure 7. Median difference between the remuneration obtained in different regions of Argentina for the aforementioned surgical procedures.

When evaluating the surgical procedures, significant differences were observed in the proximal humerus fractures in the Interior versus CABA, with minimum values of 128 dollars and 72 dollars, respectively, ($p < 0.003$) and maximum values of 230 dollars and 128 dollars, respectively ($p < 0.001$). There was also a difference of 205 dollars in Buenos Aires against 361 dollars in the interior for the maximum values of total arthroplasties ($p < 0.009$).

Research and teaching

There were no major differences in the main aspects of continuing medical education and academic activities. The training options offered by the different health systems was recognized by 32.3% of Argentines and 25% of foreigners. The highest rate corresponded to the CABA subgroup (44%).

100% of foreigners and 95% of Argentines (CABA: 91%, Buenos Aires: 91.6% and Interior 100%) invest personal funds in their professional training.

98.9% of Argentines and 100% of foreigners consider that the most reliable updating system is the one provided by scientific societies. Only one of the professionals of all the respondents of both groups chose the private postgraduate training systems as more reliable. None of the 115 respondents chose the one offered by industry as the most reliable postgraduate training system (Figure 8).

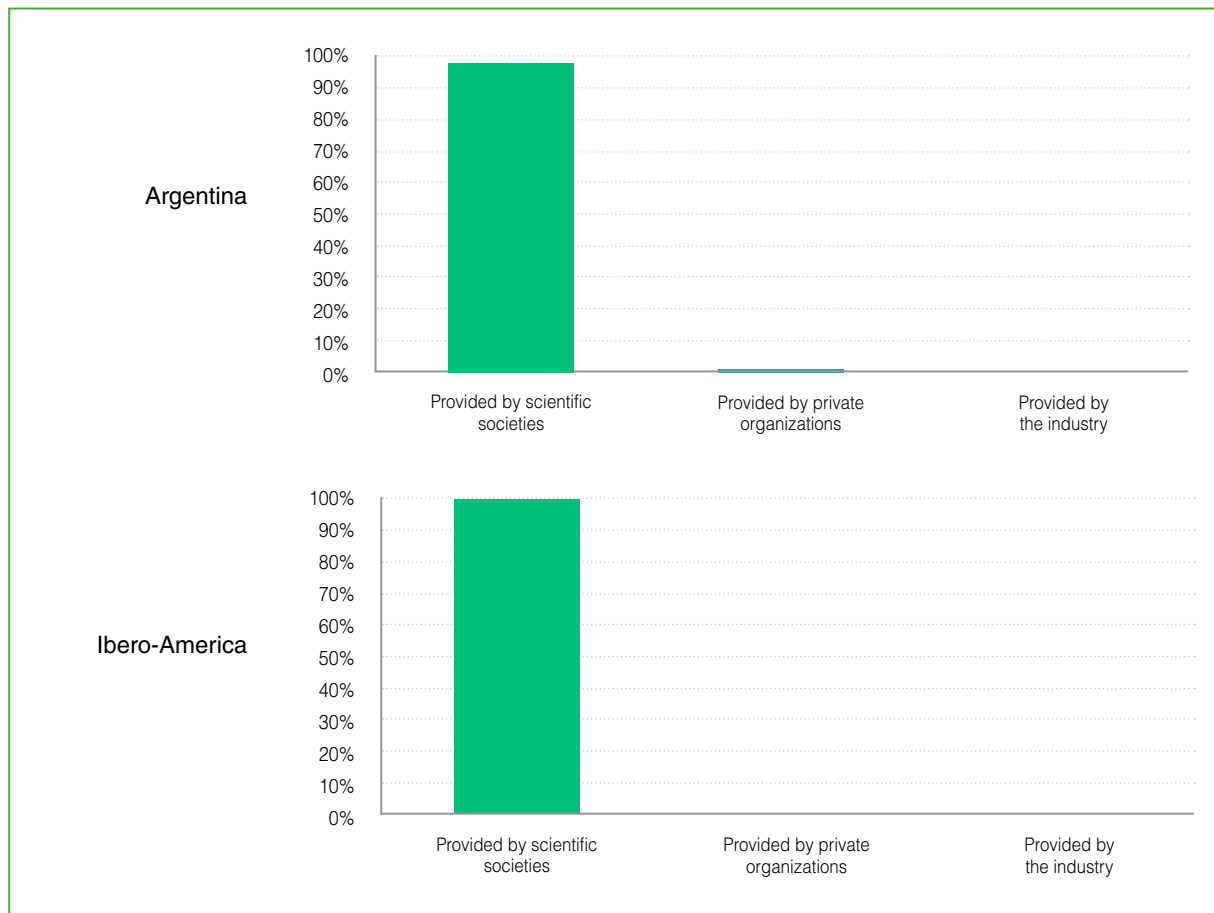


Figure 8. Degree of confidence in medical update systems.

With regard to academic activity, 46% of Argentines teach undergraduate courses, the highest rate was recorded in CABA (61.7%) and the lowest in the Interior (31.7%). The participation rate of Ibero-American colleagues was similar to that of CABA (62.5%).

53.5% of Argentines practice postgraduate teaching, the highest rate corresponds to the CABA (73%) and the lowest, to Buenos Aires (37%). Once again, the rate of Ibero-Americans is close to that of the CABA surgeons (75%).

Finally, in relation to scientific production, 75% of Ibero-Americans stated that they had published in international scientific journals, while the figure among Argentines was less than half (32.3%). Surgeons from CABA had the highest rate (55%), while those from the Interior subgroup had the lowest (14.6%).

With regard to scientific publications in the country itself, Ibero-Americans did so in 81.2% of cases. Once again, the highest rate in our country was from the CABA (94%) and the lowest, from the Interior subgroup (51.2%).

69.7% of Argentines and 87.5% of Ibero-Americans have expectations of making a publication in the next two years. CABA had the highest rate among ours (82.3%) and Interior, the lowest (58.5%).

DISCUSSION

The survey carried out has allowed us, for the first time, to have a real picture of the degree of satisfaction and the remuneration of a subspecialty of Orthopedics and Traumatology in our country compared to the international Ibero-American context.

Physician satisfaction can be influenced by intrinsic (age, gender, race, and specialty) and extrinsic (work environment, practice setting, patient characteristics, and income) factors.^{2,7} It would be a mistake to consider remuneration as the only or the most important factor. Locke¹³ defined job satisfaction as a positive and pleasant emotional state resulting from the subject's subjective perception of work experiences, beyond economic considerations.

When evaluating the degree of professional satisfaction in medical practice, there is an even more comprehensive concept that is "work commitment". This may be a more useful construct than job satisfaction per se, since the latter also includes satisfaction with the choice of career and with the system.⁶

The results obtained show us a significant degree of dissatisfaction with working conditions. Less than half of the 99 Argentine doctors (47.42%) who responded to the survey expressed being "very satisfied" with their choice of medical career, compared to 75% of Ibero-Americans. In a study published in 2014, 88% of Australian orthopedists reported being satisfied or moderately satisfied with their career.¹⁴ 84% of a group of US orthopedists >50 years old stated that they were satisfied or very satisfied with their career.¹⁵

31% of Argentines would choose medicine again, as opposed to 68.7% of Ibero-Americans. The difference is even greater if we compare with American orthopedists, 81% of them would choose the medical career again according to a survey carried out in 2020.¹⁶

40.5% of Argentines would opt again for Orthopedics and Traumatology against 62.5% of Ibero-Americans. In the aforementioned survey, 91% of Americans would choose the same specialty again.¹⁶

The tendency to advise or not advise their children to follow the same profession is an indicator widely used in this type of survey. Only 29.9% of Argentines would recommend their children to choose medicine compared to 69% of Ibero-Americans.

In a question whose response surely exceeds the conditions of medical practice, almost 80% of the Argentines surveyed would consider working in another country if the conditions were met, against 50% of Ibero-Americans.

What are the reasons that led to this degree of dissatisfaction? The cause of dissatisfaction is multifactorial. The degree of recognition felt by the Argentine doctor is lower than that of the Ibero-Americans. The perception about the recognition of patients for their work is similar in Argentines and Ibero-Americans surveyed, but 95% of Argentines consider that the patient is not concerned about whether or not their doctor has a fair remuneration. 76.2% of Argentines do not feel recognition of their professional activity by health companies and employers. 80.8% of Argentines consider that working conditions have worsened.

Low pay is a constant in the answers. Orthopedists are the highest paid medical specialty in some countries.¹⁶ Even the concern in such cases becomes whether orthopedic surgeons earn too much.¹⁷

60% of American orthopedists feel that they are well rewarded for their work.¹⁷ In our survey, 31.2% of Ibero-Americans considered themselves to be well paid, while for Argentines, this figure barely reached 4%.

Health insurers impose, in our field, an arbitrary value and recognition of medical practice based on their own interests. Only 4% of the Argentines who responded to the survey stated that they could freely set their fees for surgical procedures.

The average remuneration per health insurance consultation and in institutions comparable to our health insurers was much lower among Argentine doctors, with statistically significant differences with respect to Ibero-Americans. In some cases, Argentine colleagues responded that they had a percentage of patients that they had to see free of charge as part of the contract with certain institutions. These cases were left out when calculating the average value of the consultations, because they would have determined a much lower value. It should also be considered that the dollar value used is the “stock market dollar” and that if the value of the informal dollar had been used, the fees of the Argentines would have been even worse.

The minimum consultation value stated in the survey was 3 dollars for Argentines, a marked difference with the minimum value in one of the Ibero-American countries represented in the study in which charging less than 70 dollars for an orthopedic consultation could bring ethical problems to the professional with his or her medical college. The difference in consultations is also reflected in surgical practices. In all cases, the values charged in our country are enormously lower than those abroad, on average, they are a proportion of 14.3%.

It could be argued that the devaluation of our currency influences the results, that is undoubtedly true, but there is also a marked disproportion with respect to the values of other goods and services. If we compare the minimum value of consultations, in Spain, 26 kilos of bread could be bought; in Chile, 20 kilos and, in Argentina, a little less than two kilos. The value of an average consultation in Argentina is equivalent to between a dozen and a dozen and a half pastries.

The value of a square meter of construction in the city of Santiago de Chile

(\$3,441)¹⁸ is equivalent to 2.4 shoulder arthroplasties performed in that city at the average value. A Buenos Aires surgeon would have to do 16.5 total shoulder arthroplasties to reach a square meter, which, moreover, at an international price is much lower than in Santiago de Chile (2,600 dollars).¹⁸ We could continue comparing products and, with all of them, the proportion is the same.

CABA doctors have low fees in all the practices considered in this survey. This contrasts with their greater academic production and teaching activity. The lower income of doctors in large cities has been described. In the United States, doctors in rural areas and low-cost-of-living cities tend to earn higher salaries than those in large cities.¹⁹ There will be many arguments that justify it, but this fact, somehow, is opposed to the well-known statement “for equal work, equal remuneration” based on article 14 bis of our National Constitution and the Labor Contract Law.

Finally, the effect on family life is not a minor fact. The time dedicated to family activity and leisure is valued by different medical satisfaction surveys. 45.8% of the Argentine doctors consulted expressed being dissatisfied with the amount of time available for family, social and recreational activities, unlike 6.5% of Ibero-Americans.

Does it make sense that our employers and society “waste” time considering our degree of satisfaction? Clearly, the level of satisfaction of physicians must be taken into account and should be a primary interest in Public Health.^{7,20} It has been shown that the level of job satisfaction, regardless of the profession, influences the worker’s performance, determining lower rates of absenteeism, higher productivity and loyalty to the system. Medicine does not escape this phenomenon.^{2,5,6}

There is a proportional relationship between the physician’s level of satisfaction with the perception of patients and the outcome of treatment. Linn et al.²¹ compared the levels of patient satisfaction with those of job satisfaction of the doctors who provided their care in 16 centers of hospitals teaching general internal medicine. Sites with more satisfied patients were more likely to have more satisfied staff and teaching physicians.

In an observational study involving patients and physicians, Urriago Niño² demonstrated that the greater the physician’s personal satisfaction, the greater the patient’s satisfaction with the perceived quality of care.

The results of medical practice are also markedly influenced by the level of professional satisfaction. Prins et al.²² found that physicians who are more committed to their work are significantly less likely to make mistakes. Stressed, depressed, and dissatisfied physicians report a higher likelihood of making errors and more frequent instances of suboptimal patient care.

In a survey carried out by the British National Health Service (NHS), employee engagement affected many aspects of patient care, including infection and death rates.²³ Staff intention to leave their jobs has also been shown to be strongly related to lower levels of patient satisfaction.

Linn et al.²¹ cited lower rates of patient absence, more efficient use of ancillary staff to provide direct patient care, and more reasonable charges for a routine follow-up visit at centers with satisfied providers. Patients treated by professionals with a higher degree of satisfaction have more adherence to the indicated treatments.

Low satisfaction also affects the adherence of professionals to the system. The media have recently reflected the desertion of specialists from the prepaid health care system.²⁴

Finally, prolonged low satisfaction is associated with self-reported psychiatric symptoms and worse perceived mental health.²⁵ Physicians have more psychological distress than most other working populations. The stages that follow dissatisfaction are stress, depression, burn-out, drug addiction and early abandonment of the profession.

Alternative solutions

The Argentine professionals surveyed showed a strong commitment to their career despite markedly unfavorable working conditions. A high percentage (95%) invest personal funds in their professional training. The survey showed a great predisposition to get involved in teaching and research tasks, beyond the fact that they are not valued by the system.

Fortunately, satisfaction is not a static variable, on the contrary, it reflects a dynamic interaction between the expectations of professionals and the environments in which they work. This always gives the possibility to modify the result of this interaction. Intrinsic factors, such as age, cannot be modified. Extrinsic factors, on the other hand, can be modified and the solution should focus on them.

The assessment of this problem often not perceived by the rest of society, disdained by employers and insufficiently exposed by ourselves, is the first step to find solutions. To be effective, these must include all the protagonists of the health system. As long as this does not happen, we have the right to feel that we are not well treated by a society whose quality of life and health we care for.

Study limitations

This study is based on the opinion of 115 traumatologists from all over Ibero-America. This gives strength to the results, but they can also be influenced by subjectivities.

The average fee values between the minimum and the maximum were taken, but this does not necessarily represent the reality of daily care. It is likely that the average values tend to be overestimated, since it is more frequent to receive payments close to the minimum than to the maximum in the professional activity.

In these calculations, we did not subtract from the fees the values corresponding to taxes, debits and the effect of inflation due to the delay in collection. This last factor was also mentioned by colleagues as problematic along with the bureaucracy and intermediaries in the payment.

CONCLUSIONS

The results of the survey showed low average levels of satisfaction in the Argentine professionals surveyed. There are statistically significant differences in professionals from other Ibero-American countries both in terms of remuneration and wellbeing indices. The feeling of being the “worst treated” in Ibero-America has objective reasons demonstrated by the results of this survey.

If there are no profound changes in the care system, remuneration and working conditions, sooner or later consequences will appear that will affect not only professionals, but also patients and the system in general.

Disclaimer

When carrying out the study, the exchange rate per dollar in Argentina were 195 Argentine pesos with 33 cents in the official market and 210 pesos in the informal market. Five months later, at the time of publication, the value of the dollar is 314.85 and 338 pesos, respectively. This represents a devaluation of our currency higher than 60% and implies a sharp drop in the value of the fees with certain repercussions in the levels of satisfaction found in this survey.

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Conflict of interest: We are shoulder and elbow surgeons exposed to the same working conditions as our Argentine colleagues participating in the study.

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Annex

Questionnaire for Argentine doctors

Dear colleague, you have been invited to participate in the study on “Remuneration and level of satisfaction of the members of the Asociación Argentina de Cirugía de Hombro y Codo,” in your capacity as a member of the Asociación Argentina de Cirugía de Hombro y Codo.

It is important for you to keep in mind that participation in the study is voluntary and anonymous. Please read all the information provided in this document before answering the survey.

This study aims to find out how specialists who belong to the Asociación Argentina de Cirugía de Hombro y Codo perceive their working conditions and to compare them with experts from other Latin American countries. To do this, you are asked to answer this survey as honestly as possible, which has closed questions and open questions in which you can express your personal opinion. All responses will be analyzed anonymously and the results will be analyzed together. The Board of Directors of our Association has approved this study.

1. I have read the information sheet of the Informed Consent, I have received a satisfactory explanation about the study procedures and their purpose. I am satisfied with the information received, I have understood it and all my doubts have been answered.

I understand that my decision to participate is voluntary, and that not participating will not result in any negative consequences for my participation in the Association.

- I agree. - I do not agree.

2. In order to participate in this survey it is necessary to be a physician and member of the Asociación Argentina de Cirugía de Hombro y Codo. Are you a member?

3. Please indicate your age.

4. Sex.

5. How many years ago did you graduate from medical school?

6. Field in which you work.

7. Main place of work.

8. In which of your workplaces do you feel most comfortable professionally?

9. In which of your workplaces do you feel least comfortable professionally?

10. What would you change to feel more comfortable? If you are comfortable with all of them, you can answer “nothing”.

11. In which of your workplaces do you feel most comfortable regarding the human aspect?

12. In which of your workplaces do you feel least comfortable regarding the human aspect?

13. What would you change to feel more comfortable? If you are comfortable with all of them, you can answer “nothing”.

14. Does your workload seem excessive?

15. Does the risk of being sued by patients influence your decision-making?

16. How do you perceive that the working conditions of physicians have evolved (remuneration, relationship with employers, job stability, etc.) throughout your career?

17. Do you work on-call shifts?

18. Do you consider that our profession is socially respected? One star corresponds to nothing, 5 stars to a lot.

19. Are you satisfied with your choice of a medical profession?

20. If you are dissatisfied or somewhat dissatisfied, what are the two main causes of dissatisfaction?

21. What other profession would you choose if you could do it again?

22. Are you satisfied with your choice of orthopedics and trauma specialty?

23. What other specialty would you choose if you could do it again?
24. Would you recommend your children to study medicine?
25. How satisfied are you with the amount of time you have left each year for family, social, and recreational activities?
26. Do you feel recognition from most of your patients for your work?
27. Do you feel recognition from your employers and health companies for your work?
28. Would you consider practicing in another country with better working conditions?
29. Do you consider that your services are adequately remunerated?
30. Do you feel that your patients care that you are fairly compensated?
31. In what percentage of your surgeries can you freely set your fees?
32. What is the minimum and maximum value in pesos that you receive for making a consultation, leaving aside the places where you work for a fixed salary and the cases in which you can set your fees freely?
33. What is the minimum and maximum value in pesos that you receive for performing a complex shoulder arthroscopy, leaving aside the places where you work for a fixed salary and the cases in which you can set your fees freely?
34. What is the minimum and maximum value in pesos that you receive for performing an osteosynthesis of a proximal humerus fracture, leaving aside the places where you work for a fixed salary and the cases in which you can set your fees freely?
35. What is the minimum and maximum value in pesos that you receive for performing a total shoulder arthroplasty, leaving aside the places where you work for a fixed salary and the cases in which you can set your fees freely?
36. Are you currently involved in undergraduate teaching activity?
37. Are you currently involved in graduate teaching activity?
38. Does the health system offer you opportunities for improvement?
39. Which update system do you think is more reliable?
40. Do you regularly invest funds from your own pocket in professional training?
41. Have you published scientific papers in international media?
42. Have you published scientific papers in national media?
43. Do you see the publication of a study of your authorship in a scientific journal in the next two years feasible?

