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Starting over. Will it be the same as before?

Dr. Guillermo Rodríguez Sammartino
President of ACARO

In recent years, with the pandemic punishing the entire world, we have all experienced situations of greater restriction in our activities. From the simplest and most everyday things (such as walks down the street, visits to relatives or friends, or taking the dog for a walk) to access to health –undoubtedly, of fundamental importance–all aspects of our lives were affected by this circumstance.

The new restrictions have reduced or modified access to medical education. For almost two years, there were no face-to-face meetings, conferences, courses or assignments, and we were forced to start with a new virtual modality in which, unwillingly, we became accustomed to seeing ourselves on small grid screens of one of the so many existing virtual platforms.

It is fundamental for me to highlight the emphasis, commitment, and excellent achievements in educational matters that AAOT as well as ACARO have made and continue to make. The contributions of the AAOT or the ACARO are frequently questioned –incorrectly, according to my vision. Being involved for many years in both directive commissions, I consider that I can contribute my point of view in this regard. The focus of both boards of directors on educational matters is indisputable. They have organized conferences and courses in towns and cities all over the country (such as Tilcara, Ushuaia, Iguazú, San Martín de los Andes, etc.), as well as cadaveric courses, visits to hospital centers, validation of residency programs, certification programs, and the list could go on.

It should be noted that this enormous and federal educational offer is, in most cases, free, an important fact in these times of economic uncertainty.

All of this would have not been achieved without the effort and dedication of the people involved in the committees, regional headquarters, members of the associations and, of course, the staff of both associations, because without them, none of this would be possible.

To conclude, in these new and pleasant moments of reunion, I want us to take into account the difficult and sad situations that some have gone through, and I express my deepest wish for the creation and support of new family, friendship and work relationships that are strong, genuine and full of solidarity.

I am convinced that these new times will not be the same; it is up to us to make them better.

I greet you affectionately.

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Case presentation

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Case resolution on page 737.

KNEE PAIN AFTER SPORTS PRACTICE

A 23-year-old male recreational athlete (he plays basketball weekly and is a National League referee), consulted for patellofemoral pain in his right knee during sports practice. He did not report any history of trauma.

Upon physical examination, marked hypotrophy of the vastus medialis obliquus of the right quadriceps could be seen. The patient had pain on resisted strength tests, due to great weakness. He did not refer to previous pathologies in the right knee, nor had he suffered from low back pain, due to quadriceps atrophy (Figure 1).

Figure 1. Isometric test of the quadriceps, in which the agenesis of the vastus medialis is observed.

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Measurements of the thigh perimeter were made at 10 centimeters from the patella, with the determination of the circumference in relaxation and isometry. A Cybex isokinetic test was performed to assess the bilateral isokinetic strength of the quadriceps at three torque speeds, at 90°, 180°, and 360° (Figure 2).

Figure 2. Dynamic single-leg squat test showing vastus medialis agenesis on the right quadriceps.

A slight varus alignment of the right lower limb was observed. The possible presence of exaggerated femoral anteversion or external tibial rotation allowed us to observe right patellar strabismus.

The assessment of Cruveilhier's quadriceps angle (Q angle) is essential to quantify these alterations. In our patient, it was found to be increased. The tone and trophism of the vastus medialis were found to be decreased compared to the healthy side.

The palpation of both the medial and lateral articular facets of the patella was painful. The patellar pain was aroused by forcing active extension against the resistance of the knee, as the patella was impacted against the trochlea. Further positivity can be achieved by having the patient flex the knee under weight (when squatting), a maneuver that helps determine the angle at which pain occurs.

The longitudinal brush sign was performed, which caused pain when moving the patella longitudinally with the knee flexed at 30° and palpable and audible crepitus was found. In addition, the transverse brush sign was evaluated in the same way as with the previous sign, moving the patella transversely. This sign can be confused with the Smillie sign, in which pain, apprehension or fear, and defensive reflexes are elicited. Great shortening of the rectus femoris and psoas muscles was also observed.

Anteroposterior and lateral radiographs were requested, which were negative, as well as an axial study of both patellas at 20° and 45° (Figure 3).

Figure 3. Axial patella at 30°. The axial radiograph shows a slight lateral inclination on the right knee, with decreased space between the external patellar aspect and the external femoral condyle.

We requested a knee MRI to make a comparative study of the diameters of the vastus medialis of both thighs with Tesla 1.5 Philips equipment.

Diluted Povidone-Iodine Lavage in Total Hip and Knee Replacement: A Retrospective Comparative Study

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#Grupo GRECARO

ABSTRACT

Introduction: One of the prophylactic techniques to reduce the incidence of periprosthetic infections is dilute povidone-iodine lavage, an agent with bactericidal action against different microorganisms. The purpose of this study was to evaluate the incidence of periprosthetic infections within the first 90 days in patients who had undergone povidone-iodine lavage after implantation of prosthetic components and before wound closure. **Materials and Methods:** A comparative retrospective study was performed on patients who had undergone primary total hip or knee replacement due to advanced joint osteoarthritis between October 1999 and April 2020. We assessed the PJI rate between two cohorts: Group A, which consisted of patients who received povido ne-iodine lavage routinely, and Group B, where this solution was not applied. **Results:** 643 (47.60%) knee replacements and 708 (52.40%) hip replacements were performed. When comparing the incidence of periprosthetic infections between both groups, no statistically significant differences were observed (0.92% vs. 0.21%; p = 0.11). However, the risk of infection was increased in the first 90 days after surgery (OR = 4.5; 95% CI 0.56-36.19) when the solution was not used. **Conclusions:** The risk of developing periprosthetic infections increased 4.5 times when performing an arthroplasty without irrigation with diluted povidone-iodine. However, this could not be shown to be statistically significant.

Keywords: Joint infection; hip revision; knee revision; povidone-iodine; betadine.

Level of Evidence: III

Lavado con povidona yodada diluida en el reemplazo articular de cadera y rodilla para prevenir infecciones: estudio retrospectivo comparativo

RESUMEN

Introducción: Una de las medidas profilácticas para disminuir la incidencia de infecciones periprotésicas es el lavado con povidona yodada diluida, un agente con acción bactericida contra distintos microorganismos. El propósito de este estudio fue evaluar la incidencia de infecciones periprotésicas dentro de los primeros 90 días, en pacientes a quienes se les realizó un lavado con povidona yodada luego de implantar los componentes protésicos y antes del cierre de la herida. **Materiales y Métodos:** Se llevó a cabo un análisis retrospectivo comparativo de pacientes sometidos a artroplastias primarias de cadera y rodilla por artrosis y se comparó la indicencia de infecciones periprotésicas dentro de los primeros 90 días posoperatorios, entre pacientes que fueron operados antes de la introducción del lavado con povidona yodada y luego con su uso rutinario. **Resultados:** Se realizaron 643 (47,60%) reemplazos de rodilla y 708 (52,40%) reemplazos de cadera. Al comparar la incidencia de infecciones periprotésicas entre ambos grupos, no se observaron diferencias estadísticamente significativas (0,92% vs. 0,21%; p = 0,11). Sin embargo, se incrementó el riesgo de infección en los primeros 90 días posteriores a la cirugía (OR = 4,5; IC95% 0,56-36,19) cuando no se utilizó la solución. **Conclusiones:** El riesgo de desarrollar infecciones periprotésicas se incrementó 4,5 veces al realizar una artroplastia sin irrigación con povidona yodada diluida. Sin embargo, no se pudo demostrar que esto fuese estadísticamente significativo.

Palabras clave: Artroplastia de cadera; artroplastia de rodilla; infección periprotésica; povidona yodada.

Nivel de Evidencia: III

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INTRODUCTION

Thanks to advances in designs and the excellent long-term outcomes demonstrated, primary knee and hip arthroplasties represent one of the most frequent and fastest growing procedures in the last decade.[1] In the United States, it is estimated that more than 1 million hip and knee replacements are performed each year.[2] However, these procedures are not exempt from complications and one of the most challenging is periprosthetic infection (PPI).

Different prevention strategies have been described, such as proper hand washing, the use of disposable sterile fields, careful preparation of the skin, and antibiotic therapy.[3,4] However, PPIs account for up to 14% of hip revision causes and 25% of knee revision causes.[5]

Springer et al. conducted a study to analyze the data published by six major international registries (New Zealand, Sweden, Wales, Australia, Northern Ireland, and the United States) and found that the risk of developing chronic PPI after hip arthroplasty varies from 0.76% to 1.24%, while, in the case of the knee, the percentage ranges between 0.88% to 1.28%.[6]

Povidone-iodine (PVP-I) is a complex of povidone, hydrogen iodine, and elemental iodine. Since the latter is highly soluble in water, its slow release in an aqueous medium produces a wide spectrum of antimicrobial activity against bacteria, protozoa, fungi and viruses, through the iodination of their lipids and oxidation of their cytoplasmic and membrane components.[7,8] It also inhibits the formation of staphylococcal biofilms and there are no reports of acquired resistance.[7]

Although, in previous studies, it was not possible to demonstrate a significant difference in the rate of PPIs with the use of diluted PVP-I,[9] there are other reports that maintain that its use managed to reduce the incidence of PPIs in the hip or knee during the first 90 days.[10,11]

The purpose of this study was to compare the incidence of PPIs of the hip and knee in the first 90 days after surgery between a group of patients in whom routine PVP-I lavage was used and another group who had not undergone this procedure. Our hypothesis is that the PPI rate in the first 90 days in patients with PVP-I lavage is lower than that of patients who do not undergo this procedure.

MATERIALS AND METHODS

We carried out a retrospective analysis of patients operated on at our institution between October 1999 and April 2020. Patients who had undergone primary knee or hip arthroplasty due to a diagnosis of severe osteoarthritis and who completed a minimum follow-up of 90 days were included. Patients with simultaneous bilateral arthroplasties or who had received radiotherapy, chemotherapy or biological agents were excluded.

Two groups were formed: group A with patients operated on before December 2015, before the introduction of PVP-I lavage, and group B with patients to whom this solution had been applied, as a routine, before wound closure. In all cases, demographic data, such as age, gender, and side of the limb involved, were recorded. In hip arthroplasties, it was also documented whether it was a cemented, hybrid or uncemented replacement.

In both groups, the PPI rate was calculated within the first 90 days after surgery. PPI was defined based on the criteria described by the Second Philadelphia Consensus.[12] The microorganisms that caused the infection were also documented.

Data were recorded by a fellow trained in reconstructive orthopedic surgery of the lower limb.

Postoperative controls were performed at 3 and 6 weeks, and at 3 months.

Surgical technique

All patients were operated on by the same surgeon, in a laminar flow operating room, under hypotensive spinal anesthesia. Patients undergoing knee replacement underwent peripheral femoral nerve block prior to admission to the operating room and were operated on with a hemostatic cuff. Antibiotic prophylaxis with 1 g of cefazolin (2 g, >80 kg) was administered up to 30 min before skin incision. If the patient was allergic to cephalosporins, clindamycin was indicated.

As antithrombotic prophylaxis, tranexamic acid 20 mg/kg was administered before the procedure.

In all cases, a direct anterolateral approach was used, according to the modified Hardinge approach, and in the knee arthroplasties, an internal parapatellar arthrotomy was performed. The addition of antibiotics to the cement was selective in patients with risk factors (body mass index >35 or diabetics).

To prepare the solution, 20 cc of PVP-I (Pervinox®: PVP-I 10g/100 ml) are used with 500 cc of physiological solution in a closed and sterile bag, which results in a formula diluted to 0.38%.

After implanting the prosthetic components and before closing the wound, the tissues were covered with the aforementioned solution for 3 min, timed by the circulating nurse in the operating room. Lastly, the solution was aspirated and the wound was closed by planes (Figure).

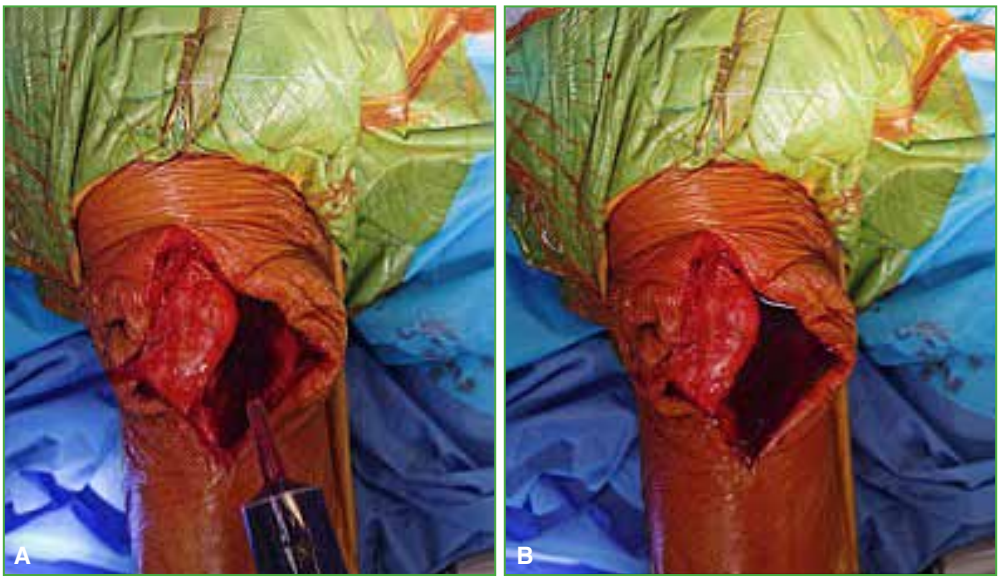

Figure. A. Administration of 520 ml of povidone-iodine solution. **B.** It remains in suspension for 180 seconds in the joint cavity.

Rehabilitation protocol

The patients began their rehabilitation using the same protocol under the strict control of a member of the Kinesiology Department. The same day of the surgery they started sitting on the edge of the bed and the limb was allowed to flex up to 90º. On the second day, gait rehabilitation was carried out using a walker as assistance. The next day, the patients walked with two Canadian crutches and, if there were no complications, their use was extended during the first three weeks. From week 3 to week 6, they used a cane, after which they walked unassisted.

Statistical Analysis

Quantitative variables are described as mean and standard deviation, and categorical variables as percentage and absolute value. Differences in continuous variables between groups were compared with Student's t-test, and categorical variables were assessed by the X^2 test. A p value <0.05 was considered statistically significant.

Univariate logistic regression was performed to evaluate the association between the use of lavage with diluted PVP-I and PPI, considering a p value <0.05 as significant. In addition, the independent contribution of age and development to PPI was assessed by constructing a multivariate logistic regression analysis. All data were entered into an Excel® spreadsheet (Redmond, USA) and the GraphPad Prism® 8.0 program (LaJoya, CA, USA) was used for statistical calculations.

RESULTS

A total of 1,356 arthroplasties were performed in 1,356 patients during the period described. Five were excluded for not completing the minimum follow-up required for the study, for which the series was finally made up of 1,351 arthroplasties. 643 (47.60%) total knee replacements and 708 (52.40%) total hip replacements were performed.

A total of 560 (41.45%) men were treated and the overall average age of the series was 68.53 ± 9.44.

Table 1 details the demographic data of the patients in both groups. There were no statistically significant differences in the mean age and sex in both groups.

Table 1. Demographic data of the patients included in the study.

	Group A	Group B	p
Number of patients (%)	866 (64.1)	485 (35.9)	
Sex (%) Male Female	 369 (42.61) 497 (57.39)	 191 (39.38) 294 (60.62)	0.24
Side (%) Right Left	 470 (54.34) 395 (45.66)	 253 (52.16) 232 (47.84)	0.44
Age (standard deviation)	68.39 ± 9.45	68.77 ± 9.42	0.48

When comparing the incidence of PPI and PVP-I lavage, no statistically significant differences were observed (0.92% vs. 0.21%; p = 0.11) (Table 2).

Table 2. Overall incidence of periprosthetic infection with or without diluted povidone-iodine lavage

	Total	Periprosthetic infection	%	p
Group A	866	8	0.92	0.11
Group B	485	1	0.21	

When analyzing each group, it was observed that there was no statistically significant difference in the prevalence of PPIs between hip and knee arthroplasties (Table 3).

Table 3. Incidence of periprosthetic infection in hip and knee arthroplasty

Surgery	Lavage	No periprosthetic infection (%)	Periprosthetic infection (%)	p
Total knee replacement	Without PVP-I solution	348 (98.9)	4 (1.1)	0.13
	With PVP-I solution	291 (100.0)	0 (0.0)	
Total hip replacement	Without PVP-I solution	432 (99.1)	4 (0.9)	0.65
	With PVP-I solution	271 (99.6)	1 (0.4)	

PVP-I = Povidone-iodine

An increased risk of infection in the first three months after surgery (odds ratio [OR] = 4.5, 95% CI 0.56-36.19) was found in patients without lavage. When adjusting the risk with the age variable, a similar result was obtained (OR = 4.6; 95% CI 0.57-37.07).

The average age of the patients when the infection was diagnosed was 73.1 ± 11.9 years (range 48-86), with a mean of 6.9 ± 1.1 (range 6-9).

The diagnosis of infection and surgical debridement were made 33 ± 5.7 days (range 26-74) after the primary arthroplasty. Secretion from the wound, dehiscence and erythema, together with pain (77.7%) were the most frequent signs that led to the diagnosis.

All patients diagnosed with infection had positive cultures and the most frequent microorganism isolated was *Staphylococcus epidermidis* (66.7%) by puncture or intraoperative sample; in two cases, *Staphylococcus aureus* (22.2%) was isolated and, in one patient (11.1%), *Proteus mirabilis*.

DISCUSSION

The most important finding of our study was an increased risk of infection within 90 days after surgery (OR = 4.5; 95% CI 0.56-36.19) in patients who had not received 0.38% diluted PVP-I lavage. Although the PPI rate decreased with the use of this solution, this did not represent a statistically significant difference (0.92% vs. 0.21%; p = 0.11).