Questionnaire for foreign doctors

1. I have read the information sheet of the Informed Consent, I have received a satisfactory explanation about the study procedures and their purpose. I am satisfied with the information received, I have understood it and all my doubts have been answered.

I understand that my decision to participate is voluntary, and that not participating will not result in any negative consequences for my participation in the Association.

- I agree. - I do not agree.

2. Please indicate your age.

3. Sex.

4. How many years ago did you graduate from medical school?

5. Field in which you work (you can check more than one option). Private patients are understood to be those who pay their fees directly to the professional without intermediaries. Healthcare plans are entities managed by trade unions. Health insurance corresponds to mutual or prepaid plans in which the patient pays a monthly fee and the doctors work for a value for each practice they provide.

6. Country in which you work.

7. In which of your workplaces do you feel most comfortable professionally?

8. In which of your workplaces do you feel least comfortable professionally?

9. What would you change to feel more comfortable? If you are comfortable with all of them, you can answer "nothing".

10. In which of your workplaces do you feel most comfortable regarding the human aspect?

11. In which of your workplaces do you feel least comfortable regarding the human aspect?

12. What would you change to feel more comfortable? If you are comfortable with all of them, you can answer "nothing".

13. Does your workload seem excessive?

14. Does the risk of being sued by patients influence your decision-making?

15. How do you perceive that the working conditions of physicians have evolved (remuneration, relationship with employers, job stability, etc.) throughout your career?

16. Do you work on-call shifts?

17. Do you consider that our profession is socially respected? One star corresponds to nothing, 5 stars to a lot.

18. Are you satisfied with your choice of a medical profession?

19. If you are dissatisfied or somewhat dissatisfied, what are the two main causes of dissatisfaction?

20. What other profession would you choose if you could do it again?

21. Are you satisfied with your choice of orthopedics and trauma specialty?

22. What other specialty would you choose if you could do it again?

23. Would you recommend your children to study medicine?

24. How satisfied are you with the amount of time you have left each year for family, social, and recreational activities?

25. Do you feel recognition from most of your patients for your work?

26. Do you feel recognition from your employers and health companies for your work?

27. Would you consider practicing in another country with better working conditions?

28. Do you consider that your services are adequately remunerated?

29. Do you feel that your patients care that you are fairly compensated?

30. In what percentage of your surgeries can you freely set your fees?
31. What is the minimum and maximum value in pesos that you receive for making a consultation, leaving aside the places where you work for a fixed salary and the cases in which you can set your fees freely?
32. What is the minimum and maximum value in US dollars that you receive for performing a complex shoulder arthroscopy, leaving aside the places where you work for a fixed salary and the cases in which you can set your fees freely?
33. What is the minimum and maximum value in US dollars that you receive for performing an osteosynthesis of a fracture of the proximal humerus, leaving aside the places where you work for a fixed salary and the cases in which you can set your fees freely?
34. What is the minimum and maximum value in US dollars that you receive for performing a total shoulder arthroplasty, leaving aside the places where you work for a fixed salary and the cases in which you can set your fees freely?
35. Are you currently involved in undergraduate teaching activity?
36. Are you currently involved in graduate teaching activity?
37. Does the health system offer you opportunities for improvement?
38. Which update system do you think is more reliable?
39. Do you regularly invest funds from your own pocket in professional training?
40. Have you published scientific papers in international media?
41. Have you published scientific papers in national media?
42. Do you see the publication of a study of your authorship in a scientific journal in the next two years feasible?

‘Irreparable’ Rotator Cuff Tears: Tips and Tricks to Achieve Arthroscopic Repair

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ABSTRACT

Irreparable rotator cuff tears are major injuries that can drastically affect the quality of life of the patients. Despite the complexity of the procedure and the high rates of re-tear, surgical repair is justified due to the lack of less aggressive and palliative alternatives. If a repair is not achieved, surgical alternatives are considered including tendon transfer, superior capsular reconstruction, or even reverse shoulder arthroplasty. Accordingly, arthroscopic repair must be performed in order to save the severely injured rotator cuff. The aim of this study is to summarize some of the arthroscopic techniques for repairing the so-called irreparable rotator cuff tears.

Key words: Tendon injury; rotator cuff; tendon repair; arthroscopy.

Level of evidence: V. Expert opinion

Roturas “irreparables” del manguito rotador: trucos y consejos para conseguir una reparación artroscópica

RESUMEN

Las roturas irreparables del manguito rotador son lesiones graves que pueden conllevar consecuencias drásticas en la calidad de vida de los pacientes. Pese a que su reparación es compleja y la tasa de re-rotura es alta, el intento de reparación se justifica por la ausencia de alternativas poco agresivas o paliativas. Cuando no se consigue una reparación, la alternativa es la transferencia tendinosa, la reconstrucción capsular superior o incluso la prótesis invertida de hombro. Por tanto, en muchos casos de cirugía primaria, se debe intentar la reparación artroscópica con el fin de “salvar” el manguito rotador gravemente lesionado. El objetivo de este artículo es resumir algunas de las técnicas artroscópicas para conseguir una reparación de roturas “irreparables” del manguito rotador.

Palabras clave: Lesión tendinosa; manguito rotador; reparación tendinosa; artroscopia.

Nivel de Evidencia: V Opinión de expertos

INTRODUCTION

According to Patte, massive rotator cuff tears are those that are within groups III and IV of his classification, that is, they present a full-thickness tear of two or more tendons, with involvement >4 cm in length.¹ A tear is defined as irreparable when the degree of retraction prevents the native tendon from approximating its insertion footprint in the proximal humerus, despite the mobilization of the tissue and the release of the adhesions. Tears with little healing potential are also considered irreparable, that is, those in which the acromiohumeral interval is <6 mm in an anteroposterior radiograph (Hamada-Fukuda grade 2),² grade III tears according to the Patte¹ classification and ruptures with severe muscle hypotrophy (fat infiltration >50%) (Goutallier type 3-4)^{3,4}. Thus, a massive tear is considered to be irreparable when a compromise of two or more tendons is combined with a retraction of the cuff in the coronal plane up to the glenoid rim and, in addition, it associates a fatty infiltration >50%, with a vertical migration of the humeral head.¹⁻⁴

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We must keep in mind that not all massive tears are irreparable and not all irreparable tears are massive. According to published studies, the prevalence of irreparable massive tears is 40% of all rotator cuff tears⁵ and up to 40% of these tears are symptomatic, causing pain and difficulty in performing basic activities of daily living. This clinical presentation is usually accompanied by loss of strength and limitations in range of motion. In these patients, different treatment alternatives can be proposed to improve symptoms and prevent progression to joint damage that would require the implantation of a reverse shoulder arthroplasty.

Multiple techniques are currently available for the treatment of irreparable rotator cuff tears, although none is clearly superior to the others. To choose the best treatment, it is essential to consider the clinical characteristics and the functional needs and demands of each patient, as well as the characteristics of each tendon tear.

The purpose of this article is to describe various tips and tricks that can be applied when performing an arthroscopic repair of an 'irreparable' rotator cuff tear.

TIPS AND TRICKS

Footprint medialization

It is used in patients with a retracted rotator cuff tear (usually medial to the apex of the head) which, once debrided in a standard manner, does not cover the greater tuberosity and sometimes even barely reaches the bone. In these cases, the only option to increase the chances of repair and healing of the tendon is medialization of the footprint. This technique consists of the removal of a part of the most lateral cartilage of the humeral head in order to expose an extra amount of bone in the greater tuberosity (Figure 1). This allows repair of the retracted supraspinatus to be made to the bone. The amount of cartilage that can be resected is not well studied, but it is accepted that up to 8-10 mm can be removed without risk of creating an internal space conflict between the repaired tendon and the superior labrum/biceps long head insertion. Footprint medialization could produce biomechanical alterations due to the shorter distance between the insertion (in case of healing) and the point of rotation of the shoulder in abduction maneuvers. However, it seems logical that function will be better with a repaired and medially healed tendon than with an unrepaired or unhealed tendon. Through partial repair with footprint medialization, it is also possible to avoid tension on the suture and thus be able to restore rotator cuff stability following Burkhart's suspension bridge theory.⁶ By reconstructing the rotator cuff cable, balance is restored and the humeral head is kept centered in order to improve symptoms, function and also delay, as far as possible, the progression towards subacromial arthropathy of the rotator cuff.⁶

Margin convergence

Margin convergence is a technique that consists of an approximation closure of the tendon margins of the remaining rotator cuff, either as a primary technique or as an adjuvant technique to a repair. In the former, it is typically used over an extensive tear, normally in a U (or L) shape retracted to the glenoid, but with a movable tendon remnant that allows approximation between the anterior and posterior tendon ends. In the technique we use, a single high-strength suture is used that is entered and retrieved from the posterolateral and anterolateral portals, with a view from the lateral portal. With a tissue penetrator entering posteriorly, grasping half of the suture (leaving two long and equivalent ends), the posterior rotator cuff is penetrated from superior to inferior, and the same is done with another tissue penetrator from superior to inferior in the anterior rotator cuff. The anterior penetrator retrieves the posterior suture loop and exits retrogradely from the anterior part of the rotator cuff. At this time, the tissue penetrator enters the loop that protrudes from the anterior part of the tendon and retrieves one of the loose strands coming out of the posterior part of the rotator cuff, and this strand is brought out of the anterolateral portal. In this instance, the posterior tissue penetrator grasps the posterior suture and retraces the posterior aspect of the tendon from superior to inferior at a point slightly more lateral to the one previously traversed. The anterior tissue penetrator also crosses the anterior part of the tendon from superior to inferior, and recovers the posterior suture that remained grasped by the posterior penetrator, traversing the anterior part of the tendon retrogradely, in the same way that it was previously done. After passing through it, there will be another loop created and, then, the anterior penetrator will enter through this loop and grab the free suture that exits through the anterolateral portal, causing it to pass through this second loop.

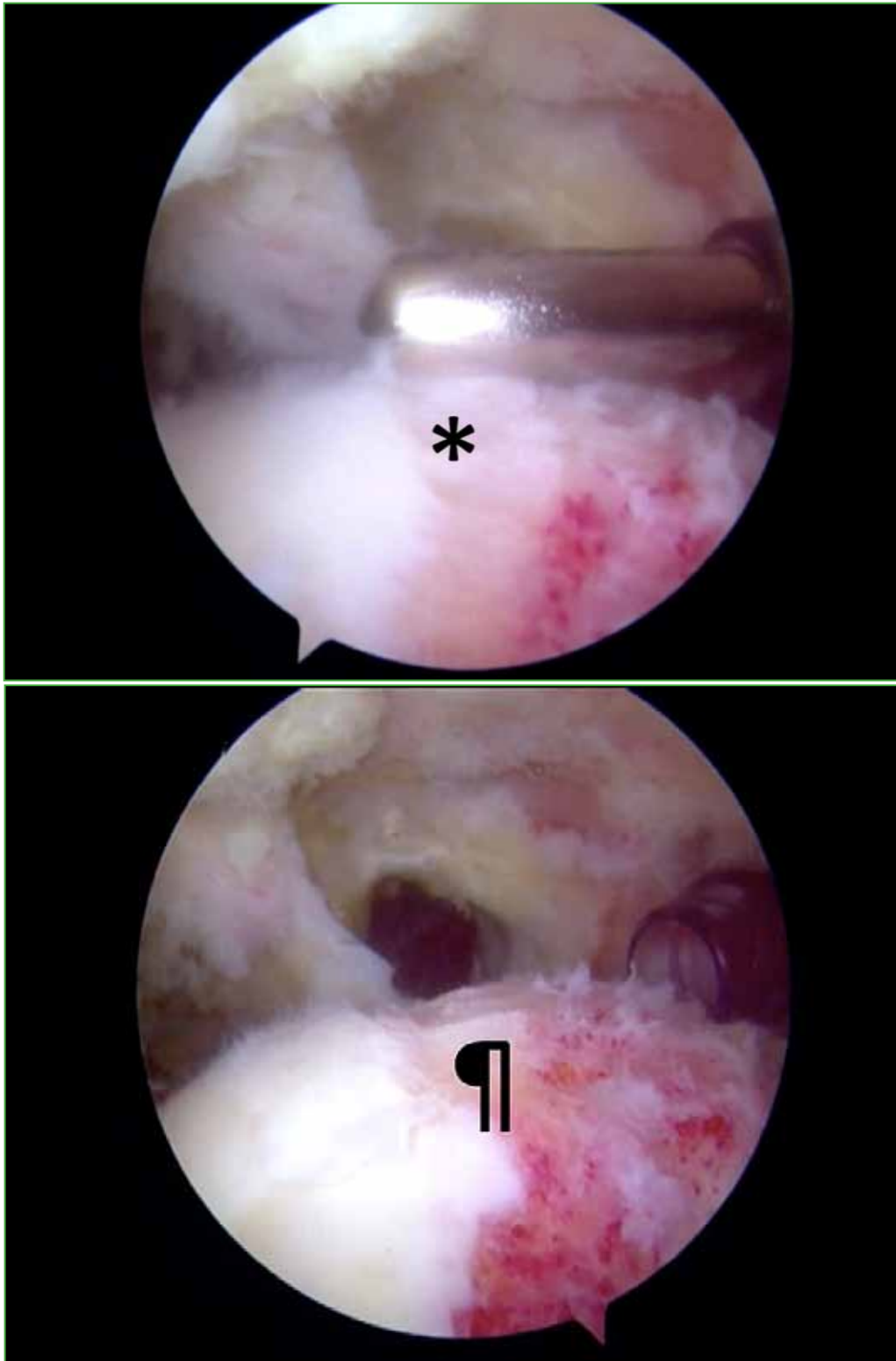


Figure 1. Complete retracted tear of the supraspinatus with view from the posterior portal. Removal of 5 mm of the most superior cartilage of the humeral head (*) and final appearance of the bleeding bone once the cartilage has been removed (9).

This maneuver will be repeated as many times as necessary until reaching the most lateral part of the tendon. The free strand coming from the posterolateral portal will then be retrieved from the anterolateral portal, and can be tied with a non-slip knot, completely closing the existing tendon defect (Figure 2).

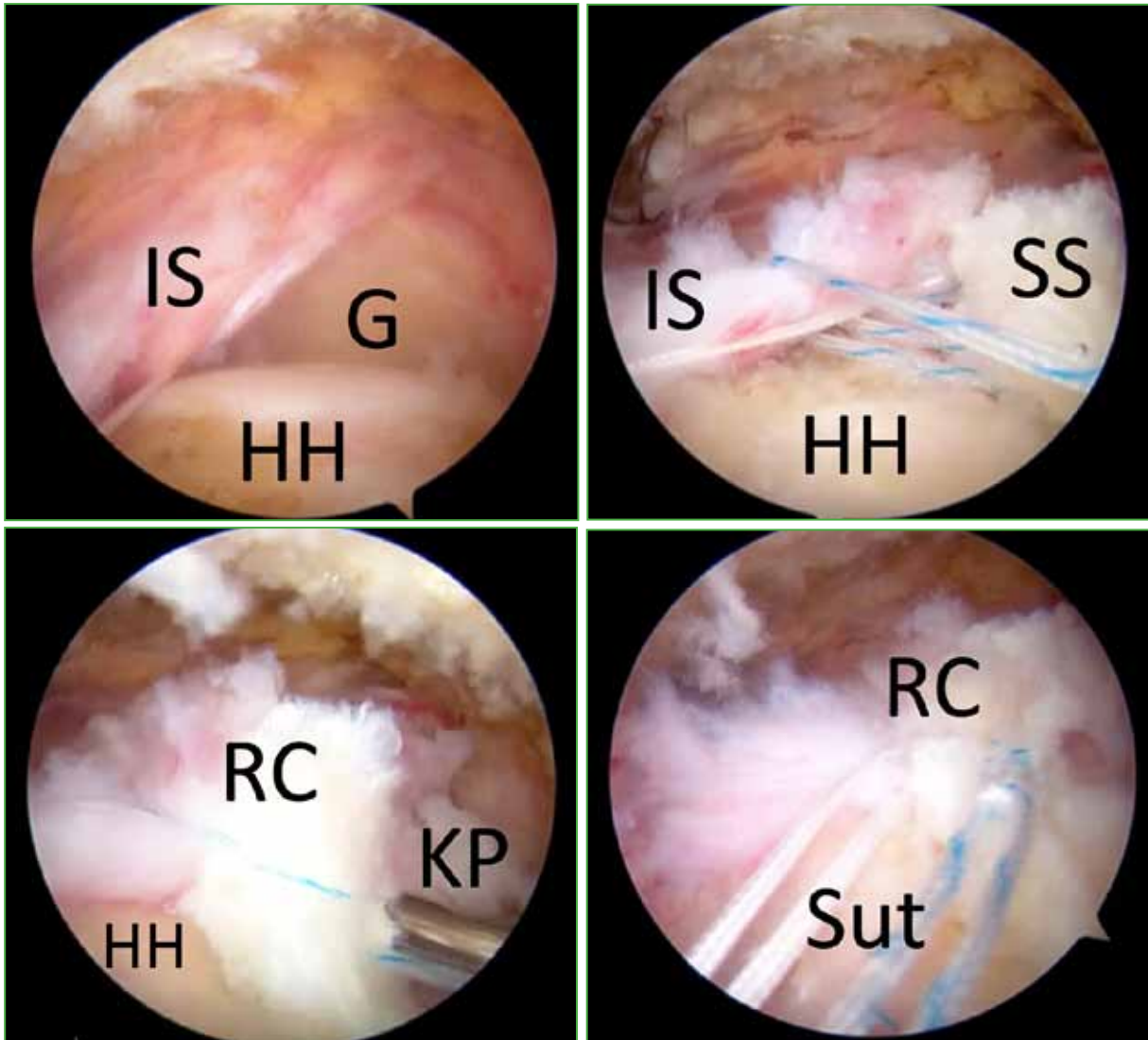


Figure 2. Complete retracted supraspinatus tear with lateral view. The glenoid (G), the infraspinatus (IS) and the humeral head (HH) can be seen. Once the sutures have been passed, the approximation of both tendons is achieved, obtaining closure of the rotator cuff (RC) once the suture of the margin convergence with the knot pusher (KP) has been tied. Finally, the convergence and medial anchor sutures (Sut) can be attached through a lateral knotless anchor to complete the repair.

It is important to mention that the convergence of margins must be fixed to the bone. This technique essentially makes an irreparable tear repairable, but then the tendon must be anchored to the bone for better kinetics and kinematics. Our method of choice for bone anchoring would be equivalent to a double row. Before closing the defect, a suture anchor is placed in the bone medially, on the greater tuberosity, and one end of each suture is passed on each side of the converging tendon (or 2 sutures if the anchor has double sutures) to then tie it once the closure by convergence is completed. The convergence and anchor sutures can then be incorporated into a knotless anchor laterally. When this technique is used, it is essential to repair the tendon without creating tension in the pillars (infraspinatus and subscapularis), and maximum biological respect is necessary.

Interval slide

Interval slide is a technique described by Burkhart to increase the lateral excursion of a retracted rotator cuff and thus allow a tension-free repair.⁷ The opening of the posterior interval consists of the separation between the supraspinatus and the infraspinatus to facilitate the reduction of the tendon to its footprint (Figure 3).



Figure 3. Complete retracted tear of the supraspinatus (SS) with posterior view. The glenoid (G), the infraspinatus (IS) and the exposure of the scapular spine (SSp) are shown after an interval slide is made between the supraspinatus and the infraspinatus. It can be seen how the supraspinatus is capable of reaching the humeral head (HH). Ultimately, margin convergence should be performed to close the space created between the infraspinatus and supraspinatus (double arrow).

The opening of the anterior interval consists of the separation between the supraspinatus and the subscapularis, as in the opening of the posterior interval, to be able to facilitate the reduction of the tendon to its footprint, although these actions have the risk of causing devascularization of the tendons which can hinder healing. Likewise, it is worth mentioning that the interval slides can produce maladjustments in the adaptations of the coupling of forces that have occurred over time. Therefore, it is necessary to ensure that the technique will actually allow a healing repair of the tendon, especially in its anterior portion. To favor biology and not injure the vascularization while reducing the possibilities of creating biomechanical alterations, Lo and Burkhart described the opening of the anterior interval in continuity, which consists of the section of the coracohumeral ligament from the base of the coracoid, so that, when repairing the subscapularis, repair of the supraspinatus is facilitated with less tension, avoiding the division of the junction between the subscapularis and the supraspinatus.⁷ It is worth mentioning that, often, the three techniques must be combined, since the interval slide, on occasions, only allows reaching the bone if the footprint is medialized. In addition, the posterior interval opening must sometimes be carried out to the base of the scapular spine and, therefore, it is advisable to perform a posterior margin convergence afterwards. It is also important to point out that the posterior interval slide must be performed with care so as not to injure the supra-scapular nerve as it passes through the spinoglenoid notch.

The surgeon can opt for a tenotomy of the long head of the biceps as an addition to the techniques described above with the aim of improving pain (Figure 4).⁸

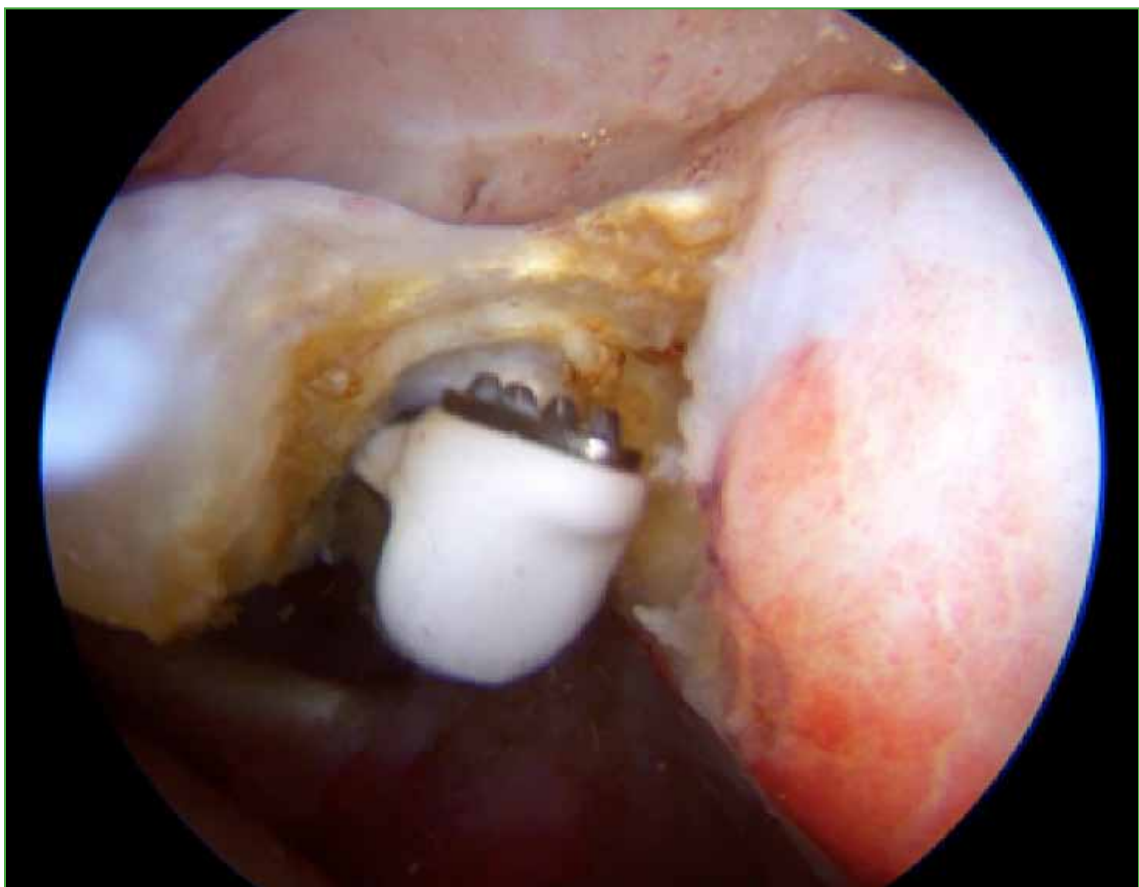


Figure 4. Intra-articular posterior view during a biceps tenotomy using a radiofrequency device.

Additional measures to promote healing

Subacromial spacer

The subacromial spacer is a biodegradable device that is placed between the acromion and the proximal epiphysis of the humerus (acromiohumeral joint) and allows the humeral head to descend, thus reducing friction during shoulder motion (Figure 5). This implies better pain control and an increase in the range of motion by avoiding a possible elevation of the humeral head.⁹ This is a rescue technique in patients >65 years of age with a massive and irreparable rotator cuff tear without associated arthropathy, but with full passive range of motion and correct glenohumeral stability, when seeking to perform a previous alternative to a more invasive procedure due to the general conditions of the patient. It can also be applied to relieve subacromial pain caused by humeral head elevation until the cuff has healed or pain improvement has allowed a better balance of forces in the shoulder. Cases have also been described in which the subacromial spacer is used as a protection system associated with a tendon suture in order to reduce the rate of tear.^{10,11}

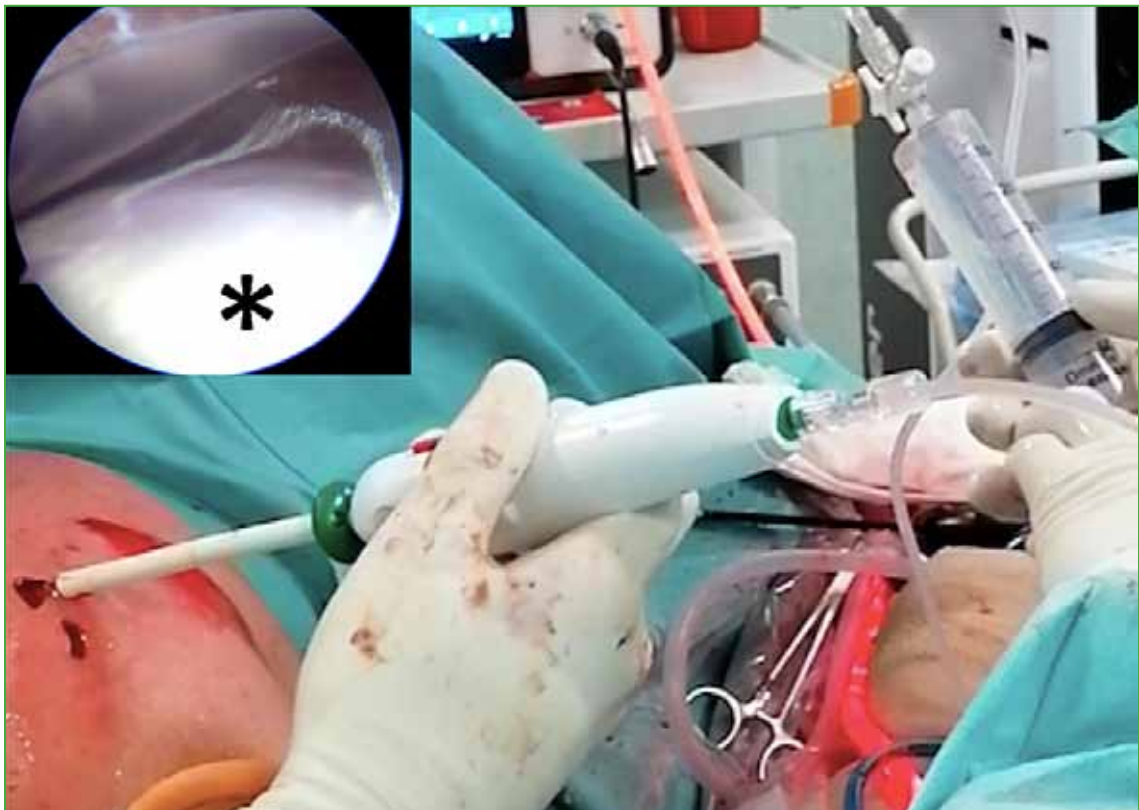


Figure 5. External view of the placement of a subacromial spacer on a patient's left shoulder in a beach chair position. The image in the box (*) shows the interior aspect (subacromial view from the posterior portal) of the balloon once inflated with sterile saline.

Intratendinous and intraosseous platelet-rich plasma

Due to the reparative potential of platelet-rich plasma, it can be used as an adjuvant treatment for some of the techniques described above. Our preference is the intraosseous infiltration as opposed to the intratendinous or tendon-bone interface, since, in most cases, the biological problem lies in the subchondral bone and the enthesis. The growth factor applied at the interface (tendon-bone junction) leaks, in most cases, to the subacromial or intra-articular space, thus escaping from the area where these proteins are most interesting. Even when the growth factor is applied in the subacromial or intra-articular space, we have seen cases of joint stiffness in the setting of

postoperative immobilization as a result of delicate rotator cuff repair. This may be due to the presence of platelet-rich plasma as opposed to platelet-poor plasma, since the former has a greater profibrotic potential. However, even applying platelet-poor plasma (with lower risk of postoperative stiffness), the fact that the factor escapes the place where it is of interest means that the interface application is not our choice. Instead, we opt for intraosseous infiltration just at the level of the repair (Figure 6).



Figure 6. Intraosseous application of growth factors on the left shoulder in a patient in a beach chair position. The placement of a number 14 Abbocath catheter can be seen and how it allows the intraosseous administration of the growth factor once it is connected to the syringe containing the drug.

This can be done in two ways. On the one hand, we have a motorized system composed of a trocar with an internal male needle that can be removed, connected to a motor (Arrow On Control Powered Bone Access System, Teleflex Medical Europe Ltd, Dublin, Ireland) covered with a sterile plastic sheath. The trocar is introduced and when the desired point is reached, the inner male needle or sleeve is removed and the growth factor is infiltrated. Should the position of the needle be changed, the sleeve or male needle is screwed on again, and it is reconnected to the motor. Another less expensive alternative is to use a 0.8-mm Kirschner wire that is inserted by motor laterally at the level of the cortical bone of the greater tuberosity, under direct vision, and advanced about 2 cm. The Kirschner wire is then left in place and a #14 Abbocath catheter is used to cannulate the needle. Once the Abbocath is inserted into the bone, the Kirschner wire is removed and the growth factor is infiltrated. It is important to point out that the subacromial space should not be filled with growth factor, but it is important that it remains at the level of the greater tuberosity.

Micro perforations

The creation of micro perforations in the humeral footprint before tendon repair improves the biological environment by providing a greater local flow of stem cells and other factors that favor tendon healing.¹² However, this technique would be discouraged when the humeral head is highly osteoporotic, because there is a risk of further weakening the bone and producing a failure of the tendon to bone anchorage.

Postoperative Instructions - Immobilizer in Abduction

The abduction orthosis is a tool that can be used after a rotator cuff repair to reduce tension on the suture. In biomechanical and *in vitro* studies, the amount of stress borne by the rotator cuff has been shown to be influenced by the position of the shoulder. Therefore, we can reduce the stress supported in the repaired area by leaving the arm in abduction and thus reducing the rate of re-tears and promoting prompt healing.^{13,14} The degrees of abduction can decrease as the weeks go by. Normally, it will start with an abduction of around 60° for about two weeks, decreasing by 10° per week thereafter. This is only of interest in those more retracted tears and with a more delicate repair.

Rescue techniques: tendon transfer

Following the repair of massive rotator cuff tears, tendon re-tear rates range from 40% to 70%.¹⁵ For this reason, we sometimes recommend performing a tendon transfer in addition to a borderline repair. Our tendon transfer of choice for irreparable tears of the posterosuperior cuff is the Elhassan transfer, which consists of transferring the lower trapezius to the greater tuberosity with Achilles tendon allograft augmentation. The addition of this transfer to a borderline repair is important in the setting of active external rotation deficiency or even preoperative pseudoparalysis. With this technique we achieve an improvement in both pain reduction and shoulder strength (Figure 7).^{16,17}

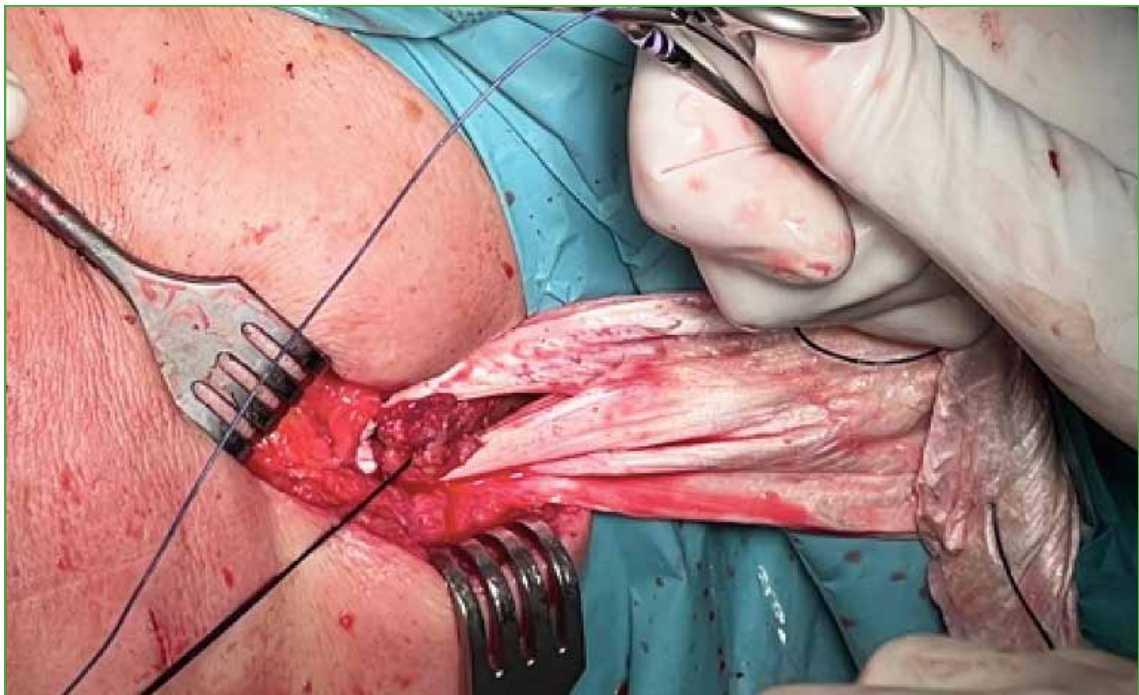


Figure 7. Lower trapezius tendon transfer for the reconstruction of an irreparable rotator cuff tear. Posterior photograph showing the connection between the Achilles tendon allograft and the lower trapezius.

CONCLUSIONS

There are different arthroscopic techniques that increase the chances of repairing ‘irreparable’ complex tears of the supraspinatus tendon. These include footprint medialization, margin convergence, interval slides, subacromial spacers, biological therapies (platelet-rich plasma), micro perforations, or spatial immobilizers in abduction. It must be taken into account that these tears have a high rate of re-tearing due to poor healing. The patient must know the real expectations to which he or she should aspire. However, these are some of the tricks that will increase the chances of success in the face of a complex repair. All this can enable clinical improvement and patient functionality, as well as prevent progression to glenohumeral osteoarthritis and thus the subsequent placement of an inverted arthroplasty.

Conflict of interest: The authors declare no conflicts of interest.

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Glenohumeral Bone Defects: A Review of the Diagnostic and Therapeutic Advances Over the Last 20 Years

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ABSTRACT

Introduction: The approach and treatment of glenohumeral bone defects have evolved intending to provide more individualized management for patients. However, to date, there are no articles that compile these historical advances. **Objective:** To describe the most relevant literature on the diagnostic analysis and therapeutic options for glenohumeral bone defects reported in the last 20 years. **Materials and Methods:** A search was conducted in the PubMed database with the terms “Glenoid defect,” “Humeral defect,” “Shoulder instability” and “Glenoid track,” filtered by year from 2000 to 2021. Studies published in English and Spanish, involving adult patients, were included. **Results:** We reviewed a total of 56 articles. A narrative chronological review of the approach to glenohumeral bone defects in anterior instability was performed. **Conclusions:** Technological advances have allowed the development of evaluation and management algorithms aimed at achieving the best outcomes according to the characteristics of each patient. To date, the current literature recommends surgical treatment of instability based on the objective measurement of glenohumeral bone defects, for which arthroscopy and 3D reconstruction tomography offer the most accurate quantification.