Multiple interventions have been published to reduce the risk of infection during and after arthroplasty, for example, reducing the staff circulating in the operating room, positive pressure ventilation with laminar flow, and control of factors inherent to the patient (perioperative blood glucose values, body mass index, anemia or immunosuppression).[13,14]

The use of antiseptic agents in preoperative lavage has cytotoxic effects on bacteria in surgical wounds; however, these agents can injure host tissue, increasing the rate of wound complications.[15] von Keudell et al. evaluated the harmful effect of different concentrations of PVP-I on bovine tissues and found that the 0.35% dilution was the one that caused the least harmful effects on the host.[16]

In 2010, Brown et al. demonstrated a decrease in the PPI rate with the use of PVP-I diluted to 0.35%.[10] They reported 18 cases (0.97%) of infection within the first 90 days before the use of diluted PVP-I and only one (0.15%) after its application. Thus, its use has begun to spread in other institutions.[17]

Recent studies have reported on the results of intraoperative lavage protocols during arthroplasties, comparing the use of chlorhexidine, vancomycin powder and PVP-I, the latter having higher bactericidal power than the others.[18]

In 2019, Hernandez et al.[19] published an analysis of 11,738 hip and knee arthroplasties in which they compared surgeries with systematic irrigation of PVP-I diluted to 0.25% before closing the wound, with another group in which physiological solution was used. There were no statistically significant differences in the PPI rate at three months, but a decrease in events was observed within one year.

Perhaps one of the studies with the best level of evidence published in this regard was that of Calkins et al., who carried out a randomized controlled trial that included 234 patients (153 knees and 81 hips) who received intraoperative irrigation with physiological solution and were compared with 223 patients (144 knees and 79 hips) who underwent lavage with PVP-I diluted at 0.35%. There was a statistically significant decrease in infections (3.4% vs. 0.4%; p = 0.03) within three months after arthroplasty. Because of these results they felt an ethical obligation to conclude the study earlier than planned.[11]

Although a statistically significant decrease could not be demonstrated in our series, the difference in the PPI rate after the introduction of the diluted PVP-I lavage (0.92% vs. 0.21%) suggests that there could be a tendency to reduce the development of an infectious complication within the first 90 postoperative days. In addition, we were able to observe that the risk of developing PPI in the early postoperative period increased 4.5 times in patients without systematic irrigation with this solution (OR = 4.5; 95% CI 0.56-36.19).

In a recent systematic review and meta-analysis of seven studies involving 31,213 hip or knee arthroplasties, Kim et al.[20] found no significant differences in the rate of PPI between patients who received PVP-I irrigation before wound closure and those who did not.

We consider that PVP-I lavage represents a simple, low-cost method without consequences for the host tissue. Based on the results obtained in our study with a large number of cases, we suggest its routine use.

The limitations of our study are its retrospective design, the low number of events and the lack of a meticulous analysis of the previous comorbidities of each of the patients that could influence the development of the infection and constitute a confounding factor. However, we consider that the number of patients included, the homogeneity of the population, and the fact that all cases were operated on by the same surgeon allowed us to perform an appropriate statistical analysis. It should be noted that, to our knowledge, this is the first national study in this regard and invites us to carry out research with more appropriate designs that allow conclusions to be drawn with a better level of evidence.

CONCLUSIONS

Irrigation with 0.38% diluted PVP-I after component placement and prior to wound closure in hip and knee arthroplasty decreased the rate of PPI within the first 90 days, with no statistically significant association (0.92% vs. 0.21%; p = 0.11). However, the risk of developing an infection was 4.5 times higher in patients without PVP-I lavage.

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

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Next Generation Sequencing for the Detection of Pathogens in Hip Surgery: Experience and Diagnostic Feasibility in a Tertiary Care Center in Argentina

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ABSTRACT

Introduction: Early diagnosis of a periprosthetic joint infection (PJI) and identification of the pathogen are paramount. Next-generation sequencing (NGS) can identify the nucleic acids in a given germ in a short period. To our knowledge, there are no reports of its use in the management of PJI in South America. Our objective was to demonstrate the diagnostic feasibility of the NGS technique on the samples obtained from a series of patients operated on in Buenos Aires, Argentina. **Materials and Methods:** A prospective series of 20 patients undergoing septic and aseptic hip revision surgery from December 2019 to March 2020 was analyzed. Intraoperative samples of synovial fluid, deep tissue, and intramedullary canal were obtained and sent to the NexGen Microgen laboratory (Texas, USA) for analysis. **Results:** Seventeen patients were finally eligible to present a sample suitable for analysis. In 100% of the samples, NGS results were obtained within 72 hours of surgery. In one case, the NGS result reported a germ different from the one identified in the postoperative soft tissue cultures, allowing antibiotic therapy to be corrected. In another case, NGS identified *Parabacteroides gordonii* in aseptic revision surgery. In another patient, the NGS identified *Morganella morganii*, in which conventional postoperative cultures were negative in single-stage revision surgery. **Conclusion:** In this study, we demonstrated the diagnostic feasibility of NGS, obtaining results within 72 hours immediately after surgery for pathogenic organisms in patients with PJI and negative cultures.

Keywords: Periprosthetic joint infection; next generation sequencing; revision surgery; hip arthroplasty.

Level of Evidence: IV

Secuenciación de próxima generación para la detección de patógenos en cirugía de cadera: experiencia y viabilidad diagnóstica en un centro de atención terciaria de la Argentina

RESUMEN

Introducción: El diagnóstico rápido y definitivo con identificación del patógeno es fundamental cuando hay una infección periprotésica. La secuenciación de próxima generación permite identificar el ADN en un germen determinado en un período de tiempo corto. Hasta donde sabemos, no hay reportes sobre su empleo para el manejo de la infección periprotésica en Sudamérica. Nuestro objetivo fue demostrar la viabilidad diagnóstica de las muestras obtenidas de una serie de pacientes operados en Buenos Aires, Argentina, y analizadas con la técnica de secuenciación de próxima generación. **Materiales y Métodos:** Se analizó a una serie prospectiva de 20 pacientes sometidos a cirugía de revisión séptica y aséptica de cadera desde diciembre de 2019 hasta marzo de 2020. Se obtuvieron muestras intraoperatorias de líquido sinovial, tejido profundo y canal endomedular, que fueron enviadas para su análisis al laboratorio NexGen Microgen (Texas, EE.UU.). **Resultados:** Se seleccionaron 17 pacientes, porque una muestra era apta para el análisis. Todos los resultados se recibieron dentro de las 72 h de la cirugía. En un caso, el resultado de la secuenciación de próxima generación informó un germen distinto del identificado en los cultivos posoperatorios de partes blandas, lo que permitió corregir la antibioticoterapia. En otro, esta técnica identificó *Parabacteroides gordonii* en una revisión aséptica. En otro paciente, identificó *Morganella morganii*, a partir de cultivos negativos en una revisión en un tiempo. **Conclusión:** Se demostró la viabilidad diagnóstica con la secuenciación de próxima generación, se pueden obtener resultados dentro de las 72 h posteriores a la cirugía de microorganismos patógenos en pacientes con infección periprotésica y cultivos negativos.

Palabras clave: Infección periprotésica; secuenciación de próxima generación; cirugía de revisión; artroplastia de cadera.

Nivel de Evidencia: IV

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INTRODUCTION

Periprosthetic joint infection (PJI) is a rare but devastating complication that is associated with a higher rate of morbidity and mortality.[1,2] Managing this scenario is challenging and costly, and requires particular expertise to achieve an optimal result.[3,4]

Making a quick and definitive diagnosis with the identification of the causal microorganism is fundamental for the management of a PJI,[5-7] since not identifying the infecting germ leads to the administration of an empirical antimicrobial treatment, with the possibility of not covering the true pathogen. On the other hand, a negative culture has been associated with a 4.5 times higher risk of reinfection than a positive one.[8] There are various bacteriological culture techniques, such as polymerase chain reaction, to improve diagnostic accuracy. However, polymerase chain reaction has a limited sensitivity ranging from 50% to 81.6%,[9,10] and, on the other hand, it is ineffective in identifying fungal or polymicrobial infections, and differentiating contaminants from the true infectious organism.[10.11]

Next-generation sequencing (NGS) is a novel and cost-effective technique that can identify all nucleic acids in a given germ in a short period of time. It is capable of sequencing all the DNA present in a sample and provides more complete information on the microbial profile,[12] which allows efficient identification of the genomes of bacteria and fungi. Tarabichi et al.[13] demonstrated the usefulness of this technique by identifying potential pathogens in 81.9% of PJI cases with a negative culture.