Keywords: Glenohumeral bone defects; shoulder instability; glenoid track; Hill-Sachs lesions.

Level of Evidence: IV. Narrative review

Defectos óseos glenohumerales: Un recorrido en los avances diagnósticos y terapéuticos durante los últimos 20 años

RESUMEN

Introducción: El abordaje y el tratamiento de los defectos óseos glenohumerales han evolucionado en miras de brindar un manejo más individualizado para los pacientes. Sin embargo, hasta la fecha, no existen artículos que recopilen dichos avances históricos. **Objetivo:** Describir la bibliografía más relevante sobre el análisis diagnóstico y las opciones terapéuticas de los defectos óseos glenohumerales en los últimos 20 años. **Materiales y Métodos:** Se realizó una búsqueda en la base de datos PubMed con los términos “Glenoid defect,” “Humeral defect,” “Shoulder instability” y “Glenoid track,” filtrada por año desde 2000 hasta 2021. Se incluyeron estudios publicados en inglés y español, de pacientes adultos.

Resultados: En la búsqueda, se revisaron 56 artículos según los criterios planteados. Se llevó a cabo una revisión narrativa cronológica sobre el abordaje de los defectos óseos glenohumerales en inestabilidad anterior. **Conclusiones:** Los avances tecnológicos han permitido desarrollar algoritmos de evaluación y manejo dirigidos a lograr los mejores desenlaces según las características de cada paciente. La bibliografía actual recomienda el tratamiento quirúrgico basado en la medición objetiva de los defectos óseos glenohumerales, para lo cual la artroscopia y la tomografía con reconstrucción 3D ofrecen la cuantificación más acertada.

Palabras clave: Defectos óseos glenohumerales; inestabilidad del hombro; pista glenoidea; lesiones de Hill-Sachs.

Nivel de Evidencia: IV Revisión narrativa

INTRODUCTION

The wide range of motion of the glenohumeral joint occurs at the expense of a demand on multiple mechanisms to preserve joint stability. Different dynamic and static components are essential to preserve joint congruence and, in this way, make movement effective in the different planes. The bony static components involve the

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humeral head that articulates with a glenoid fossa that is comparatively smaller, concave, and shallow. At rest, the concavity-compression effect secondary to negative intra-articular pressure is the main stabilizing factor of the joint. Other stabilizers, known as the dynamic stabilizers, including the capsule, the glenohumeral ligaments, and the rotator cuff, are important in varying degrees of motion. From the bone point of view, the characteristics of the glenoid fossa, specifically its depth, its width and its version, as well as the position of the scapula, can alter joint stability.¹

In the 16th century, Ambroise Paré, considered the father of modern surgery, described glenohumeral dislocations and considered those associated with fractures to be complex.² Nowadays, it is known that, in episodes of acute dislocation and its recurrences, bone injuries can be generated either by fractures, by loss due to attrition, or by impaction both at the glenoid and humeral levels.³ These are known as glenohumeral bone defects, which have an impact on therapeutic decision-making when approaching a patient with shoulder instability.

The analysis of glenohumeral bone defects has been the subject of study and debate in shoulder surgery for the last 20 years, changing as arthroscopic techniques and imaging studies have evolved. This has enabled modifications in treatment and its postoperative outcomes. In this narrative review, we present the most relevant literature in sections divided by five-year periods.

2000-2005 A NEW MILLENNIUM BEGINS

In 2000, Burkhart and De Beer published one of the most relevant articles on glenohumeral instability.⁴ In an analysis of cases of traumatic glenoid defects and their relationship with therapeutic failure using Bankart surgery, they established that arthroscopic Bankart surgery obtains the same outcomes as open surgery if there are no glenoid bone defects. These findings were initially described as “inverted pear” due to their arthroscopic appearance. In addition, they described, for the first time, humeral defects as significant Hill-Sachs lesions if they generate engagement with the anterior rim of the glenoid in a functional athletic position (abduction of 90° combined with external rotation from 0 to 135°). They proposed treatment with capsular shift or humeral osteotomy and considered that glenoid defects required bone grafts to recover stability, that the procedure of transferring the coracoid to the anterior rim of the glenoid, better known as the Latarjet procedure, was preferred.⁵

Later, in 2002, the same authors suggested an arthroscopic method to establish a more precise quantification of glenoid defects.⁶ In the same year, when studying patients with Bankart lesions with a bone component, Porcellini et al. found that arthroscopic fixation with anchors in defects of less than 25% allowed return to sport in 92% of patients.⁷ In 2004, using the arthroscopic method of quantification of Burkhart defects, Lo et al. noted that the “inverted pear” shape requires a bone loss of at least 25-27% of the inferior glenoid, and for its treatment, they recommended bone grafts in order to restore the anatomy.⁸

2006-2010 THE YEARS OF GREATEST FRENCH INFLUENCE

In 2007, in France, Boileau, after carrying out a study to identify risk factors for recurrence with Bankart surgery,^{9,10} published the ISIS score (Instability Severity Index Score), which takes into account factors such as age, sports participation and the type of sport, as well as characteristics in conventional radiography of bone defects and ligament hyperlaxity.¹¹ Since then, the ISIS score has become one of the most used tools for making therapeutic decisions between Bankart-type arthroscopic surgeries or open procedures, such as Latarjet surgery, to prevent recurrence of instability.

Likewise, in 2007, Yamamoto introduced the concept of the “glenoid track”, analyzing the contact area between the humeral head and the glenoid in different abduction positions, in a cadaveric study. The glenoid track corresponds to 84% of the glenoid surface, if there are no bone defects. This author concluded that defects in the humeral head can engage with the anterior rim of the glenoid with movements of the shoulder in flexion and abduction, when the humeral defect extends medially over the medial margin of the track.¹²

After proposing the arthroscopic measurement technique in 2002, Chuang exposes, in 2007, a method for the pre-surgical quantification of glenoid defects by means of computed tomography with three-dimensional reconstruction (3D CT).¹³ One year later, using multiplanar reconstruction tomography and quantitative analysis, d’Elia et al. recommended bone grafting procedures for defects greater than 20%.¹

In 2009, in a cadaveric study to calculate the defects that cause instability, Yamamoto and Itoi found that defects located in the anterior portion of the glenoid of 6 mm, equivalent to 20%, generate significant anterior instability.¹⁴ Bollier and Arciero published an algorithm and set a 20% limit to indicate Latarjet surgery.¹⁵

During the same year, when making a synthesis of the evidence available up to that moment, Provencher proposed an algorithm calculating the defects with preoperative 3D CT or arthroscopic evaluation (Figure). Defects <15% in the glenoid are not significant, while those >30% are indicated for bone augmentation with grafting or Latarjet surgery. For the gray zone located between 15% and 30%, which would later be defined as “subcritical defects”, it is proposed to consider the clinical characteristics of the patient in terms of their functional demand and sports practice.¹⁶

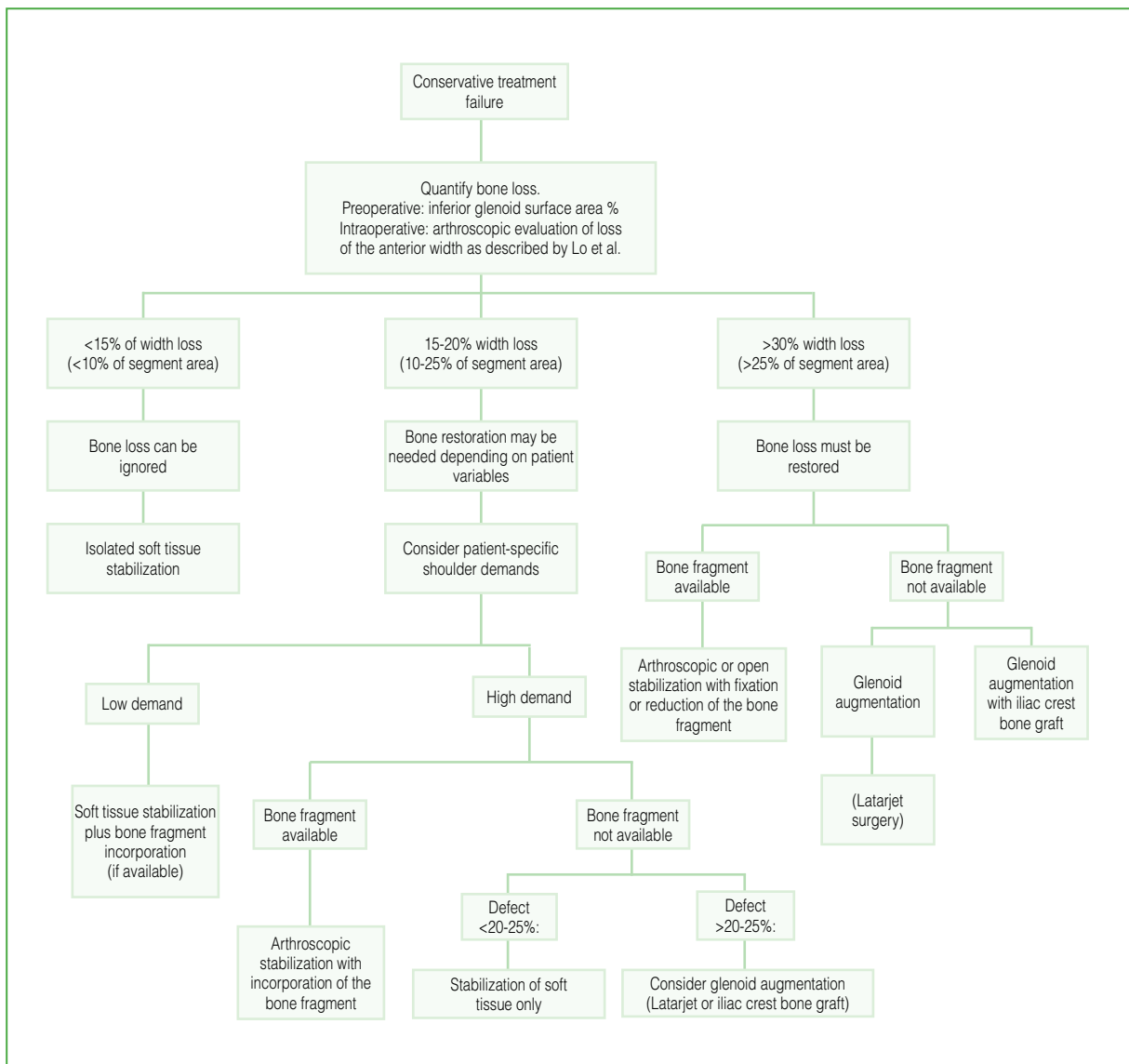


Figure. Algorithm for the surgical management of glenoid bone loss. Adapted from: Piasecki DP, Verma NN, Romeo AA, Levine WN, Bach BR Jr., Provencher MT. Glenoid bone deficiency in recurrent anterior shoulder instability: Diagnosis and management. *J Am Acad Orthop Surg* 2009;17(8):482-93.

2011- 2015 THE IMPORTANCE OF ENGAGEMENT ON OR OFF THE TRACK

In 2011, Bhatia carried out a systematic review of level I evidence studies, and proposed 25% as the limiting defect for recommending bone procedures. In this publication, he stressed the importance of quantifying the defects and taking into account the age and sports participation of the patients when choosing the type of surgery, especially with borderline defects.¹⁷ Focusing on the analysis of Hill-Sachs injuries, in a biomechanical study in 2012, Guiles compared surgical alternatives for the treatment of humeral defects such as *remplissage* (filling of the Hill-Sachs bone defect with capsule and infraspinatus tendon), resurfacing, and the use of allografts. He showed that all procedures are effective in improving stability, with the exception that *remplissage* decreases external rotation.¹⁸ In an analysis of Hill-Sachs lesions, Provencher defined them as frequent lesions that require a study of their size, orientation, and other concomitant glenoid or capsulolabral lesions. He indicated that humeral defects >30% merit surgical management with combined procedures, such as arthroplasty, allografts, *remplissage*, and resurfacing.¹⁹

A few years later, in a study of 100 patients with instability, Kurokawa established the prevalence of Hill-Sachs lesions was 94% and that 7% of them had medial extension with respect to the glenoid track.²⁰ In 2013, Metzger published a clinical study to apply the concept of the glenoid track explained in cadaveric studies by Yamamoto et al. As a result, he noted that 13% of patients with instability and Hill-Sachs injury are at risk of injury engagement with bipolar injuries off the glenoid track. 85% of these patients show functional engagement on examination under anesthesia. This engagement can be predicted before surgery with precise measurements on diagnostic images and is related to the patient's age and recurrence episodes. He stressed the importance of evaluating the lesions in a bipolar way, considering that bone defects at the glenoid and humeral levels are enhanced, increasing the risk of recurrence.²¹ In the middle of this same year, in a comparative study between the different imaging options for the study of glenohumeral bone defects, Bishop et al. stated that 3D CT is the most reliable study to quantify glenoid defects.²²

In 2014, Di Giacomo et al. synthesized previously established concepts, looking for an arthroscopic and radiological way to analyze bipolar lesions and quantify humeral defects to predict their engagement at the glenoid level. With this method, the engaged lesion is called an off-track Hill-Sachs injury, according to its size and whether its medial margin is more internal than the glenoid track, which generates a lack of bone support to the injury. Based on this quantification, they created a treatment paradigm, categorizing the findings in four types of patients, according to glenoid defects (< or >25%) and type of Hill-Sachs lesion (on-track vs. off-track) (Tables 1 and 2). Based on this categorization, the therapeutic decision is proposed, ranging from arthroscopic Bankart surgery to Latarjet surgery. The authors' recommendation is to convert Hill-Sachs injuries from off-track to on-track, with procedures such as bone grafting or *remplissage* to restore stability.²³

Later, in 2015, Shaha et al. conducted a study on a military population and found that <20% defects treated with Bankart stabilization may have poor functional outcomes. Based on a quartile analysis of bone loss, they defined defects >13.5% as "subcritical" in the active population with high functional demand.²⁴ This concept of subcritical defects calls into question the previous limit of 20% for recommending bone stabilization procedures and highlights the need to assess the patient's functional environment and sports demand. This would be reconsidered by the group of Yamamoto et al. in 2019, who, when evaluating a civilian population of young athletes or patients with high functional demand, defined a subcritical glenoid bone loss as that between 17% and 25%.²⁵

Table 1. Anterior instability categories

Group	Glenoid defect	Hill-Sachs lesion
1	<25%	On-track
2	<25%	Off-track
3	≥25%	On-track
4	≥25%	Off-track

Adapted from: Di Giacomo G, Itoi E, Burkhart SS. Evolving concept of bipolar bone loss and the Hill-Sachs lesion: From “engaging/non-Engaging” lesion to “on-track/off-track” lesion. *Arthroscopy* 2014;30(1):90-8.

Table 2. Treatment paradigm

Group	Recommended treatment
1	Arthroscopic Bankart repair
2	Arthroscopic Bankart repair plus <i>remplissage</i>
3	Latarjet surgery
4	Latarjet surgery with or without humeral procedures (humeral bone grafting or <i>remplissage</i>) depending on the engagement of the Hill-Sachs lesion after the Latarjet procedure.

Adapted from: Di Giacomo G, Itoi E, Burkhart SS. Evolving concept of bipolar bone loss and the Hill-Sachs lesion: From “engaging/non-Engaging” lesion to “on-track/off-track” lesion. *Arthroscopy* 2014;30(1):90-8.

2016-2021 THE NON-FRENCH INFLUENCE TIPS THE BALANCE

As of 2016, two studies focused on evaluating the association of bone defects measured on imaging with the natural evolution of instability and its clinical-functional impact. McNeil et al. performed an analysis of glenoid bone loss from attrition, and found that it increased along the duration of instability symptoms.²⁶ For their part, Wolke et al. found a relationship between imaging findings and bone loss quantified with functional scores for specific scales of shoulder function and quality of life (WOSI, Rowe, SSV).²⁷ Three years later, Dickens published one of the first studies evaluating the impact of the natural evolution of shoulder instability on bone defects. In it, he identified that, after the first episode of dislocation, a bone loss of 6.8% can be generated in the anterior rim of the glenoid. Considering the impact of bone defects on instability, the study suggested considering early surgical stabilization in a young, athletic population.²⁸

As of 2017, several authors questioned the reliability of tomographic or arthroscopic measurement strategies for bone defects. Moroder et al. stated that there was a lack of standardization of protocols for taking and measuring tomographic images to quantify glenoid defects.²⁹ Later, in 2019, Funakoshi explained that there was a discrepancy between calculations of bipolar defects in surgical planning with tomography and intraoperative findings by arthroscopy.³⁰ For their part, after a systematic literature review, Gowd et al. detected an inconsistency in the analysis of Hill-Sachs lesions, observing that only 3.2% of the studies quantify humeral defects.³¹ In 2019, Yamamoto introduced the new concept of on-track injuries. In his analysis, he divided the glenoid track into four zones. According to the authors, peripheral Hill-Sachs lesions, which take up more than 75% of the glenoid track, have worse functional outcomes.³²

At the end of 2020, a fundamental study on changing understanding and therapeutic decisions in shoulder instability was published. Complementing the Boileau current given by the ISIS scale with the concept of the glenoid track, Di Giacomo et al. proposed the GTIMS (*Glenoid Track Instability Management Score*) (Table 3), a new treatment algorithm that combines the concept of the glenoid track with the risk factors of the ISIS scale, using advanced tomography images. With this new instrument, a more conservative treatment indication is obtained than with the ISIS score, which recommends twice as many Latarjet surgeries, with equally satisfactory clinical outcomes.³³

Table 3. GTIMS (*Glenoid Track Instability Management Score*)

GTIMS prognostic factors	Score
Age at the time of surgery (years)	
≤20 years	2
>20 years	0
Sport type	
Contact or overhead	1
Other	0
Level of sports competition	
Competitive	2
Recreational/none	0
Shoulder hypermobility	
Confirmed anterior or inferior hypermobility	1
Normal mobility	0
Evaluation of bone loss in 3D tomography	
On-track	0
Off-track	4
Total GTIMS	10

Adapted from: Di Giacomo G, Peebles LA, Pugliese M, Dekker TJ, Golijanin P, Sanchez A, et al. Glenoid track instability management score: Radiographic modification of the Instability Severity Index Score. *Arthroscopy* 2020;36(1):56-67.

Also in 2020, Rossi et al. published an expert consensus using the Delphi technique on the management of glenohumeral instability with associated bone loss. The consensus concluded that a history of recurrent instability and failed soft tissue surgery makes it necessary to suspect bone defects. In addition, according to the experts, the image of choice for their study is 3D CT using the “en face” view as the most accurate method for measuring the glenoid. In contrast to this, they pointed out that Hill-Sachs lesions, even to this date, are poorly quantified and classified. Finally, they recommended the bone stabilization procedure for glenoid defects >20%.³⁴

Finally, Yamamoto and Itoi enunciated the concept of the central track or peripheral track, subdividing the glenoid track into four zones that include the Hill-Sachs occupation of the track. For on-track injuries at the level of its central configuration, they proposed treatment with Bankart arthroscopic surgery, given the low probability of being engaged. Unlike what happens with on-track defects within the peripheral portion, if the patient is a contact athlete, stabilization with Latarjet surgery or *remplissage* is recommended. On the other hand, if he or she performs

any non-contact sports practice, arthroscopic stabilization with Bankart surgery is recommended. This recommendation is based on the worse results on the WOSI scale without recurrent instability in patients with peripheral lesions within the glenoid track (occupation $\geq 75\%$ of the glenoid track).³²

CONCLUSIONS

Shoulder dislocations can lead to glenohumeral bone defects that are associated with significant symptoms of instability. During the last two decades, many authors have made significant contributions to these defects, which have allowed them to modify both the approach to patients, as well as the therapeutic options and their postoperative outcomes. Currently, we know that 3D CT and arthroscopy are essential tools for the evaluation of bone defects, although there is still no perfect method to quantify them. Likewise, the introduction of the categorization of Hill-Sachs lesions as on-track or off-track gives us a treatment paradigm to guide surgical therapeutic decisions. In general, all the contributions point to a common idea, in which it is concluded that the treatment must be oriented in a holistic and individual way for each patient, according to their age, functional environment, sports demand, and glenohumeral bone defect.

Finally, the evolutionary path has not been entirely easy, it presented contrasts between important currents, such as the case of the French school that defends Latarjet surgery, which has been attacked by the American influence. The current literature leans toward treatment directed by objective measurement of glenoid defects, and there is a trend toward specialized diagnosis and treatment.

Conflict of interest: The authors declare no conflicts of interest.

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Translation and Cross-cultural Adaptation of the *Constant-Murley Score* into Argentine Spanish

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ABSTRACT

Introduction: Few questionnaires to quantify and categorize subjective and objective functional limitations in shoulder pathology have been translated into Argentine Spanish. **Objective:** To carry out the standardization, translation and cross-cultural adaptation of the Constant-Murley Score into Argentine Spanish. **Materials and Methods:** The cross-cultural adaptation was carried out following the steps proposed in the guide of the International Society of Pharmacoeconomic and Outcomes Research which establishes the guidelines for the translation and cultural adaptation of patient-reported outcome measures. **Results:** The version resulting from the translation process into Spanish was evaluated through cognitive interviews in two stages. Subsequently, the questions were reformulated for a better understanding of the elements and their response options, and specific modifications were made. **Conclusion:** We carried out the cross-cultural adaptation of the Constant-Murley score, obtaining a useful tool for the population of Argentina with shoulder pathologies.

Keywords: Constant-Murley score; shoulder.

Level of Evidence: II

Traducción y adaptación transcultural del Constant-Murley Score al español de la Argentina

RESUMEN

Introducción: Pocos cuestionarios para cuantificar y categorizar las limitaciones funcionales subjetivas y objetivas en la patología de hombro han sido traducidos al español de la Argentina. **Objetivo:** Realizar la estandarización, traducción y adaptación transcultural del *Constant-Murley Score* al español de la Argentina. **Materiales y Métodos:** La adaptación cultural se realizó siguiendo las etapas propuestas en la guía de la *International Society of Pharmacoeconomic and Outcomes Research* que establece las directrices para la traducción y adaptación cultural de medidas reportadas por los pacientes. **Resultados:** La versión traducida al español fue evaluada mediante entrevistas cognitivas en dos etapas. Posteriormente se reformularon preguntas para el mejor entendimiento de los elementos y sus opciones de respuesta y, dentro de cada apartado, se realizaron modificaciones específicas. **Conclusión:** Se logró realizar la traducción y adaptación transcultural del *Constant-Murley Score*, con lo que se obtuvo una herramienta para aplicar en la población argentina con patologías de hombro.

Palabras clave: Escala de Constant-Murley; cuestionario; hombro.

Nivel de Evidencia: II

INTRODUCTION

Shoulder pain is one of the most frequent causes of orthopedic consultation, with a prevalence of up to 66% in the general population. This condition is often associated with a restricted range of motion and limitation of activities of daily living.¹

There are multiple questionnaires to quantify and categorize the subjective and objective functional limitations of shoulder disease. However, at present, only the SPADI (*Shoulder Pain and Disability Index*), the EQ-5D (*European Quality of Life Five Dimensions*), the Short Form-36 and the ASES scale (*American Shoulder and*

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Elbow Surgeons) have been validated in Argentine Spanish.²⁻⁵ The rest of the tools are published in English, and the translation and validation into Argentine Spanish are not available. For this reason, when they are used in our environment, translation errors occur and altered results are obtained due to interpretation and application errors. That is why the use of scales with translation, cultural adaptation and validation for use in Spanish speakers is suggested.⁵

The *Constant-Murley Score* (CMS) was described in 1987 as an instrument to assess general shoulder function.⁶ The ESSSE (*European Society for Surgery of the Shoulder and Elbow*) recommends it for use in research, which is why it has been widely used in recent decades.^{7,8}

The CMS has been criticized for its imprecise terminology and fuzzy methodological definitions. In recent decades, multiple studies have been published aimed at standardizing measurement tools in an accurate and reproducible way.⁸ In 2008, Constant published a guide with additional recommendations, without including a standardized protocol, thus leaving room for different interpretations in its application, especially on the measurement of strength.^{7,9} Aside from the methodological difficulties, there is no validated translation, which is why today the use of this tool is criticized for its wide measurement variations.⁹ Thus, it is important to carry out a translation and a cultural adaptation that allow its standardized application and methodology in our country.

OBJECTIVE

The objective was to carry out the standardization, translation and cross-cultural adaptation of the CMS to Argentine Spanish for the population of our country.

MATERIALS AND METHODS

Tool

The original version of the questionnaire in English used to perform the translation and cultural adaptation is divided into four sections (A, B, C, D). The first two correspond to the subjective part, and total 35 points, while the other two make up the objective exam, worth 65 points. The maximum total is 100 points.¹⁰

The first section corresponds to "Pain", in which the patient must indicate, on a line, the maximum degree of pain felt in the last 24 hours.

Section B comprises four items referring to the activities carried out in the last week, in terms of sleep quality, the ability to work regularly and the ability to perform leisure activities without limitation.

Section C includes four individual tests that assess active range of motion in anterior elevation, abduction, external rotation, and internal rotation.

Finally, section D evaluates force with a dynamometer.

Translation and cultural adaptation

The cultural adaptation of the tool was carried out following the steps proposed in the guide published by the ISPOR (International Society of Pharmacoeconomic and Outcomes Research) that establishes the guidelines for the translation and cultural adaptation of patient-reported outcomes measures:¹¹ 1) preparation; 2) translation; 3) reconciliation; 4) back translation; 5) back translation review; 6) harmonization; 7) cognitive debriefing; 8) review of cognitive debriefing results; 9) proofreading; 10) final report.¹¹

In stage 1, preparation, permission was requested from the authors of the original tool to carry out the cultural adaptation. For this, an email was sent to Ilija Ban, main author of the Danish adaptation and standardization version of CMS¹⁰ and to Roger Emery, co-author of the 2008 version of Constant,⁷ who granted permission. In this phase, the doubts and ambiguities related to the conceptual meaning of the conflicting items of the questionnaire were also clarified with the authors. The authors were invited to actively participate as advisors throughout the process. The working group was made up of two traumatologists with extensive experience in the use of this tool, two bilingual professional translators and an expert methodologist in tool adaptation and validation.

In stage 2, translation, two native Argentine translators with experience in translating medical texts independently translated the original English version into Argentine Spanish. In turn, both translators were asked to write a report assessing the level of difficulty in translating each item (where 1 indicates "very easy to translate" and 10 "very difficult to translate"), with comments on challenging phrases that highlight, or uncertainties, and the rationale for their choices to resolve them.

In stage 3, reconciliation, a unified version of the aforementioned translations into Argentine Spanish was reached by consensus. Any doubts or discrepancies that arose during the translation were discussed with the authors of the original questionnaire.

In stage 4, the back translation into English of the version that emerged in the previous stage was carried out. This was done by a native English language translator who did not have access to the original document. The purpose of back translation is to provide a quality assurance step that is used to ensure that the reconciled translation is conceptually equivalent to the original version. As with the previous translators, he was asked for a report in which he communicated the level of difficulty in translating each item, with comments on the conflicting phrases and the reasoning behind his choice to resolve them.

In stage 5, back-translation review, the English back-translation was compared with the original version. The original authors were asked, through a form sent by email, to issue their degree of agreement on the adequacy of the back translation with respect to the original version, scoring between 1 (totally disagree) and 10 (totally agree) for each item, including the observations that they considered pertinent. Scores less than or equal to 3 indicate that the translation is not considered appropriate; between 4 and 6, doubtful, and between 7 and 9, appropriate. The translation is defined as consensual when 70% of scores equal to or greater than 7 are reached.¹² Any conceptual discrepancies or other problematic elements identified were presented to the translators for review and discussion. Updates to the reconciled translation were made as needed.

In the same way as Ban et al.,¹⁰ we added an illustrated example of the correct position of the patient and the dynamometer with respect to the wrist to facilitate understanding of the section.

During the exchanges of information between the work team and the authors of the original version, we integrated stage 6 (harmonization) which, instead of being seen as an isolated step, was included as continuous quality control to guarantee the conceptual equivalence of the translations.

Stage 7, cognitive debriefing, aims to assess and guarantee an adequate level of comprehensibility and cognitive equivalence of the new translation. The guidelines proposed by the COSMIN guidelines (Consensus-based Standards for the selection of health Measurement Instruments) suggest carrying out 7 or more cognitive interviews to obtain a “very good” rating.¹³ For this stage, a series of cognitive interviews were conducted with 5 traumatologists and 5 patients from the target population. After a detailed explanation by the research team about the type of study, its objective and the characteristics of the questionnaire, they were presented with the information sheet to participate.

The interviews were conducted by videoconference following the probing method, which consists of additional questions to unravel each stage of the question-answer process.¹⁴ For its preparation, a structured script was followed according to which the participants read the instructions and, subsequently, each of the questions, answering them one by one. Throughout this process, they were asked to try to explain in their own words the meaning of each item and its possible answers and to identify those parts or words that were difficult for them to understand or were confusing. During the interview, participants’ body language expressions and comments that might indicate difficulties in reading or understanding the questionnaire format were recorded. In addition, we recorded the degree of comprehension of the format, the instructions, and the questions (*Annex*). In case of identifying any word, phrase or answer option in the survey as confusing, they were asked to propose an alternative expression on how to rewrite the statements in order to improve understanding.

A detailed and literal annotation of each of these aspects was made in order to be evaluated later. The interviews were recorded.

In stage 8, review of the cognitive interviews, the results of the comprehension test were reviewed and the translation was finalized. The instructions, the response format and the elements of the instrument that were not clear in at least 20% had to be reassessed.¹⁵ Therefore, the comprehensibility requirement is set at a minimum inter-rater agreement of $\geq 80\%$. This step is used to support the conceptual, semantic and content equivalence of the sentences used in the survey, so that they are easily understood by the target population.

Stage 9, proofreading, was not carried out as such because it is a brief tool and because during the previous stages the correct wording (grammar and spelling) of the tool was always ensured.

ETHICAL CONSIDERATIONS

The study complies with current ethical and confidentiality requirements, including obtaining informed consent from participants in cognitive interviews. Their identity was preserved by hosting data in Excel spreadsheets on the computers of the Orthopedics and Traumatology Service with an alphanumeric code; only the authors of this study had access through their institutional user.

In addition, the informed consents were filed in an office to which only members of the work team had access.

RESULTS

The version resulting from the Spanish translation process was evaluated through cognitive interviews in two stages. In the first, five specialists in traumatology of the upper limb were interviewed and, in the second, five patients with omalgia evaluated in the office were evaluated in the office. All interviews were conducted within the private care setting. The characteristics of the interviewees are detailed in [Tables 1 and 2](#). The participants stated that the instructions were understandable and easy to carry out, but that, in some cases, the questions needed additional words or phrases for better understanding. For this reason, words were added or deleted and questions were reformulated for a better understanding of the elements and their response options.

Table 1. Characteristics of the professionals interviewed

Age	Sex	Years of experience
42	Male	13
52	Male	28
33	Male	3
38	Male	7
34	Male	4

Table 2. Characteristics of the patients interviewed

Profession	Age	Sex	Diagnosis
Retired	76	Female	Rotator cuff injury
Retired	81	Male	Glenohumeral osteoarthritis
Professor	56	Female	Adhesive capsulitis
Mason	63	Male	Rotator cuff injury
Retired	69	Male	Rotator cuff injury

All the interviewees mentioned that, in the patient's personal data section, it must be specified that the requested information concerns name, surname, age and occupation. In addition, they suggested that the order of the items implies that the item "número de teléfono" (telephone number) be located in the same sector as the personal data, and then continue with the options regarding the date and the reason for consultation.

In the interviews, it was suggested to separate the questionnaire from the instructions. For this reason, we decided to create a simple and agile questionnaire containing only the measurements, free of redundant instructions, and a separate annex of instructions. The objective of the annex is that the interviewer, in case of doubt, has access to a segment with clear measurement rules endorsed in the literature.

Within each section of the CMS (Pain, Activities of Daily Living, Range of Motion, and Strength) specific modifications were made.

Pain Section (“Dolor”)

Unlike the original version, the line was divided into 15 proportional segments/gaps, without using exact measurements. In this way, measurement errors and the difficulty of printing a form with an exact 15 cm line are avoided. At the beginning of this section, we decided to add the instruction “Se lee al paciente la pregunta y se le entrega la hoja para que él mismo realice una marca en el segmento elegido” (“The question is read to the patient and the sheet is given to him so that he can make a mark on the chosen segment”), since the original instructions were not understood by most of the interviewees. At the suggestion of the participants, illustrations corresponding to the different degrees of pain were added to simulate a visual analog scale and facilitate understanding.

The sentence “Califique el nivel máximo de dolor que haya sentido en el hombro al realizar sus actividades habituales en las últimas 24 horas” was reformulated for better understanding to: “¿Cuál fue el máximo de dolor que tuvo usted en el hombro en las últimas 24 horas para realizar sus actividades habituales?”

Activities of Daily Living Section (“Actividades de la vida diaria”)

In this section, as in the previous section, it was measured on a segmented line with proportional distances.

In the question regarding sleep interruption, three out of five of the professionals suggested modifying the third option (“Todas las noches”) for “Interrupción todas las noche”; therefore, said modification was introduced.

The question “¿Cuánto de sus tareas diarias habituales le permite realizar su hombro?” was rephrased to “¿Cuántas de sus tareas diarias habituales le permite realizar su hombro?” because it was previously a literal translation from English to Spanish without grammatical agreement. In this way, the options were modified according to the question: “todo/nada” was changed to “todas/ninguna”. In the options of the answer to question number 3, a similar modification was made; from “todas/ninguna” to “todo/nada”.

With the intention of simplifying the instructions, the questions that involved making a mark on the line were grouped, and then the questions with multiple choice answers were placed.

Range of Motion Section (“Movimiento”)

The first section, referring to “Elevación anterior y abducción” was reformulated, because the original text was not clear to any of the interviewees. For each movement, exemplary photos were added.

It was decided to replace the long arm goniometer with a standard goniometer, which is available in our daily practice.

Strength Section (“Fuerza”)

A clarification on the use of the dynamometer was added: “La fuerza se mide con un dinamómetro digital validado para estos fines o con una balanza de resorte analógica o digital.” Another clarification was made on the position of the arm and the situation of the dynamometer or the scale when performing strength.

At the end of sections A and B, and C and D, a sentence was added for the annotation of the respective score subtotals.

DISCUSSION

The CMS has been translated, adapted and validated into numerous languages.^{10,16-18} This version is the first with translation into Argentine Spanish and adaptation to the Argentine culture. It was performed strictly in accordance with the guidelines published by ISPOR.¹¹ During the translation and adaptation process, modifications were made to the original questionnaire with the aim of achieving a version more in line with the cultural understanding of our country and in order to standardize the steps of the evaluation protocol.

The Danish model on which our translation and adaptation was based was the first to incorporate the recommendations of Gerber et al., in 2008,^{7,10} and to produce a standardized version in English.¹⁰ Regarding the translation, modifications were introduced in the formulation of certain questions in order to achieve a more colloquial and understandable language for our population. Regarding cultural adaptation, during the interviews it was observed that no difficulties arose because the CMS does not include elements that may vary significantly with the Argentine idiosyncrasy. In accordance with the suggestions made by the professionals interviewed in this adaptation, it was decided to separate the questionnaire for the patients from the instructions for the interviewer, unlike other versions.^{10,16} This scale has been questioned for various reasons, including the difficulty in assessing the degree of pain, the subjective interpretation of range of motion during daily activities by the patient, and the initial lack of a standardized way of measuring strength.^{7,10,19} It is divided into four sections: Pain, Activities of Daily Living, Range of Motion, and Strength. Modifications were made in each of the sections.

Pain Section (“Dolor”)

At the beginning of the Pain section, it was decided to clarify that the question should be read to the patient and then the sheet should be handed over to him/her so that he or she can make a mark on the segment. The original versions fail to specify this step, it is not clear whether the question should be asked by the evaluator or read by the patient. The exact question to be asked is also not referenced, which can make it difficult to standardize the questionnaire.^{5,10} Ntourantonis et al. did not find the original score practical and reported that the patients did not understand how to answer the section.¹⁶

Ban et al.¹⁰ scored pain on a 0-15 cm line using a ruler. However, when printing the questionnaire, the scale may be lost, so it may be subject to errors. That is why we decided to use a form of measurement by segments and proximity regardless of the total length of the line.

Also, to facilitate understanding, we added images simulating faces with different degrees of discomfort, that is, a visual analog scale for pain. This new way of assessing pain differs from that of the original CMS,⁵ where it was a visual pain scale without values, as well as the 2008 modification,⁸ where it recommends using a tool with two sides, one with values of one side and no values on the other.