The use of this technology is possible in our country; however, carrying out the sequencing to obtain a specific germ is not enough, a database is also needed with which to compare the sequences obtained, and thus determine the microorganism that has such sequencing. Therefore, the larger the database, the more likely it is to obtain a specific and reliable match. In this sense, the NexGen Microgen laboratory (Texas, USA) has the program with the largest known database in the world, including DNA sequences obtained from lunar rocks. The main challenge researchers face is limited resources. As a result, genomic tools, specifically genome sequencing technologies, are not widely available because of the operational cost to implement them, shipping costs, customs costs, and the profit margin for local companies, not to mention the distance to the target laboratory. These factors could delay the transfer and analysis of the sample and, in this way, alter its quality and results.

To our knowledge, there are no reports on the use of this technique in the management of PPIs in South America. The objective of this study was to prospectively demonstrate the viability of samples obtained from a cohort of patients operated on in a tertiary care hospital in Argentina, which were analyzed with the NGS technique in the NexGen Microgen laboratory (Texas, USA). Secondly, to evaluate the role of NGS in detecting microorganisms in a cohort of patients undergoing septic and aseptic revision hip surgeries.

MATERIALS AND METHODS

Patients

After obtaining approval from the Ethics Committee of our institution, we prospectively analyzed a series of 20 patients who agreed to participate in the study and had undergone total hip arthroplasty revision surgery between December 2019 and March 2020. Patients diagnosed with PJI and aseptic loosening, as defined by the Musculoskeletal Infection Society (MSIS) criteria, were included.[14]

Preoperative evaluation

All patients were evaluated before surgery according to institutional protocols, which included blood tests to determine glomerular filtration rate (GFR), C-reactive protein (CRP), and D-dimer. Preoperative antibiotics were suspended two weeks before the index surgical procedure until the collection of samples for culture, pathology analysis, and NGS.

All patients had access to the results of the preoperative blood tests used for diagnosis; however, not all had a biopsy and PCR of preoperative biological fluid. Since 2014, the Hip Department of our institution has indicated to evaluate revisions with clinical suspicion of infection by intraoperative synovial PCR, and a value >9.5mg/l is considered positive.[15]

During the study period, two-stage surgery was indicated in the following cases: 1) upon confirmation of chronic PJI according to the MSIS[14] criteria; and 2) to functionally active patients, with independent or minimally aided walking (index of instrumented activity of daily living ≤7).[16] Similarly, single-stage surgery was indicated in the following cases: 1) those with confirmation of chronic PJI according to the MSIS criteria,[14] but without fistula or active wound drainage, 2) patients with low functional demand (index of instrumented activity of daily living >7)[16] and 3) acetabular bone stock with a defect lower than grade 3 of the Paprosky classification[17] and femoral bone stock with a defect lower than or equal to grade 3B of that classification.[17,18]

Intraoperative sample collection

Patients were placed in the lateral decubitus position, and a posterolateral hip approach was performed in a laminar flow operating room. During anesthetic induction, each patient received a dose of antibiotic adapted to them. Since 2011, we have administered a dose of 1,000 mg of tranexamic acid, intravenously, during anesthetic induction and an additional 1,000 mg during closure, in all surgeries.[19] The revision surgeries were performed by four specialist hip surgeons from our institution.

Synovial fluid, deep tissue, and intramedullary canal samples were taken from all patients at the time of surgery. Synovial fluid was obtained sterile, using an 18-gauge needle before arthrotomy. Lastly, the femoral acetabulum and intramedullary canal were swabbed.

All samples were quickly collected in sterile containers and sent for study by private courier. Deep tissue samples were also sent to the institutional laboratory for routine cultures, including cultures of aerobic and anaerobic bacteria, fungi, and acid-fast bacilli. Likewise, samples were sent to pathology for analysis by freezing and PCR of intraoperative synovial fluid was requested.

Next generation sequencing

DNA extraction

DNA extraction is performed on submitted samples with the QIAamp DNA Mini Kit column-based extraction kit (Qiagen GmbH, Hilden, Germany). The samples are treated in a differential way to adapt them to the DNA extraction protocol:

- Synovial fluid: the fluid is centrifuged and 200 µl are extracted as starting material for the extraction.
- Deep soft tissue: the tissue is cut with a sterile scalpel blade into pieces of approximately 1 mm^3 and up to 20 mm^3 of representative material is mixed with a phosphate-buffered saline solution until reaching a final volume of 200 µl and continuing with the extraction.
- Intramedullary canal material: it is suspended in phosphate-buffered saline to a final volume of 200 µl and then extracted.

Once the sample has been adapted to the protocol, DNA extraction is performed following the manufacturer's instructions. The elution volume is 50 µl. The samples are placed in 1.5 ml tubes and stored in a refrigerator at -20°C until use.

Shipment of samples

From the DNA of each of the samples, an aliquot of 15 µl is placed in a 0.5 ml tube and labeled according to its identifier. The DNA sample is sent by FedEx® in a container to the NexGen Microgen laboratory (Texas, USA).

NGS Study

The NexGen Microgen laboratory carries out NGS studies by amplification of the 16S rRNA gene in the samples sent to detect pathogens of bacterial origin.

Bioinformatic analysis and reporting of results

The NexGen Microgen laboratory analyzes the data obtained according to its own protocol and sends the results to our hospital by email within 72 hours to complete the database.

Antibiotic treatment

After surgery, when a case was considered to be septic, a course of intravenous antibiotic therapy was administered for six weeks, according to the criteria of the surgeon and the Infectious Disease Service of our institution. When the typing of the germ and its sensitivity were adequate and the selected antibiotic reached adequate bioavailability by the oral route, this route of administration was chosen. Infection control was carried out 15 days, a month, and six weeks after the surgical procedure, and clinical findings were controlled, such as the state of the wound, the presence of pain, and the results of blood tests (GFR, CRP).

RESULTS

NGS was performed in 20 cases, and 17 were selected, because they had a suitable sample for analysis. The first three cases were discarded because permission from the Ministry of Health to ship the samples abroad could not be obtained in time. Although the samples were stored in the refrigerator below -80°C, after 3-5 days, they were considered to have lost their quality for testing due to denaturation of nucleic acids.

The series consisted of 17 patients, 64.70% (11 patients) were men and 35.30% (6 patients) were women. Nine cases (52.95%) corresponded to the left hip and eight (47.05), to the right. The average age was 68 years (range 37-86). Before surgery, 10 revisions (58.83%) were interpreted as aseptic and the remaining seven (41.17%) as septic. The surgeries were: single-stage revisions (9 cases; 52.94%) and two-stage revisions (7 cases; 41.17%); in four of them (57.14%), it was the first surgical stage (spacer placement) and, in three (42.86%), the second stage (reimplantation). Lastly, the remaining surgery (5.89%) was debridement with sampling and implant retention. Table 1 summarizes the demographic data of the series.

Table 1. Patient data.

Case	Age	Sex	Side	Septic/Aseptic	Surgical stage
1	77	M	R	Septic	2nd. spacer
2	73	M	L	Aseptic	1°
3	86	F	L	Aseptic	1°
4	77	F	L	Aseptic	1°
5	37	M	L	Septic	2nd. Reimplantation
6	77	M	R	Septic	2nd. Reimplantation
7	72	F	R	Aseptic	1°
8	73	F	L	Septic	Debridement
9	61	M	R	Aseptic	2nd. spacer
10	43	M	R	Aseptic	1°
11	74	F	L	Septic	2nd. Reimplantation
12	54	M	L	Aseptic	1°
13	67	M	R	Septic	2nd. spacer
14	81	M	L	Aseptic	1°
15	65	M	R	Aseptic	1°
16	67	M	R	Aseptic	1°
17	78	F	L	Septic	2nd. spacer

M = male, F = female, L = left, R = right.

Positive preoperative cultures were obtained in seven (41.17%) patients (cases 1, 2, 5, 8, 11, 13, and 17). The predominant germ was methicillin-sensitive *Staphylococcus aureus* (MSSA) (3 cases; 42.85%), followed by methicillin-resistant *S. aureus* (MRSA) (2 cases, 28.57%) and *Propionibacterium acnes* and *Escherichia coli*, one case each (14.28%). Only four (57.14%) of the seven patients with positive preoperative cultures had an acute inflammatory process in the frozen pathology analysis of revision surgery, the remaining three cases (42.85%) were non-inflammatory processes.

The preoperative infectious staging was different according to each particular case and, due to the heterogeneity of the sample, the GFR, CRP and D-dimer values obtained in the preoperative period, as well as the preoperative cultures and the anatomopathological analysis by freezing, were grouped in Table 2.