Range of Motion Section (“Movimiento”)

In the modified version, it is specified that the movements must be performed without pain and in a sitting position.⁸ In agreement with other authors, such as Ban et al., and Çelik,^{10,16,17} and at the suggestion of the interviewed participants, we believe that evaluating rotations in a sitting position could be complex and impractical to perform, thus we clarify in the instructions that all movements must be performed in a standing position with a separation of the width of the shoulders.

In addition, we believed it important to add images of each of the movements in order to facilitate the understanding of the evaluators and standardize the physical examination.¹⁰

Strength Section (“Fuerza”)

The way of evaluating strength changed from that of the original version of the CMS.⁵ We standardized the use with endorsed digital dynamometers and also with an analog or digital spring balance, as described by Bankes et al. and Johansson et al., among others.^{20,21} There are variations within the literature regarding the measuring instrument and the position where it should be placed.¹⁹ This lack of standardization leads to difficulties when comparing published results. The equipment used to assess strength in different studies varies between digital and analog dynamometers. Bankes et al. used the Isobex® dynamometer, validated and created by Gerber et al., and compared it to a fixed spring balance and an unsecured spring balance. They did not find significant differences with the results obtained with the fixed spring balance.^{20,22} They discouraged the use of the unsecured spring balance due to the variability in the records. In 2005, Johansson and Adolffsson validated the use of digital scales, which are commonly used to weigh bags on tourist trips.²¹

The position of the patient when evaluating strength conditions the result obtained.²³ However, numerous studies do not specify the necessary position.²³ The original method to assess strength was described by Moseley,²⁴ who used a spring balance in 90° flexion and 90° abduction. Maximum isometric strength is measured in 90° abduction, since, according to electromyographic reports, this is the moment of greatest supraspinatus and deltoid recruitment.^{10,25} Due to the lack of specification of the strength evaluation plane, Bankes et al. proposed a standardized method in 1998²⁰ and finally, in 2008, the exact position was detailed.⁷ In our adapted questionnaire, we implemented the recommendations described by Bankes et al., positioning the patient standing with the arm at 90° abduction in the scapular plane, the elbow extended and the forearm pronated, and performing three repetitions one minute apart.²⁰ Those patients who do not achieve the indicated position receive a score of zero, thus solving the inconsistencies in the measurements.^{7,16,20}

Despite being the only version adapted to Spanish, it is not without limitations. First, it should be mentioned that the number of interviewees was small (5 professionals and 5 patients) and may not represent the entire population capable of using this questionnaire. However, the number of interviewees is similar to that used in previous versions.¹⁶ There is currently controversy regarding the ideal number of interviewees, however, the guide used to carry out this version suggests that the translation should be tested in a cognitive interview by at least 5 to 8 individuals, who should speak the language into which the translation will be made.¹¹

Second, all the professionals interviewed were traumatologists, which represents a bias at the professional level. However, it is important to note that traumatologists specializing in the shoulder apply questionnaires such as the CMS on a daily basis and that other translations have been made based on interviews only with traumatologists.²⁶

Despite the fact that the CMS is widely used in Argentina for the evaluation of numerous shoulder pathologies, there is still no standardized protocol in Spanish that allows a correct measurement of the CMS, without leaving room for the free interpretation of results. For this reason, having this new tool available can contribute to a better understanding of the functional deterioration of patients and unify the way in which they are evaluated. This results in a benefit for both the treating surgeon and the patient, and for the generation of future scientific studies.

The translation and adaptation of this score can contribute to the scientific community and improve the quality of patient care. However, it has not yet been validated and compared with other questionnaires for the functional study of the shoulder. An evaluation of the psychometric properties of the CMS is still pending, so a study that includes this analysis is recommended in order to achieve the maximum benefit of this scale.

CONCLUSIONS

It was possible to carry out the translation and cross-cultural adaptation of the CMS and a tool was obtained to apply to the population of Argentina with shoulder diseases. In this way, there will be a standardized protocol in our language in order to facilitate care activity and the quality of care and treatment provided to patients. We believe it is particularly important that other evaluation tools should be translated and adapted to our language in order to have more study elements.

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Annex: Guía entrevistas cognitivas

Fecha:
 Identificador del participante:
 Minuto de Inicio:
 Minuto de Finalización:

Instrucciones

- ¿Puede decirme con sus propias palabras qué se le explica en las instrucciones?
- ¿Puede describir algo confuso o alguna dificultad que tuvo para comprender estas instrucciones?
- ¿Hay alguna palabra o frase que cambiaría para mejorar las instrucciones?

Ítem

- ¿Qué significa [ítem] para usted?
- Con sus propias palabras, ¿cómo explicaría lo que significa esta pregunta?

Opciones de Respuesta

- Lea cada opción de respuesta y dígame qué significa para usted.
- En relación a [ítem], ¿sugiere modificar alguna opción de respuesta?
- ¿Alguna vez podrían elegir la primera opción de respuesta? ¿Por qué o por qué no? ¿Puede describir una experiencia en la que se podría elegir la última opción de respuesta?
- ¿Qué otras opciones de respuesta no están cubiertas en este ítem?

Cobertura del Contenido

- ¿Qué otras opciones relacionadas a [ítem] no están cubiertas en este cuestionario?

Formato

- Observar al encuestado completando el cuestionario. Tenga en cuenta las expresiones faciales, las indicaciones de dificultad para leer, si pasa las páginas de un lado a otro. Escuche los comentarios sobre la dificultad para leer o preguntas que indiquen falta de claridad o facilidad de uso.
- Por ejemplo, "He notado que ha vacilado, ¿Qué sugerencias tiene para que el cuestionario sea más fácil de completar?"

Extensión

- ¿Qué le pareció la cantidad de tiempo que le llevó completar el cuestionario?

Comentarios:

Ítems Confusos:

CUESTIONARIO - ESCALA DE CONSTANT-MURLEY

- Datos personales:
 - Nombre
 - Apellido
 - Edad
 - Número de teléfono
- Diagnóstico:
- Lado:
 - Derecho
 - Izquierdo
- Fecha de consulta:
 - Preoperatoria
 - 3 meses
 - 6 meses
 - 1 año
 - años
 - Otro

Sección de evaluación subjetiva

A. Dolor.

¿Cuál fue el máximo dolor que tuvo usted en el hombro en las últimas 24 horas para realizar sus actividades habituales? (Indíquelo seleccionando un segmento) (Figura 1)

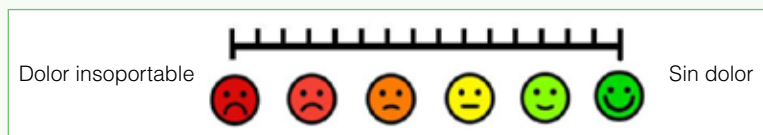


Figura 1. Escala visual análoga del dolor.

B. Actividades de la vida diaria.

Las siguientes 4 preguntas se refieren a las actividades de la vida diaria que haya realizado en la última semana.

1. ¿Cuántas de sus tareas diarias habituales le permite realizar su hombro? (Indíquelo seleccionando un segmento) (Figura 2)

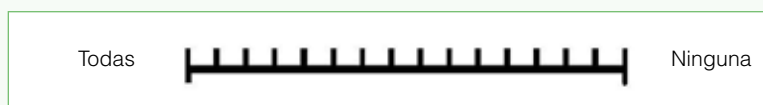


Figura 2.

2. ¿Cuánto de su actividad recreativa habitual le permite realizar su hombro? (Indíquelo seleccionando un segmento) (Figura 3)



Figura 3.

3. ¿Su sueño se ve interrumpido a causa del hombro? (Marque un casillero)

- Sueño sin interrupciones
- Interrupción ocasional
- Interrupción todas las noches

4. ¿Hasta qué altura puede usar la mano cómodamente? (Marque un casillero)

- Por debajo de la cintura
- Hasta la cintura
- Hasta el esternón
- Hasta el cuello
- Hasta la parte superior de la cabeza
- Por encima de la cabeza

SECCIÓN DE EVALUACIÓN OBJETIVA

C. Movilidad

1 y 2: Elevación anterior y abducción (Tabla 3)

Tabla 3.

Rango	0°-30°	31°-60°	61°-90°	91°-120°	121°-150°	151°-180°
Elevación anterior						
Abducción						
Puntos	0	2	4	6	8	10

3. Rotación externa

- Manos detrás de la cabeza, codos hacia delante
- Manos detrás de la cabeza, codos hacia atrás
- Manos en la parte superior de la cabeza, codos hacia delante
- Manos en la parte superior de la cabeza, codos hacia atrás
- Elevación completa de los brazos

4. Rotación interna

- Región lateral del muslo
- Detrás del glúteo
- Articulación sacroilíaca
- Cintura
- 12.^a vértebra torácica
- Nivel interescapular (entre los omóplatos)

D. Fuerza: puntos.

INSTRUCCIONES

A. Dolor.

Se lee al paciente la pregunta y se le entrega la hoja para que él mismo seleccione un segmento de la línea. La línea contiene 15 segmentos. Cada uno vale un punto. En caso de ser puntuado en el medio de dos segmentos, se redondea hacia arriba o hacia abajo, según cercanía con el segmento más próximo. (Figura 4)

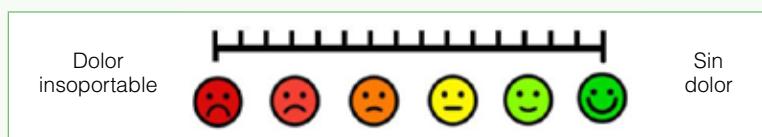


Figura 4.

B. Actividades de la vida diaria.

En las siguientes dos preguntas el entrevistador leerá las preguntas y el paciente realizará una marca en el segmento elegido.

El puntaje se determina según el segmento seleccionado. Segmentos 1-3 = 4 puntos, 4-6 = 3 puntos, 7-9 = 2 puntos, 10-12 = 1 punto, 13-15 = 0 puntos. (Figuras 5 y 6)

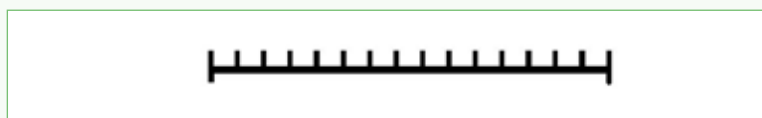


Figura 5.

1. ¿Cuántas de sus tareas diarias habituales le permite realizar su hombro?

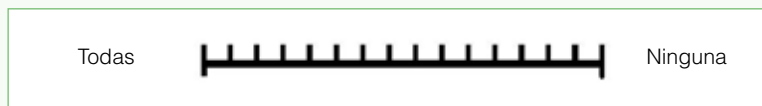
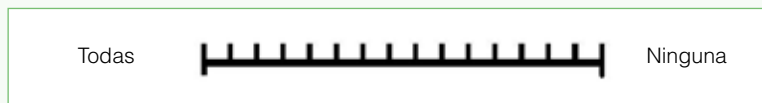


Figura 6.

2. ¿Cuánto de su actividad recreativa habitual le permite realizar su hombro?



En las preguntas 3 y 4, el entrevistador leerá las preguntas y dará verbalmente las opciones al paciente.

3. ¿Su sueño se ve interrumpido a causa del hombro?

- Sueño sin interrupciones (2 puntos)
- Interrupción ocasional (1 punto)
- Interrupción todas las noches (0 puntos)

4. ¿Hasta qué altura puede usar la mano cómodamente?

- Por debajo de la cintura (0 puntos)
- Hasta la cintura (2 puntos)
- Hasta el esternón (4 puntos)
- Hasta el cuello (6 puntos)
- Hasta la parte superior de la cabeza (8 puntos)
- Por encima de la cabeza (10 puntos)

Puntaje total para las secciones A+B (subtotal de la evaluación subjetiva, 0-35 puntos): ____ puntos

SECCIÓN DE EVALUACIÓN OBJETIVA

C. Movilidad

Se evalúa la movilidad activa indolora máxima alcanzada en cada plano de movimiento. En caso de registrar una mayor movilidad con dolor, esta no será tenida en cuenta.

Primero, el evaluador muestra el movimiento deseado y luego el sujeto lo realiza. Para todos los ejercicios, el sujeto debe estar parado y con los pies apuntando hacia delante y separados a la distancia entre hombros.

1 y 2: Elevación anterior y abducción (Tabla 3) (Figuras 7 y 8)

La elevación anterior y la abducción son registradas con un goniómetro de brazos largos. El sujeto debe realizar los movimientos sólo con el brazo afectado. (0-20 puntos) La referencia del goniómetro se coloca en el brazo y en el eje de las apófisis espinosas de la columna dorsal.

Tabla 3.

Rango	0°-30°	31°-60°	61°-90°	91°-120°	121°-150°	151°-180°
Elevación anterior						
Abducción						
Puntos	0	2	4	6	8	10



Figura 7. Elevación anterior, dividido por rangos.



Figura 8. Abducción, dividido por rangos

3. Rotación externa (Figura 9)

El sujeto debe realizar la rotación externa sin ayuda, y las manos deben estar ubicadas por encima y por detrás de la cabeza sin tocarla. El sujeto debe realizar los movimientos con ambos brazos simultáneamente, pero solo se registran los realizados con el brazo afectado. Se comienza por “manos por detrás de la cabeza, codos hacia delante”. Se otorgan 2 puntos por cada movimiento completo por separado. (0-10 puntos)

- Manos detrás de la cabeza, codos hacia delante
- Manos detrás de la cabeza, codos hacia atrás
- Manos en la parte superior de la cabeza, codos hacia delante
- Manos en la parte superior de la cabeza, codos hacia atrás
- Elevación completa de los brazos



Figura 9. Rotación externa

4. Rotación interna (Figura 10)

El sujeto debe realizar la rotación interna sin ayuda y debe señalar con el dedo pulgar los puntos de referencia anatómica indicados. El sujeto debe realizar los movimientos solo con el brazo afectado. Se comienza por “región lateral del muslo”. Los movimientos deben realizarse sin dolor. (0-10 puntos)

- Región lateral del muslo (0 puntos)
- Detrás del glúteo (2 puntos)
- Articulación sacroilíaca (4 puntos)
- Cintura (6 puntos)
- 12.^a vértebra torácica (8 puntos)
- Nivel interescapular (entre los omóplatos) (10 puntos)



Figura 10. Rotación interna

D. Fuerza (0-25 puntos): puntos.

La fuerza se mide con un dinamómetro digital validado para estos fines o con una balanza de resorte analógica o digital. Para realizar la evaluación, el sujeto debe estar parado, con los pies apuntando hacia delante y separados a la distancia entre hombros.

El brazo debe estar en 90 grados de abducción en el plano escapular. Si el brazo no puede elevarse a 90 grados, el puntaje es 0. La muñeca debe estar en pronación, de modo que la palma mire hacia abajo, y el codo en máxima extensión. La correa superior del dinamómetro debe colocarse alrededor de la muñeca del sujeto de manera que quede sobre la cabeza del cúbito. La correa o punto de fijación inferior del dinamómetro debe estar fija a la altura de la cintura, sobre por ejemplo, una mesa o escritorio. no debe sostener el evaluador ninguna de las correas del dispositivo. Se le pide al sujeto que empuje hacia arriba lo máximo posible durante 5 segundos. Al mismo tiempo, se lo estimula de manera verbal: Listo 3-2-1 empuje... empuje... empuje.

El puntaje se calcula a partir del mejor de un total de 3 intentos, cada uno de los cuales se realiza con un intervalo mínimo de 1 minuto entre ellos. El puntaje corresponde a la fuerza en libras (máximo 25 puntos). Si la fuerza se mide en kilogramos, el puntaje se calcula multiplicando por 2.2.

Puntaje total para las secciones C+D (subtotal de la evaluación objetiva, 0-65 puntos): ___ puntos

Puntaje total de Constant A+B+C+D (0-100 puntos): puntos.

Efficacy and Adaptability of Use of the Shoulder Pacemaker® Device During the Strengthening Phase of Shoulder Rehabilitation

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ABSTRACT

Shoulder pathology is one of the most common causes of care in Orthopedics, being caused by multiple entities such as instability, rotator cuff injuries, osteoarthritis, adhesive capsulitis, among others, which can present several signs or symptoms, and that will require comprehensive management. One of the fundamental pillars in the management of shoulder pathology is physiotherapy. Technological advancements have allowed the advent of devices that help us improve the physiotherapy process. In this study, we share our experience with the use of the Shoulder Pacemaker®, a device designed to improve muscle balance in patients with shoulder pathology.

Key words: Shoulder; instability; rotator cuff; osteoarthritis; rehabilitation; Shoulder-pacemaker.

Level of Evidence: III

Eficacia y adaptabilidad de uso del dispositivo Shoulder Pacemaker® durante la fase de fortalecimiento en la rehabilitación de hombro. Estudio preliminar

RESUMEN

La patología de hombro es una de las causas más comunes de atención en salas de Ortopedia, y puede deberse a múltiples entidades, como inestabilidad, lesiones del manguito rotador, artrosis, capsulitis adhesiva, que pueden provocar un sinnúmero de signos o síntomas, y requerirán un manejo integral. Uno de los pilares fundamentales en el manejo de la patología de hombro es la fisioterapia. El avance tecnológico ha permitido la incorporación de dispositivos que nos ayudan a mejorar el proceso de fisioterapia. En este estudio, compartimos nuestra experiencia con el uso del Shoulder Pacemaker®, un dispositivo diseñado para mejorar el balance muscular en pacientes con patología de hombro.

Palabras clave: Hombro; inestabilidad; manguito rotador; artrosis; rehabilitación, Shoulder-Pacemaker®.

Nivel de evidencia: III

INTRODUCTION

The treatment of shoulder pathology and its complex approach force us to understand its intricate anatomy and biomechanics, considering that the shoulder is a joint complex that is made up of four joints (glenohumeral, acromioclavicular, scapulothoracic, sternoclavicular), making it the joint with the greatest range of motion of the body. It allows the upper limb to be placed in multiple positions; however, this same characteristic is what predisposes it to the appearance of diseases.¹

We understand the shoulder as a functional unit that, in order to work properly, needs its structures to work in coordination. Its anatomical structure allows functions that include six degrees of freedom, three of rotation and three of translation.² Translation movement is the difference between the humeral head and the glenoid, while

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rotation has three degrees: internal and external rotation in relation to the trunk, medial and lateral rotation in relation to an anteroposterior axis perpendicular to the plane of the scapula, and an anterior and posterior tilt along an established axis at the spine of the scapula, characteristics that allow the shoulder a wide range of motion and must be well understood to adequately comply with physical therapy programs.^{3,4}

The stability of the glenohumeral joint is given by the passive components that correspond to bone geometry, intra-articular pressure, the glenoid labrum and capsuloligamentary structures. Regarding the active components, the contractile muscle activity around the joint is modulated by the neuromuscular system.⁵

This dynamic stabilization factor can be improved by exercises. There are two fundamental aspects that must be taken into account during the strengthening phase: the specific strength level of each muscle group and the balance of forces on the muscles that act in the same joint.⁶

This has a great impact on the treatment of certain types of glenohumeral instability.