Table 2. Preoperative infectious analysis

Case	Preoperative GFR	preoperative CRP	Preoperative D-dimer	Preoperative culture	Pathology anatomy
1	74	89	-	*Staphylococcus epidermidis*	AIR
2	67	4	-	MSSA	NAIA
3	20	1	-	-	Metal debris
4	51	2	5821	-	NAIA
5	60	18	-	MRSA	NAIA
6	34	9	4201	-	NAIA
7	10	5	-	-	NAIA
8	102	55	-	MRSA	NAIA
9	21	4	-	-	AIR
10	11	5	-	-	NAIA
11	57	3	-	MSSA	AIR
12	13	8	-	-	NAIA
13	67	59	-	*Propionibacterium acnes*	AIR
14	14	7	-	-	NAIA
15	55	45	-	-	AIR
16	10	1	506	-	NAIA
17	65	16	-	*Escherichia coli*	AIR

GFR = glomerular filtration rate, CRP = C-reactive protein, MRSA = Methicillin-resistant Staphylococcus aureus , MSSA = Methicillin-sensitive Staphylococcus aureus , AIR = acute inflammatory response, NAIA = no acute inflammatory activity

Regarding postoperative infectious staging, the PCR analyses of synovial fluid and synovial fluid and soft tissue cultures of all cases were recorded and their results are shown in Table 3.

Table 3. Postoperative infectious analysis

Case	Synovial fluid CRP	Synovial fluid culture	Soft tissue culture
1	12	S. epidermidis	S. epidermidis/P. aeruginosa
2	0.2	Negative	Negative
3	0.6	Negative	Negative
4	0.8	Negative	Negative
5	13	Negative	MRSA
6	4.5	Negative	*S. haemolyticus*
7	0.2	Negative	Negative
8	24	*E. faecalis*	*E. faecalis*
9	0.2	Negative	Negative
10	0.5	Negative	Negative
11	0.4	Negative	Negative
12	0.6	Negative	Negative
13	28.5	Negative	Negative
14	0.3	Negative	Negative
15	11.6	Negative	Negative
16	0.4	Negative	Negative
17	4.1	Negative	E.coli

CRP = C-reactive protein, MRSA = Methicillin-resistant Staphylococcus aureus , MSSA = Methicillin-sensitive Staphylococcus aureus.

NGS results

Results of all samples submitted for NGS were received within 72 h post-surgery (Table 4). Nine (53.94%) samples were negative for genetic material corresponding to known bacterial sequences. In one of them (case 9), two-stage surgery was decided due to intraoperative findings suggestive of infection and the results of the pathology analysis that reported an acute inflammatory process. Said patient evolved favorably and, until the last follow-up, had been implanted for 22 months, with no failures or reoperations. In case 11, also with a negative NGS result, the second revision stage was performed without identification of the germ by postoperative culture, but with suspicion of infection due to the pathology anatomy analysis that suggested an acute inflammatory process and positive preoperative cultures for MSSA.

In case 5, the result of the NGS reported a different germ (*Malassezia sympodialis*) from the one identified in the postoperative soft tissue cultures (MRSA). This allowed the case to be correctly interpreted and the postoperative suppressive antibiotic therapy to be adjusted.

In patient 12, NGS allowed the identification of *Parabacteroides gordonii* sensitive to clindamycin and metronidazole when the diagnostic interpretation had been aseptic and the results of the pathology analysis had reported no acute inflammatory changes and negative postoperative cultures, so it was considered a false positive diagnosis by the surgeon and corroborated by the laboratory when discussing the findings.

Likewise, the application of NGS was decisive in patient 15. After a single-stage revision with negative pre- and postoperative cultures and frozen-section pathology analyses suggestive of an acute inflammatory process, it was possible to isolate *Staphylococcus epidermidis* DNA sequences in soft tissue samples, although not in the synovial sample. Although it could be interpreted as a false positive due to contamination, it was decided to administer adjuvant antibiotic treatment.

Table 4. Next Generation Sequencing (NGS) Results

Soft tissue NGS	Synovial fluid NGS	Antibiotic therapy
P.aeruginosa/S. epidermis	*P.aeruginosa/S. epidermis*	Ceftolozane/tazobactam + vancomycin
Negative	Negative	Levofloxacin 750 mg + minocycline 100 mg
Negative	Negative	No
Negative	Negative	No
Malassezia sympodialis	*Malassezia sympodialis*	Vancomycin + ertapenem 1 g Prolonged treatment
Negative	Negative	Ceftolozane/tazobactam + vancomycin
Negative	Negative	No
E. faecalis	*E. faecalis*	Vancomycin 1 gc/12 h
Negative	Negative	No
Negative	Negative	No
Negative	Negative	Levofloxacin 750 mg/day
Negative	*Parabacteroides gordonii*	No
Negative	*Cutibacterium acnes*	Vancomycin 1 gc/12 h/ceftriaxone 2 g/day
Negative	Negative	No
S. epidermidis	Negative	Vancomycin/ciprofloxacin
Morganella morganii	Negative	No
*Corynebacterium*sp 54%; *Corynebacterium mucifaciens* 18%; *E. coli* 12%; *Cutibacterium acnes* 5%; *Lactobacillus crispatus* 4%; *Bradyrhizobium yuanmingense* 2%; *Corynebacterium tuberculostearicum* 2%	*Corynebacterium* sp 54%; *Corynebacterium mucifaciens* 18%; *E. coli* 12%; *Cutibacterium acnes* 5%; *Lactobacillus crispatus* 4%; *Bradyrhizobium yuanmingense* 2%; *Corynebacterium tuberculostearicum* 2%	Vancomycin 2 g / Ciprofloxacin 750 mg suppressive treatment

Similarly, in patient 16, NGS identified *Morganella morganii* in soft tissues, failing to identify organisms in synovial fluid, and acute-phase reactants did not suggest infection and cultures were negative in a patient who underwent a single-stage revision.

Finally, the NGS results also changed the indications in case 17. The revision was planned at one stage due to a suspected multidrug-sensitive *Escherichia coli* infection isolated before surgery. Then, during the operation and by decision of the surgeon, a two-stage revision was chosen, a spacer was made and samples were taken, which were positive for *Escherichia coli* sensitive to multiple drugs. However, the results of the NGS made it necessary to correct the antibiotic therapy and to administer a post-implantation suppressive treatment, since it identified sequences of *Corynebacterium* sp (54%), *Corynebacterium mucifaciens* (18%), *Escherichia coli* (12%), *Cutibacterium acnes* (5%), *Lactobacillus crispatus* (4%), *Bradyrhizobium yuanmingense* (2%), and *Corynebacterium tuberculostearicum* (2%).

DISCUSSION

This study has shown that the use of NGS is feasible in Argentina for the diagnosis of an infection associated with a hip prosthesis, since the distance greater than 8000 km that separates the medical center from the molecular analysis laboratory was not an impediment to analyze, without inconvenience, all the samples sent, and obtaining a result in less than 72 hours. It is important to note that the samples were sent by private courier, without the requirement of specific transport measures that could hinder logistics. Furthermore, in recent years, the costs of these molecular analysis technologies have decreased and they have become relatively affordable diagnostic tools.[20] The NGS technique is already used in our country in various medical specialties, such as in the diagnosis of infertility[20,21] or in the differential diagnosis of specific types of muscular dystrophy.[22] The implementation of these molecular techniques for the diagnosis of a periarticular infection both in our country and in the rest of Latin America is novel and we did not find publications that report on their use. Perhaps their use is limited due to the lack of suitable local laboratories with extensive molecular databases that allow the correct interpretation of the results. Beyond the lack of regional development of these technologies, this study demonstrates that the use of these diagnostic methods is possible.

In a prospective study, Tarabichi et al. reported that the NGS technique reliably detected microorganisms in synovial fluid with a high degree of agreement with traditional cultures (96.1%);[20] in turn, it was found that NGS is a useful complement for the detection of pathogens in 81.8% of PPIs with negative culture.[13] In our series, there was agreement between cultures and NGS in eight of the 17 patients (patients 1, 3,4, 7, 8, 10, 13, 14); on the other hand, in another three, it was possible to identify a germ different from the one found in the cultures (cases 5, 12, 17), which modified the initial therapeutic behavior. Yin et al. described that the NGS technique has a sensitivity of 0.93 for the diagnosis of infection associated with a prosthesis, a value higher than that reported for the biomarkers CRP (0.67), interleukin 6 (0.47), procalcitonin (0. 67) and cultures (0.47), and these results were statistically significant ($p<0.05$). However, when evaluating specificity, NGS presented a value of 0.9, only higher than PCR (0.85; $p<0.05$).[13,23]

Although the described results of the application of NGS in the diagnosis of PJI are encouraging, several authors agree that it is necessary to validate these diagnostic methods with studies with a higher level of evidence and, in turn, evaluate the benefit-cost ratio.[24,25]

This study has limitations. Although its purpose was not to analyze the clinical outcomes, but rather the viability of using this novel technique, we believe that the patient sample is heterogeneous, which does not allow other conclusions to be drawn. In addition, no cost analysis was performed. On the other hand, its strength is its prospective design with meticulous data collection, in which samples of not only synovial fluid, but also of soft tissues were analyzed. It is important to note that the samples were analyzed in the center that has the largest genomic database in the world, a benefit when it comes to identifying the most atypical microorganisms and avoiding underdiagnosis.

CONCLUSIONS

According to our experience, the use of NGS in our field is viable as a tool for diagnosing PJI and the results are available in less than 72 hours, despite the distance from the analysis laboratory. Our findings suggest that some infections could be caused by other germs that escape conventional bacteriological detection. However, we believe that more studies are required to determine the role of NGS in the diagnostic algorithm and to understand the implication of certain rare microorganisms isolated in samples from patients who are apparently not infected.