The Stanmore classification of glenohumeral instability is based on the analysis of the combination of structural abnormalities (traumatic or atraumatic) and alterations of the neurological system.⁷ Three entities are thus defined (Table) that can be related to each other. Both the therapist and the surgeon play a fundamental role in their treatment, be it conservative or surgical, understanding that type I shall be managed surgically, type II shall initially be treated conservatively, and then surgically if there is no response, and type III, which generally requires a conservative approach, shall be treated with exercises focused on activating the center of rotation of the organism where the functional kinetic chain (core) begins, and postural education with the final objective of achieving adequate activation of the rotator cuff.⁸

Table. Stanmore classification

Polar I	Traumatic structural instability
Polar II	Atraumatic structural instability
Polar III	Abnormal muscle activation instability

Taken from Jaggi A, Lambert S. Rehabilitation for shoulder instability. *Br J Sports Med* 2010;44(5):333-40.

On the other hand, in the case of rotator cuff pathologies, rehabilitation based on the consensus of the American Society of Elbow and Shoulder (ASES) with the American Society of Shoulder and Elbow Therapists (ASSET) sets clear objectives, such as restoring ranges of both active and passive motion, an adequate couple of forces between the glenohumeral joint and the scapulothoracic joint, and restoring pain-free shoulder function.⁸

Finally, the objective of rehabilitation in patients who have undergone shoulder arthroplasty must be based on three fundamental pillars: protecting the joint, protecting the deltoid, and establishing clear expectations regarding the ranges of motion and functionality that the operated shoulder may have,⁹ that is, the management of the periarticular musculature is very important.

Regular physical therapy and commonly available muscle training therapy do not always lead to the desired result and this led to the development of an adjunctive technology called Shoulder Pacemaker®.⁹ Its functioning is based on stimulating hypoactive muscles during shoulder movement to restore muscle balance (Figure 1).

The first formal indications for the use of the Shoulder Pacemaker® device were posterior instability and scapular dyskinesis, but the vast majority of shoulder pathologies present a significant percentage of added scapular dyskinesis. The postoperative immobilization itself generates muscle weakness, alteration of force couples and could cause temporary dyskinesis.

The objective of this study was to retrospectively evaluate the results with the use of this device in a series of patients with shoulder pathology.



Figure 1. Example of use of the device during a rehabilitation session.

MATERIALS AND METHODS

A retrospective study was conducted between December 2020 and December 2021, including a search of our outpatient database and the electronic registry of our Shoulder Pacemaker® device. All patients who completed the physical therapy process and used the device during it were identified. After the identification of cases, an electronic survey was carried out that the patient had previously accepted by means of a telephone call.

The inclusion criteria were: patients who clinically presented scapular dyskinesia that was not easily reversed with the usual treatment, either with only conservative or post-surgical management, or with posterior instability. Patients who were undergoing treatment, those who expressed their wish not to participate, and those who could not be located were not included.

The elements that were assessed were the functionality after the use of the device through the Simple Shoulder Test (SST)¹⁰ and a satisfaction and adaptability survey on the use of electronic devices as a complement to the conventional physiotherapeutic process.

RESULTS

The review of medical records revealed a total of 16 patients who had used the Shoulder Pacemaker® device as an adjuvant in the physical therapy process. One of them expressed his desire not to participate in the research process, two could not be located and one was undergoing treatment, for which he did not meet the inclusion criteria; therefore, the final sample consisted of 12 patients.

Seven patients were men and 5 women; the average age was 49.8 years (range 18-67). The affected side was the left in seven cases and the right in five, there was no bilateral pathology. Six clinical entities were identified, in which rotator cuff pathology predominated. It should be noted that surgical or non-surgical management was not discriminated in patients with this diagnosis, who represented half of the sample. In [Figure 2](#), the identified entities are detailed.

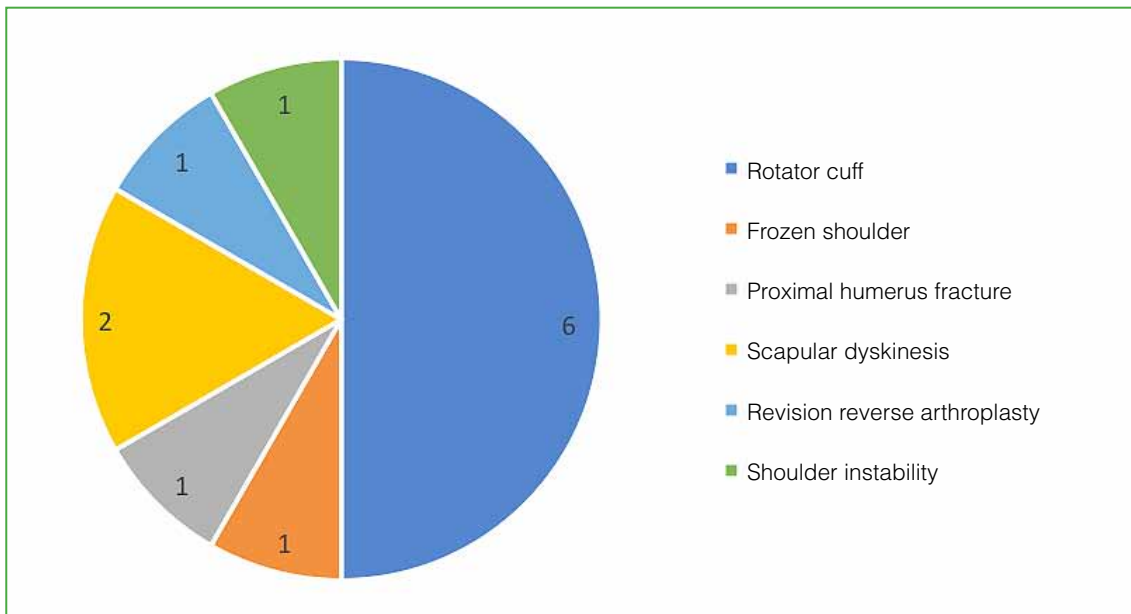


Figure 2. Pathologies addressed in our study.

The functionality of the affected shoulder was assessed with the SST, which yielded an average value of 79.86%. In 10 of the 12 patients, the average SST value was 90%, two cases had a poor evolution with an average of 29.16%. Figure 3 shows the results after the final evaluation.

The average satisfaction and adaptability rate was high, the best outcomes were obtained in rotator cuff pathology and instability, there were two cases with a low functional assessment.

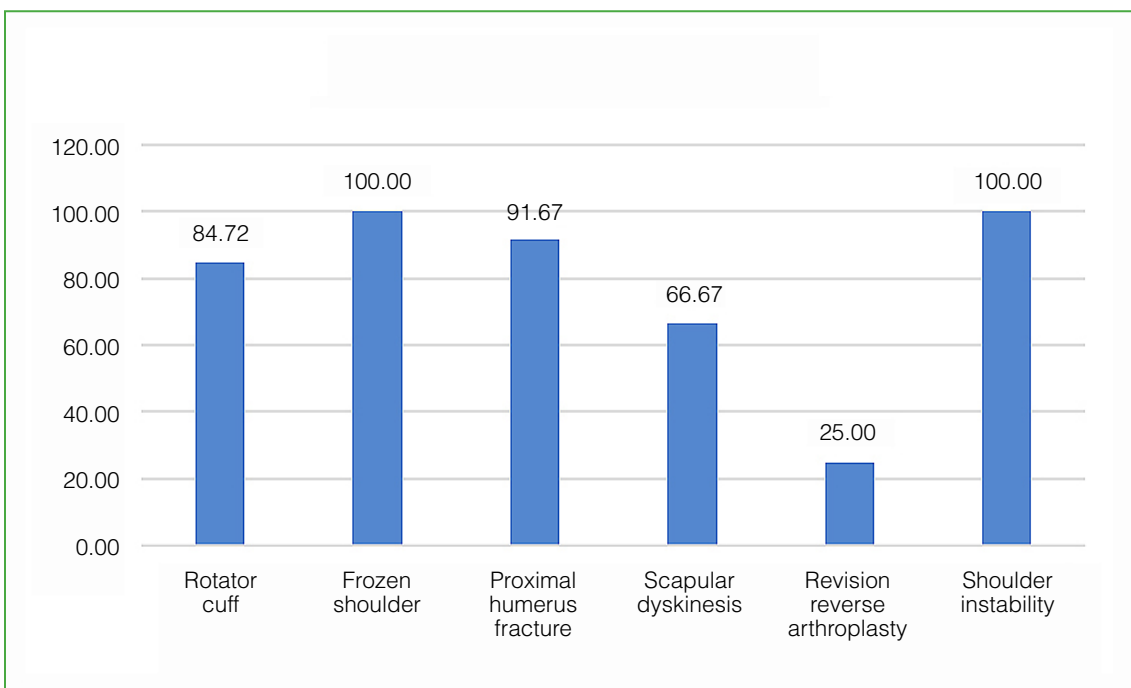


Figure 3. Average evaluation of the Simple Shoulder Test.

DISCUSSION

The device is relatively new to the market, and there is little literature to support its use in various pathologies. In 2017, Moroder et al.¹¹ carried out a pilot study whose objective was to demonstrate the functionality of this device in the activation process of hypoactive external rotator and periscapular muscles. Three patients with a diagnosis of instability and previous failed conservative treatment participated. These patients described that they were able to move their arms freely and without pain, and even without subjective or objective signs of instability, they all rated it as excellent in their rehabilitation process.

In 2020, Moroder et al.¹² carried out a case series study that included 24 shoulders in 16 patients with a diagnosis of posterior functional instability and previous failed conservative treatment and a follow-up of up to 2 years. The authors reported favorable outcomes, with a reduction in the rate of instability assessed with the WOSI (Western Ontario Shoulder Instability Index) scale, and excellent outcomes at the one and two-year follow-up. 81% were very satisfied with the device and 19% were satisfied. All would recommend its use to other patients.

In our study, there were two cases with low values. The first of them corresponds to a patient who underwent a shoulder arthroplasty due to fracture, with subsequent periprosthetic infection, plus extraction of the implant, surgical cleaning and placement of a cement spacer, and who, in a third surgical stage, underwent a reverse shoulder arthroplasty procedure in the context of pseudoparalysis and deltoid deficit, with a poor final functional assessment and a 25% SST. However, he was satisfied with the functionality remaining at the end of the process and reported that the device was easy to use. The second case that had a torpid evolution was a patient diagnosed with scapular dyskinesia and confirmed suprascapular nerve entrapment who underwent arthroscopic release, his functional ranges and scapular biomechanics were clinically excellent, but he suffered persistent neuropathic pain, which we believe influenced his score of 33.33% on the SST. He reported that the device was easy to use, but that he was not satisfied with its use. Currently, this patient is receiving pain therapy with excellent results; however, when the SST was performed, he was not in the same condition as he is today.

These two cases are considered exceptional and do not correspond to the average number of patients, but they deserve to be reported to establish a basis on the scope that the use of the device can have.

There are no published reports on the use of this device in pathologies other than those of instability, although our study includes a small number of patients, it has been shown that the indication of the device can be extended.

It is important to mention that the manufacturer has recently expanded the indications of use for other pathologies, such as pre- and postoperative management of inverted arthroplasty, rotator cuff rehabilitation, scapular dyskinesia, posterior instability, and announced that it will soon be expanded for weight-bearing athletes, pre- and post-operative deltoid rehabilitation, overhead athlete rehabilitation, and throwing athlete rehabilitation.

Knowing the limitations of retrospective studies and the probable bias that can be generated, we consider this study to be a pioneer in communicating the benefits of the Shoulder Pacemaker® device in the physical rehabilitation process.

Eleven of our patients recommended the use of the Shoulder Pacemaker® device as an adjunct in the physical therapy process to achieve excellent outcomes in the activation phase and one patient was not entirely satisfied with the device.

CONCLUSIONS

The use of electronic devices in medicine has grown exponentially in recent years, the ease of access to medical technologies has favored the development of increasingly effective diagnostic and therapeutic methods and with better results for the patient. In this study, we highlight the Shoulder Pacemaker® device in the physical rehabilitation process, where excellent outcomes have been observed in multiple pathologies, which expands the treatment possibilities for our patients, making it a practical, reliable, and safe method that is available to our patients.

Conflict of interests: The authors declare no conflicts of interest.

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Scores III

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ABSTRACT

The Editorial Committee wants to provide its readers with an update on the most commonly used scales. The use of tables and scales is a widespread practice in Orthopedics and Traumatology. The measurement and quantification of clinical, functional, and radiographic aspects has become an essential tool for decision-making in different aspects of healthcare activity. We carry out a review of the most used scales, defining their use and including original and updated literature.

Key words: Scales; scores; tables; update.

Level of Evidence: V

Puntajes III

RESUMEN

El Comité Editorial quiere brindar a sus lectores una actualización de las escalas de uso corriente. El empleo de tablas y escalas es una práctica muy extendida en la Ortopedia y Traumatología. La medición y la cuantificación de los aspectos clínicos, funcionales y radiográficos se convirtieron en una herramienta imprescindible para la toma de decisiones en diferentes aspectos de la actividad asistencial. Llevamos a cabo una revisión de las escalas más utilizadas, definiendo su uso e incluyendo bibliografía original y actualizada.

Palabras clave: Escalas; puntajes; tablas; actualización.

Nivel de Evidencia: V

INTRODUCTION

The Editorial Committee wants to provide its readers with an update on the most commonly used scores. The use of tables and scales is a widespread practice in Orthopedics and Traumatology. The measurement and quantification of clinical, functional, and radiographic aspects have become essential tools for decision-making in different aspects of healthcare activity.

We carried out a review of the most used scales, defining their use and including original and updated literature. In this opportunity, we dealt with the section of hand scores.

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MAYO ELBOW PERFORMANCE SCORE (MEPS)https://www.orthopedicscore.com/scorepages/mayo_elbow.html**Section 1 - Pain intensity** Maximum 45

- None (45)
- Mild (30)
- Moderate (15)
- Severe (0)

Section 2 - Range of motion Maximum 20

- Arc of motion >100° (20)
- Arc of motion between 50 and 100° (15)
- Arc of motion <50° (5)

Section 3 - Stability Maximum 10

- Stable (10)
- Moderate instability (5)
- Gross instability (0)

Section 4 - Function Maximum 25

- Can comb hair (5)
- Can eat unaided (5)
- Can perform personal hygiene (5)
- Can put on a shirt (5)
- Can put on shoes (5)

TOTAL SCORE (maximum 100 points)**SUGGESTED REFERENCES**

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ASES SHOULDER SCORE (*American Shoulder and Elbow Surgeons*)https://www.orthopaedicscore.com/scorepages/patient_completed_score.html**ASES Shoulder Score**

Name Age Date

1. Usual work

2. Usual Sport/Leisure activity?

3. Do you have shoulder pain at night? Yes No4. Do you take pain killers such as paracetamol (acetaminophen), diclofenac, or ibuprofen? Yes No5. Do you take strong pain killers like codeine, tramadol, or morphine? Yes No6. How many pills do you take on an average day? Yes No

7. Pain intensity

10 9 8 7 6 5 4 3 2 1 0

Pain as bad as it can be No pain at all

8. Is it difficult for you to put on a coat?

 Unable to do Very difficult to do Somewhat difficult Not difficult

9. Is it difficult for you to sleep on the affected side?

 Unable to do Very difficult to do Somewhat difficult Not difficult

10. Is it difficult for you to wash your back/do up your bra?

 Unable to do Very difficult to do Somewhat difficult Not difficult

11. Is it difficult for you to clean the perineal area?

 Unable to do Very difficult to do Somewhat difficult Not difficult

12. Is it difficult for you to comb your hair?

 Unable to do Very difficult to do Somewhat difficult Not difficult

13. Is it difficult for you to reach a high shelf?

 Unable to do Very difficult to do Somewhat difficult Not difficult

14. Is it difficult for you to lift 10 pounds (4.5 kg) above your shoulder?

 Unable to do Very difficult to do Somewhat difficult Not difficult

15. Is it difficult for you to throw a ball over your head?

 Unable to do Very difficult to do Somewhat difficult Not difficult

16. Is it difficult for you to do your usual work?

- Unable to do Very difficult to do Somewhat difficult Not difficult

17. Is it difficult for you to do your usual sport/leisure activity?

- Unable to do Very difficult to do Somewhat difficult Not difficult

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CONSTANT-MURLEY SHOULDER SCORE

https://www.orthopaedicscore.com/scorepages/constant_shoulder_score.html

Answer all questions, selecting just one unless otherwise stated.

During the past 4 weeks...

1. Pain

Severe Moderate Mild None

2. Activity Level (check all that apply)

Unaffected sleep: Yes No

Full Recreation/Sport: Yes No

Trabajo completo: Yes No

3. Arm positioning

Up to waist

Up to xiphoid

Up to neck

Up to top of head

Above head

4. Strength of Abduction [lbs]

0

1-3

4-6

7-9

10-12

13-15

15-18

19-21

22-24

>24

RANGE OF MOTION**5. Forward flexion**

31-60°

61-90°

91-120°

121-150°

151-180°

6. Lateral elevation

31-60°

61-90°

91-120°

121-150°

151-180°

7. External rotation

Hand behind head, elbow forward

Hand behind head, elbow back

Hand to top of head, elbow forward

Hand to top of head, elbow back

Full elevation

8. Internal rotation

Lateral thigh

Buttock

Lumbosacral junction

Waist (L3)

T12 vertebra

Interscapular (T7)

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Case Resolution

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Case presentation on page 464.

DIAGNOSIS: Intraosseous lipoma.

DISCUSSION

In the magnetic resonance of the left shoulder (**Figure 3**), a tumor was visualized in the centromedullary, proximal metaphyseal-diaphyseal region. It was predominantly made up of a hyperintense lesion on T1 sequences and hypointense on suppression sequences, surrounding a hypointense central sclerotic area on all sequences.