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Primary Total Hip Arthroplasty With Short Stems in Patients Under 20 Years of Age

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ABSTRACT

Introduction: To our knowledge, there is no published literature on the outcomes of short-stem total hip arthroplasty (THA) in patients under 20 years old. This study aimed to analyze clinical, radiological, and functional outcomes in patients under 20 years of age undergoing THA with a short uncemented 2B femoral stem. **Materials and Methods:** We carried out a retrospective study of 13 patients (16 THAs) treated between January 2006 and January 2021. The mean age and BMI were 16.5±2.5 years and 22.74±4.06 kg/m2, respectively. The mean follow-up was 43.3 months (range 12-128, SD ± 33.45). Surgical indications, as well as functional and radiologic outcomes, were analyzed. Implant survival was calculated with the Kaplan-Meier estimate. **Results:** The predominant indication was avascular necrosis (9/16 hips [56%]), of which 66% were associated with prolonged use of corticosteroids. Eight (50%) of the cases had undergone surgeries before the THA. The Harris hip score improved significantly from 33±16.5 to 94±5.6 (p<0.001). Ten (76%) patients required assistive devices to walk preoperatively, and no patient required them at the end of follow-up. Radiolucency was evident in one acetabular component, without clinical implications. There were no signs of femoral component loosening. The implant survival was 100% at the last follow-up. **Conclusions:** Short stems in primary THAs in patients under 20 years of age with advanced hip osteoarthritis showed clinical, functional, and radiological outcomes comparable to those previously reported in the literature for conventional stems, with the particularity of being less invasive and sparing femoral bone stock.

Keywords: Total hip arthroplasty; total hip replacement; pediatric patients; young adults.
Level of Evidence: IV

Artroplastia total de cadera primaria con vástagos cortos en pacientes menores de 20 años

RESUMEN

Introducción: El objetivo de este estudio fue analizar los resultados clínicos, radiográficos y funcionales en pacientes <20 años sometidos a artroplastia total de cadera con vástago femoral tipo 2B corto no cementado. **Materiales y Métodos:** Se realizó un estudio retrospectivo de 13 pacientes (16 artroplastias totales de cadera) operados entre enero de 2006 y enero de 2021. La edad media y el índice de masa corporal eran de 16.5 ± 2.5 años y 22,74 ± 4,06 kg/m^2, respectivamente. El seguimiento medio fue de 43.3 meses (rango 12-128, DE ± 33.45). Se analizaron las indicaciones quirúrgicas, y los resultados funcionales y radiográficos. La supervivencia del implante se calculó con la estimación de Kaplan-Meier. **Resultados:** La indicación predominante fue necrosis avascular (9/16 caderas [56%]), el 66% estaba asociada al uso prolongado de corticoides. El HHS para cadera mejoró significativamente de 33 ± 16,5 a 94 ± 5,6 (p <0,001). Diez (76%) pacientes usaban dispositivos de asistencia para caminar antes de la artroplastia, pero ninguno los necesitaba al final del seguimiento. Se observó radiolucidez en un componente acetabular sin repercusión clínica hasta el final del seguimiento. No se registraron signos radiográficos de aflojamiento del componente femoral. La supervivencia del implante fue del 100% hasta el final del seguimiento. **Conclusiones:** La artroplastia total de cadera primaria con un vástago femoral corto no cementado en pacientes <20 años con artrosis avanzada de cadera logró resultados equiparables a los ya publicados, con la particularidad de que es un procedimiento menos invasivo y ahorra capital óseo femoral.

Palabras clave: Artroplastia total de cadera; prótesis total de cadera; pacientes pediátricos; adulto joven.
Nivel de Evidencia: IV

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INTRODUCTION

The treatment of advanced hip osteoarthritis in pediatric and adolescent patients remains controversial. Historically, the options considered in this age group were total hip arthroplasty (THA) and arthrodesis. Currently, arthrodesis is not an option since future conversion to THA poses problems in recovery due to the muscle atrophy it generates and the high rates of postoperative infection and instability.[1,2] Technical challenges of THA in this group of patients include poor bone stock, bone deformities such as axis abnormalities and femoral version abnormalities, limb length discrepancies, and small femoral canals.[3] On the other hand, the chances of revision are high over time; firstly, because the reason for replacement is usually secondary osteoarthritis (that is, more complex than primary osteoarthritis) and, also, because of life expectancy. For this reason, sparing bone stock in primary surgery is of the utmost importance.[4]

The first articles published were on the management of pediatric hip pathology in patients with rheumatoid arthritis treated with cemented stems.[5,6] Today, there are published series of uncemented THA with conventional stems in patients <25 years of age, with good functional outcomes, low rate of complications and a revision rate of 7%, with a minimum mean follow-up of 4.2 years.[7]

Short uncemented stems offer some advantages when compared to conventional designs: 1) they economize on the bone stock used to fix the implant;[8] 2) less blood is lost;[9] 3) they have a lower rate of intraoperative complications;[10] and 4) in case of a future revision, the surgery is less complex.

To our knowledge, there are no reports addressing the outcomes with an uncemented short femoral stem in patients <20 years of age undergoing primary THA.

The objective of this study was to analyze the clinical, radiographic and functional outcomes in a series of patients <20 years old treated with a primary THA with a type 2B short femoral stem.

MATERIALS AND METHODS

After obtaining approval from the institution's Research Ethics Committee, we retrospectively studied 26 THAs in 23 patients <20 years of age who had undergone surgery between January 2006 and January 2021. Only cases of uncemented short femoral stem THA with a minimum follow-up of one year were included. We excluded patients with active oncological diseases related to the pathology, and those operated on with cemented femoral stems (8 patients) and standard-size uncemented stems (2 patients). After applying the selection criteria, 10 patients were excluded; consequently, 13 patients (16 hips) who had undergone primary THA with a short uncemented type 2B stem with cervicometaphyseal fixation (MiniHip™, Corin, UK) were enrolled (Figure 1).[11] The demographic data of the series are detailed in Table 1.

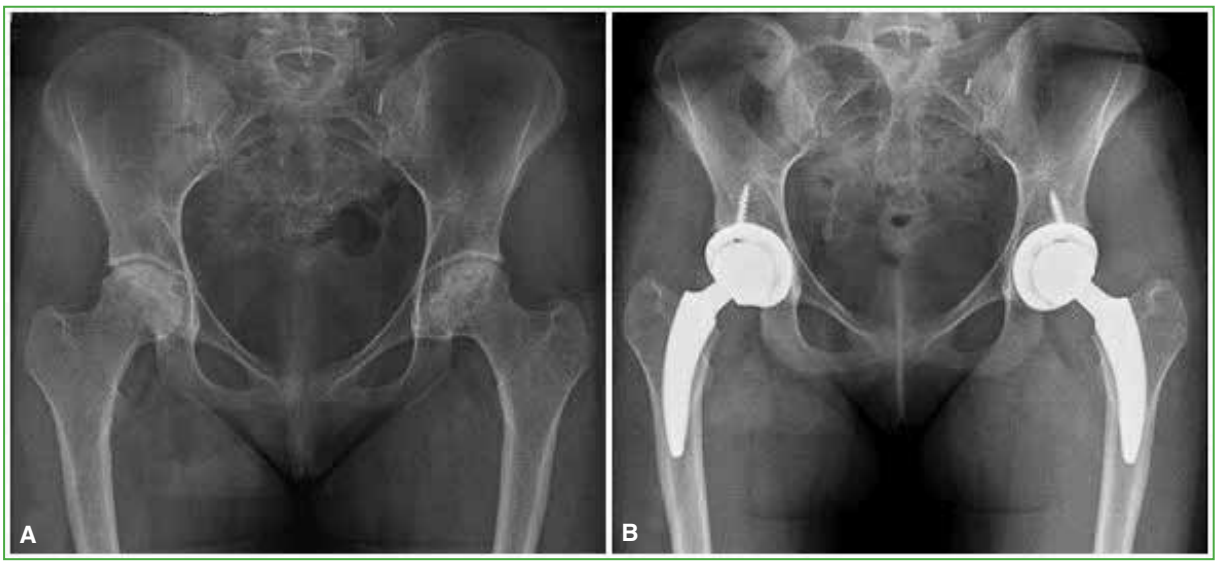

Figure 1. An 18-year-old patient with bilateral avascular bone necrosis secondary to prolonged treatment with corticosteroids for Crohn's disease. **A.** Preoperative anteroposterior radiograph of both hips. **B.** Postoperative anteroposterior radiograph of both hips after single-stage bilateral THA at the end of follow-up.