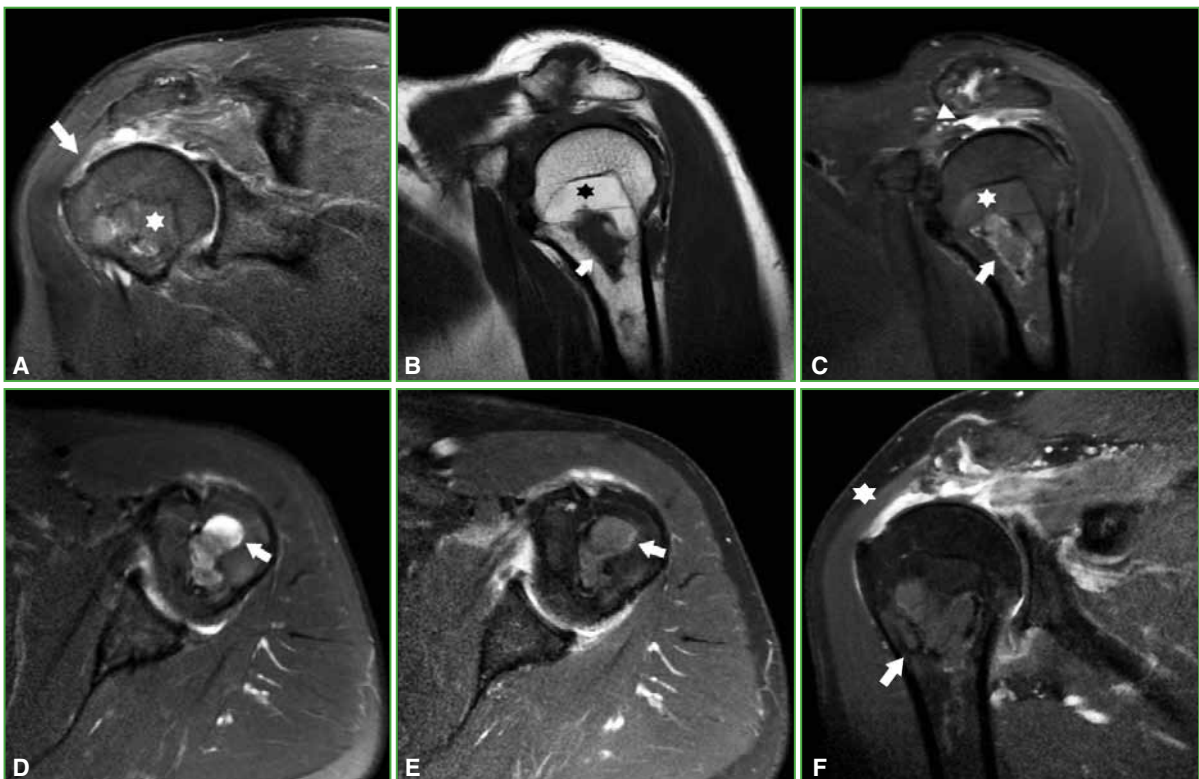


Figure 3. Left shoulder MRI. **A.** Coronal section in proton density sequence with fat suppression. Supraspinatus tear (arrow) and hypointense intraosseous lesion (asterisk). **B.** Sagittal section in T1 sequence. A predominantly hyperintense tumor (asterisk) with central hypointense lesion (arrow). **C.** Sagittal section in proton density sequences with fat suppression. The lesion becomes hypointense (asterisk) with its central component slightly hyperintense (asterisk). Supraspinatus injury. **D.** Axial section in proton density sequence with fat suppression. Heterogeneous central lesion, with a small cystic transformation (arrow). **E.** Axial section in T1 sequence with fat suppression and injection of contrast medium. Heterogeneous central lesion, with small cystic transformation (arrow) without enhancement after injection. **F.** Coronal section in T1 sequence with fat suppression and injection of contrast medium. Heterogeneous central lesion (arrow) without enhancement after injection. Supraspinatus injury (asterisk).

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It had a defined proximal margin and a poorly defined distal margin. After the injection of the contrast medium, no enhancement of any of the components of the lesion was observed.

The acromioclavicular joint presented degenerative changes with a decrease in the acromiohumeral space. Full-thickness rupture of the supraspinatus muscle tendon was visualized, with myotendinous retraction. It was suggested to complete the study with computed tomography (Figure 4).

Given the findings by magnetic resonance imaging and tomography, the treatment comprised expectant management of the bone injury and physiotherapy for the rotator cuff pathology.

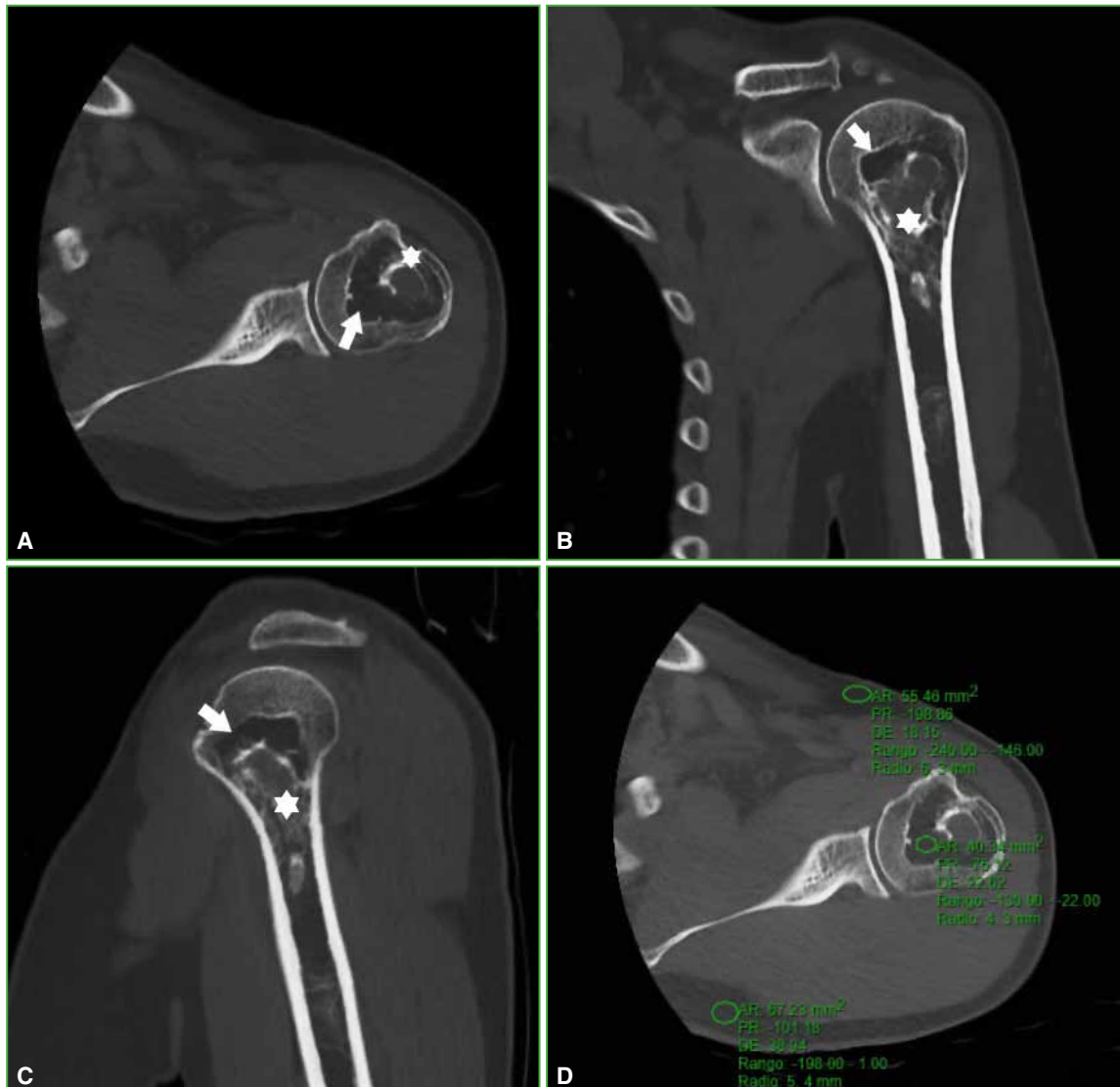


Figure 4. Computed tomography of the left shoulder. **A.** Axial section in bone window. Heterogeneous lesion that alternates hypodense (arrows) and hyperdense (asterisk) areas. **B and C.** Coronal and sagittal sections, respectively, in the bone window. A hypodense lesion (arrow) with its hyperdense central component (asterisk) without endosteal cortical invasion. **D.** Axial section in bone window where measurements of the Hounsfield Units (HU) of the lesion are made, which yield a value of -75 HU (compared with the TCS, with an average value of -150 HU).

DIAGNOSIS

Given all these findings, intraosseous lipoma was diagnosed.

Intraosseous lipomas are extremely rare and overdiagnosed, especially on MRI.

They present as fat-dense lesions in all imaging studies. They can be detected at any age and are usually asymptomatic. The most frequent type involves the calcaneus, in Ward's triangle. Treatment is indicated only when they cause symptoms, and consists of curettage and bone grafting.

A pathological classification has been described for the biopsies of these lesions (Milgram) that divides them into three groups: type I, with a predominance of viable fat cells, type II, with a predominance of transitional cells, formed, in part, by viable cells plus necrosis and calcifications, and type III, necrotic fat, calcifications, fluid levels, and reactive bone.

In imaging studies, it appears as a lytic-like lesion, with defined margins, low aggressiveness, thinning and slight cortical widening. They often have central calcifications.

Radiograph: Radiolucent intramedullary lesion, with sclerotic borders. It may have central (Milgram type II) or extensive (Milgram type III) calcifications.

Computed tomography: Intraosseous lesion with fat attenuation.

Magnetic resonance: *Type I.* T1 and T2 sequences with a hyperintense fat signal. Loss of signal with suppression. *Types II and III.* Fat necrosis with low signal on T1 sequence, high signal on T2 sequence and peripheral enhancement after contrast medium injection.

The most frequent differential diagnoses are foci of fatty bone marrow hyperplasia, fibrous dysplasia (Figure 5), simple or aneurysmal bone cyst (Figure 6), chondral lesions (enchondroma, chondrosarcoma) (Figure 7), bone infarct, avascular necrosis (Figure 8) and chondromyxoid fibroma (Figure 9).

ACTIVITY

Given this diagnosis, what treatment would you propose in your Institution?



Figure 5. Fibrous dysplasia. **A.** Radiograph of the right shoulder in internal rotation. A lesion is visualized that alternates radiolucent and radiodense areas, with a wide transition zone, and cortical thinning without rupture (arrow). **B.** Computed tomography, axial section of the proximal third of the humerus. A centromedullary “ground glass” lesion (asterisk), with marked cortical thinning (arrow). **C and D.** Magnetic resonance imaging in T1 sequences, coronal and axial planes (dotted line plane), respectively. A predominantly hypointense lesion, surrounded by hyperintense areas (spared marrow). **E and F.** Magnetic resonance in STIR sequences, coronal and axial planes (dotted line plane), respectively. A predominantly hyperintense lesion at the diaphyseal level without involvement of the epiphysis.



Figure 6. Simple bone cyst. Radiograph of the left shoulder in internal rotation. A hypodense lesion, with multiple partitions inside and cortical thinning (arrow), without epiphyseal involvement (asterisk).

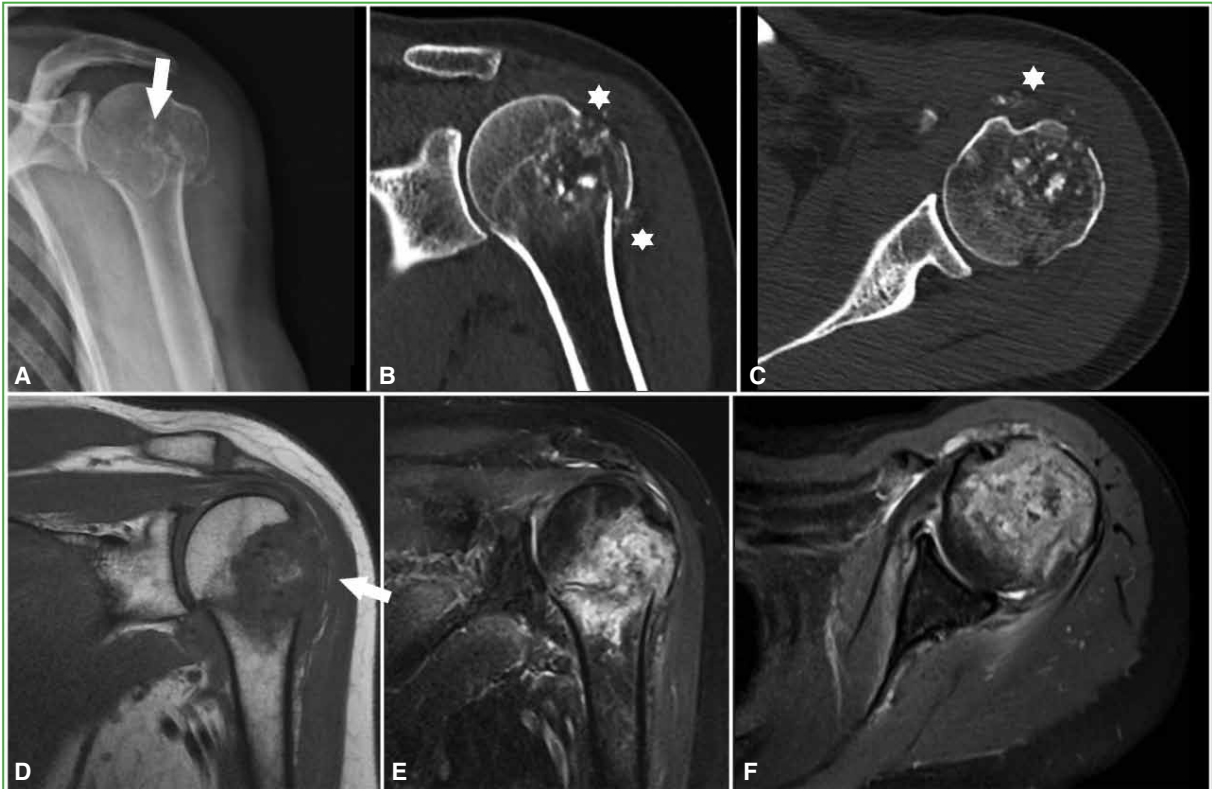


Figure 7. Chondrosarcoma. **A.** Radiograph of the left shoulder in internal rotation. Lesion that alternates radiolucent and radiodense areas (popcorn) (arrow), associated with cortical rupture due to pathological fracture. **B and C.** Computed tomography, coronal (**B**) and axial (**C**) sections of the humerus. A pathological fracture on pre-existing heterogeneous lesion. Dense images are observed in soft tissue topography (asterisks). **D.** Magnetic resonance imaging in T1 sequences, coronal plane. A predominantly hypointense lesion, with pathological fracture and soft tissue involvement (arrow). **E and F.** Magnetic resonance in STIR sequences, coronal and axial planes, respectively. A predominantly hyperintense lesion with significant bone edema.

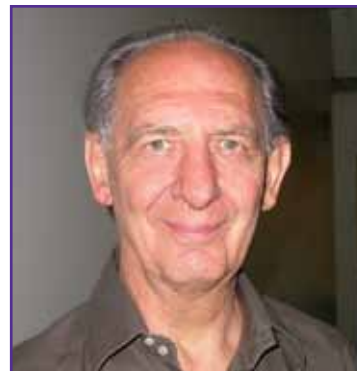


Figure 8. Bone necrosis. Radiograph of the right shoulder in internal rotation with a predominantly epiphyseal hypodense lesion (arrow) with fragmentation of the epiphysis (asterisk).



Figure 9. Chondromyxoid fibroma. Radiograph of the right shoulder in internal rotation. A metaphyseal-diaphyseal lesion, with lobulations and internal calcification (arrowhead), and cortical thinning and insufflation (arrow), without epiphyseal involvement (asterisk).

Dr. Zelman Simonovich (1932-2022)



Dr. Zelman Simonovich was born in the city of Caucete, Province of San Juan, on July 18, 1932 and died in Haifa, Israel, on July 6, 2022.

His professional training was very rigorous, including his time in many first-level services such as that of Professor Leoncio Fernández, of whom he was a disciple.

His outstanding work at the Güemes sanatorium in this capital in the 1980s led him to become head of that service, in which he reflected his transforming vision of the specialty, creating the subspecialties that currently govern orthopedics and traumatology.

In 1987 he founded the “Centro Centenario de Ortopedia y Traumatología” of which he was also its head.

This leadership was recognized in the specialty due to its constant modern and innovative vision.

He was president of the SAMECIPP (*Sociedad Argentina de Medicina y Cirugía de Pie y Pierna* [Argentine Society of Medicine and Surgery of the Foot and Leg]) during the years 1993-1994 and during this mandate, he was the IDEOLOGIST AND FOUNDER OF THE SOCIEDAD LATINOAMERICANA DE PIERNA Y PIE (FLAMECIPP [Latin American Society of the Leg and Foot]) whose first congress was held in Buenos Aires.

He possessed a deep sensitivity towards his family in particular, but also towards his patients and colleagues. He took everything and everyone into account and for this reason he was loved in medical circles.

Professional, complete, demanding, and sought after for interconsultation.

He was the trainer of many, those of whom we do not stop remembering him.

Recognized nationally and internationally for his capacity and bonhomie, he convened and was convened by notable figures such as: Bernard Regnault, Antonio and Ramón Viladot, Samuel Barouk and Michel Maestro, among others.

As a distinctive feature of his personality, I must highlight his convening power, a virtue that made him a leader in any area. Many of us owe him our training and career.

A leader has left us. We keep his teachings and wisdom.

He was a fighter, an excellent friend, and the bearer of remarkable curiosity.

Whoever felt the warmth of this man in his life will surely have noticed his interest when asked about different concerns, his attentive and serene gaze gave his interlocutor that security that he lacked or that point of view that he had not thought of.

Ansel, for his friends, was a faithful and safe hand, founder of a medical group to which his colleagues are proud to have belonged.

May time witness the permanent memory of his close family and also of those who, like us, had the privilege of having him as a role model.

*Gregorio. M. Fiks
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Letter to the Editor

Dear Editor,

I have read with interest the article by Cullari et al., recently published in the AAOT journal.¹ Phosphaturic mesenchymal tumors constitute, as the authors point out, an infrequent pathology.

We had the opportunity to identify a similar tumor of 2 cm in diameter in the popliteal fossa of a patient with osteomalacia. The size of the tumor and its successful removal allowed laboratory values to return to normal and made it possible to heal the patient's bone lesions without resorting to drug treatment (octreotide, burosumab, etc.). This case has been published.² We believe it is appropriate to mention it here, because that citation is not part of the references offered by Cullari et al.

Yours truly,

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