Table 1. Demographics of the series

Patients (hips) (n)	13 (16)
Mean age (years)	16.56 years (range 12-20, SD ± 2.58)
Gender (Male/Female)	7 (53.8%)/6 (46.2%)
Side	5 Right 5 Left 3 Bilateral
Mean body mass index	22.74 (range 16.3-31.4, SD ± 4.06) Only 1 patient (7.6%), >30
ASA Classification	ASA 1: 10 patients (76.92%) ASA 2: 3 patients (23.07%)
Mean follow-up	43.31 months (range 12-128, SD ± 33.45)

SD = standard deviation, ASA = American Society of Anesthesiology.

All the information was obtained from the prospectively collected electronic medical records of our institution, and was analyzed retrospectively by three researchers. None of them were involved in the original care of the patient. All surgeries were performed in laminar flow operating rooms through a posterolateral approach, and were performed by one of four trained hip surgeons on the surgical team. Epidural hypotensive anesthesia and tranexamic acid were administered before the incision. All patients received prophylactic antibiotics with three doses of intravenous cefazolin (1 g/8 h). Thromboembolism prophylaxis was indicated during the first postoperative month, with 40 mg/day of low molecular weight heparin, subcutaneously, in patients with one-stage bilateral surgery and 100 mg/day of aspirin, orally, in patients with with low clinical risk or unilateral surgery.

In addition to preoperative planning, the Woolson method was used to calculate leg lengthening, with a Steinman pin inserted proximal to the acetabulum as a stable pelvic landmark.[12] A porous acetabular component (Trinity™, Corin, Cirencester, UK) was placed with an uncemented press-fit technique in the acetabular area. The number of screws used to protect the cup fixation was defined during surgery and depended on the degree of pressure impaction obtained. Femoral reconstruction involved a partially neck-preserving osteotomy using the center of the neck as a constant landmark. We added a simple step to the original surgical technique to prevent a lateral cortical perforation. This step involved the use of a curved Mirizzi vascular clamp to enter the intramedullary canal, along the same path as the femoral neck. After using a curved awl at the entry point 3 mm above the center of the neck, progressive rasps were used until the planned size was achieved.[13]

The rehabilitation protocol included early mobilization after surgery, ambulation with a walker, and full weight-bearing for 15 days. Patients were then encouraged to progressively resume normal activities of daily living, as tolerated, with the use of a cane based on the clinical evolution and follow-up radiographic findings.

The clinical evaluation was performed with the Merle D'Aubigné[14] scale and the Harris Hip Score (HHS). Pain was assessed with the visual analog scale. All patients were scored before surgery and at the last follow-up. Whether they used assistive devices for walking before and after surgery was also documented.

The preoperative radiographic evaluation was performed by a complete examination of an anteroposterior radiograph of the pelvis and lateral hip. The degree of preoperative joint degeneration was characterized with the Tönnis[15] classification and the Dorr classification to establish the morphology of the proximal femur.[16]

Anteroposterior and lateral radiographs of the hip were obtained immediately postoperatively, at 15 days, 6 months, 12 months, annually, and at the end of follow-up. Two independent observers, blinded to clinical outcomes, performed all radiographic measurements comparing immediate postoperative radiographs with those at last follow-up. Femoral radiolucency was defined as any irregular line between the stem and the bony interface; periprosthetic osteolysis was defined as progressive bone loss >5 mm and was assessed using Gruen's zones.[17] The

radiographic evaluation of stem fixation was performed according to the method of Engh et al.[18] Femoral stem subsidence was determined using the method described by Loudon and Charnley,[19] by measuring the distance from a selected (but variable) point on the femoral prosthesis to a fixed point on the bone. Definitive loosening was considered sinking >5 mm or progressive demarcation around the stem. The cups were analyzed in the three zones described by DeLee and Charnley.[20]. Radiolucencies were classified into lines extending over <50% of an area, >50% of an area but not completely, or over the entire area. The width of any radiolucent line observed was classified into: <1 mm, 1 to 2 mm, or >2 mm.

All complications were recorded and divided according to the time they appeared. Septic failure was considered to be any case that required revision surgery due to surgical site infection, according to the definitions standardized by the Musculoskeletal Infection Society revised at the International Consensus Meeting. Aseptic implant failure was defined as the need for revision surgery due to non-infectious causes.

RESULTS

The causes that led to the indication for surgery were: three idiopathic chondrolysis, three avascular bone necroses (ABN) secondary to epiphysiolysis, two sequelae of septic arthritis, one sequela of acetabulum fracture, one developmental dysplasia with sequela of failed pelvic osteotomy, and six cases (all three bilateral) of ABN induced by prolonged corticosteroid treatment secondary to Crohn's disease, lupus, and acute lymphoid leukemia. In total, nine (56%) of the cases corresponded to ABN secondary to different causes (Table 2, Figure 2). Eight patients (50%) had undergone surgery before the THA. (Figure 3)

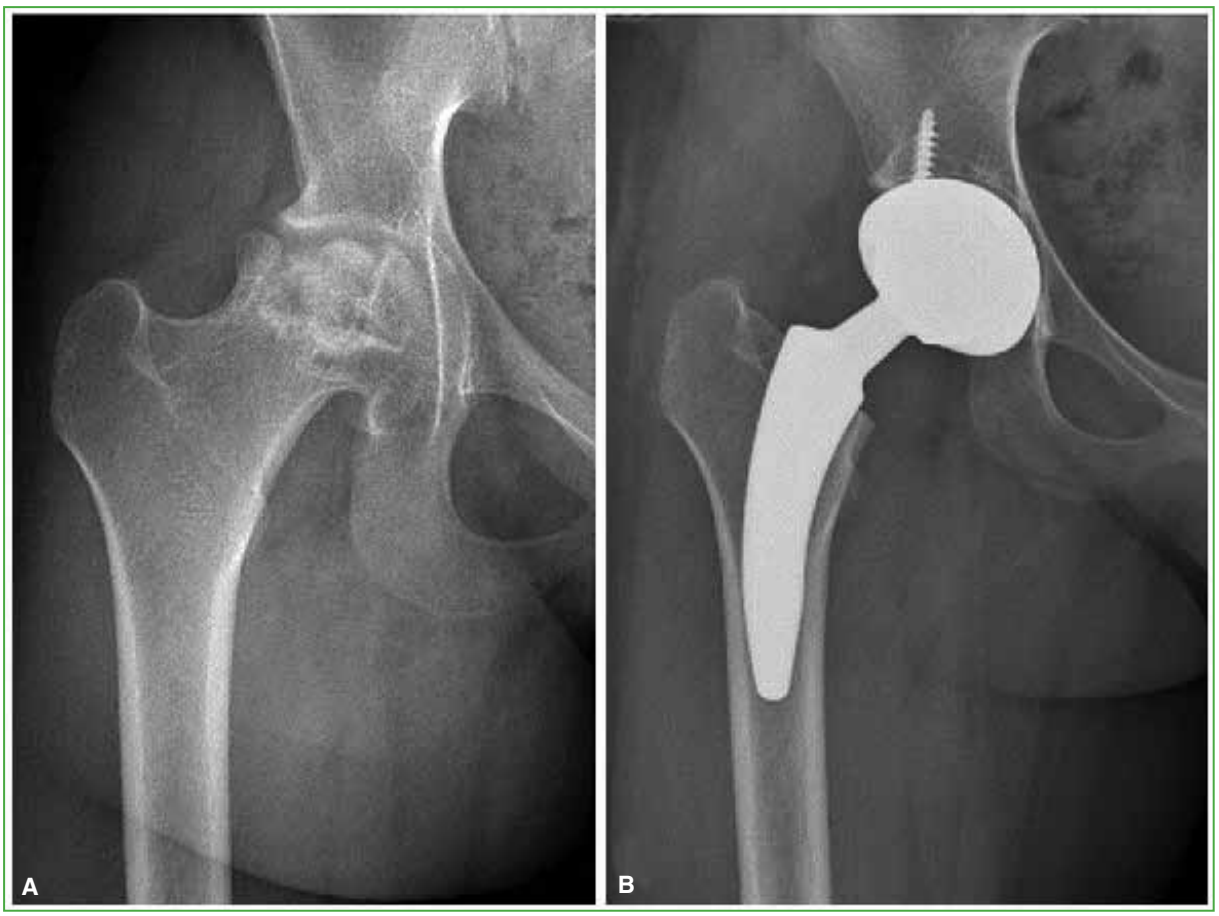

Figure 2. A 19-year-old patient with bilateral avascular bone necrosis secondary to prolonged corticosteroid treatment for acute lymphoid lymphoma. **A.** Preoperative anteroposterior right hip radiograph. **B.** Postoperative anteroposterior right hip radiograph after single-stage bilateral THA at the end of follow-up.

Table 2. Characteristics of each case

Patient	Total hip arthroplasty	Age (years)	Sex	Side	Diagnosis	Previous surgery	Bearing surface	Pre-surgery use of ambulation device	Post-surgery use of ambulation device	Complications
1	1	12	F	Right	IC	CHD	C-P	A pair of crutches	No	No
2	2	14	M	Left	ABN, FNF	R/O	C-C	No	No	No
3	3	14	F	Right	Dysplasia	TPO	C-P	Cane	No	No
4	4	15	F	Left	ABN, FNF	No	C-C	Crutches	No	No
5	5	15	F	Left	SA sequela	CHD	C-C	Cane	No	No
6	6	16	M	Right	IC	No	C-P	Cane	No	No
7	7	18	F	Bilateral	ABN, corticosteroids, Crohn's disease	No	C-P	Walker	No	No
7	8	18	F	Bilateral	ABN, corticosteroids, Crohn's disease	No	C-P	Walker	No	No
8	9	19	F	Bilateral	ABN, corticosteroids, ALL	Bilateral Forage	C-C	Wheelchair	No	No
8	10	19	F	Bilateral	ABN, corticosteroids, ALL	Bilateral Forage	C-C	Wheelchair	No	No
9	11	20	M	Left	SA sequela	No	C-P	No	No	Intraoperative trochanteric fracture, sciatic nerve injury
10	12	20	M	Bilateral	ABN, corticosteroids, lupus	No	C-P	No	No	No
10	13	20	M	Bilateral	ABN, corticosteroids, lupus	No	C-P	No	No	No
11	14	14	M	Left	ABN due to epiphysiolysis	Osteodesis	C-P	Crutches	No	No
12	15	16	M	Right	Sequela of acetabular fracture-dislocation	Acetabulum R/O	C-P	Crutches	No	No
13	16	15	M	Right	IC	No	C-P	Crutches	No	No

M = male, F = female, IC = idiopathic chondrolysis, ABN = avascular bone necrosis, FNF = femoral neck fracture, R/O = reduction and osteosynthesis, SA = septic arthritis, ALL = acute lymphoid leukemia, CHD = controlled hip dislocation, TPO = triple pelvic osteotomy, C-C = ceramic-on-ceramic, C-P = ceramic-on-polyethylene.

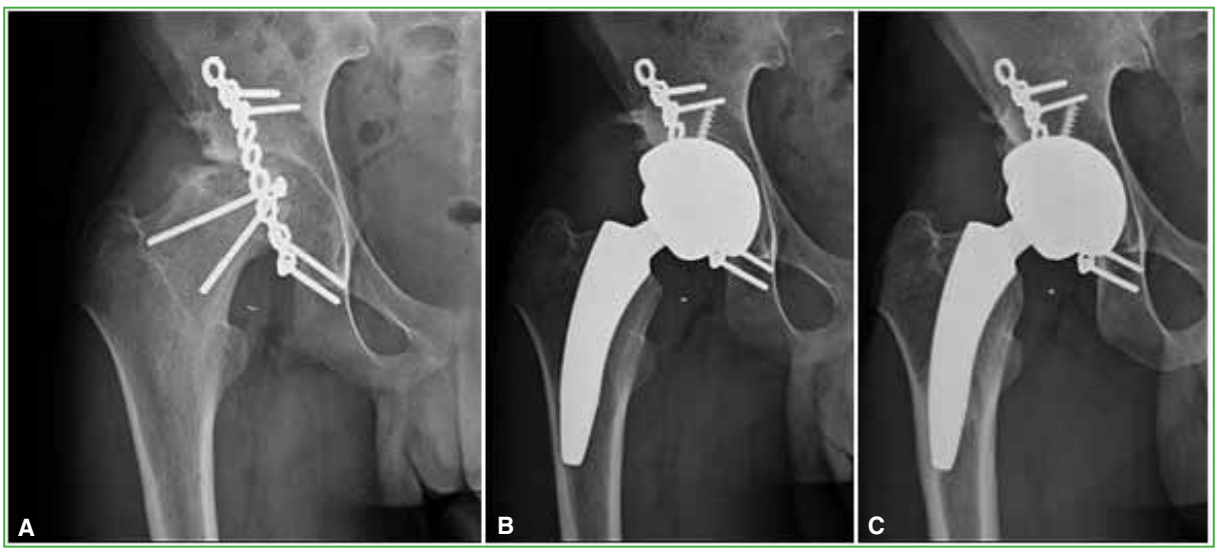

Figure 3. A 16-year-old patient with sequela of a dislocated acetabular fracture. **A.** Anteroposterior right hip radiograph before total hip arthroplasty. **B.** Anteroposterior right hip radiograph in the immediate postoperative period. **C.** Anteroposterior right hip radiograph after 10 years of follow-up.

The average hospital stay was 2.86 days (range 1-4). Only one patient out of the 13 (7%) required transfusions, one of three cases of single-stage bilateral THA.

A fourth-generation ceramic-on-ceramic Delta™ surface (Biolox, CeramTec, Plochingen, Germany) was used on five hips while, in the remaining 11 cases, ceramic on highly cross-linked polyethylene with posterior rim was used. This decision depended on the authorization of the patients' health insurance. Osseointegration was achieved in all cups and, according to the Engh classification, all stems were stable, without any sign of loosening. A patient who had undergone single-stage bilateral surgery had a radiolucent line in acetabular zone 1 of the right hip eight months after the operation; however, as he remained asymptomatic, he received conservative treatment (Table 2).

The mean HHS went from 33.31 (range 8-64; SD ± 16.528) to 94.13 (range 78-100; SD ± 5.691; p<0.001). There was also a significant improvement in the Merle D'Aubigné score when comparing preoperative with postoperative values [8.62 (range 2-13); SD ± 3.30 vs. 17.56 (range 16-18); SD ± 0.81, p<0.001]. Likewise, the global VAS pain score also improved markedly [8.63 (range 2-13) SD ± 3.30 vs. 0.84 (range 16-18), SD ± 5.691; p<0.001] (Table 3). Regarding the use of an ambulatory device, 10 (76.9%) patients needed one before surgery and none required it at the end of follow-up.

Table 3. Functional evaluation

Score	Preoperative value	Range	Postoperative value	Range	p
Harris Hip Score	33	8-64	94	78-100	0.001
Merle D'Aubigné Scale	8	2-13	17	16-18	0.001
Visual analog scale	8	5-10	1	0-5	0.001

A complication was recorded in a 20-year-old patient operated on for sequela of septic arthritis in childhood. At the time of surgery, he had almost complete agenesis of the femoral head with a dysplastic acetabulum and limb shortening of 35 mm. During surgery, there was a fracture of the greater trochanter treated with cerclage wire and, in the postoperative period, he presented motor paralysis of the sciatic nerve and neuropathic pain. Six months after the THA, he required a sciatic neurolysis. At the end of the follow-up, the recovery of motor function was complete, he did not have a limp, but he suffered from persistent neuropathic pain, with dysesthesia in the sole of his foot.

No cases of thigh pain, instability or infection were detected. The implant survival rate was 100% at the end of follow-up.

DISCUSSION

It is increasingly common to face the need to perform a THA for end-stage hip disease in adolescent or young adult patients. There are multiple publications that describe the outcomes with cemented and uncemented prostheses in this age group.

In this study, we presented a series of consecutive patients treated with short-stem uncemented prostheses and a mean follow-up of 43 months. To the best of our knowledge, this is the first study to specifically report the outcome of femoral reconstruction with a uncemented short stem in patients <20 years of age.

The short cervical-metaphyseal stems use the calcar and the lateral femoral cortex as support points, providing stability through metaphyseal fixation and preserving as much of the neck as possible,[11,21] which, associated with a correct biomechanical and functional contribution, makes it a good option in young patients. When performing a radiographic analysis between type 2B short stems and uncemented conventional stems, it was estimated that short stems allow 42% of femoral bone stock to be preserved.[24]

Rainer et al. analyzed a series of 12 patients (13 THAs) <16 years old with uncemented stems with a mean clinical-radiological follow-up of 2.4 years. In the results, they described that 10 of the 13 cases (77%) had ABN as a surgical indication.[22] Clohisy et al. published a series of 88 patients and 102 hips and reported that ABN was the most common cause (incidence 44%).[7] In our series, 56% of the cases corresponded to ABN due to various causes, which is consistent with the trend of these indications.

In this study, a significant improvement in pain and function was demonstrated, which was seen both in functional scores and in the discontinuation of ambulation devices. There was no evidence of radiolucency or signs of loosening at the stem level, and revision of the components was not necessary. Tsukanaka et al. analyzed 111 patients (132 hips) who underwent primary THA before the age of 20, in the period 1987-2010, extracted from the *Norwegian Arthroplasty Register,* with a mean follow-up of 14 years (range 3-26). They reported 31 (27.92%) revisions, 18 of them (58.06%) were due to aseptic loosening; 11 (35,4), due to wear of the acetabular insert and the rest of the causes were due to osteolysis, infection, and instability.[4]

It is important to note that many of these patients arrive at surgery using ambulation devices. Bessette et al. studied a series of patients <21 years old who underwent THA with a minimum follow-up of 10 years. All used ambulation devices, but at the end of the follow-up, only 56% were still using them.[23]

Our study has limitations. Firstly, its retrospective design and the inherent biases of said design. The size of the sample meant that a small number of cases were included, which restricted the production of a more precise statistical analysis. Secondly, the study lacked a control group with similar characteristics. Thirdly, our survival rates should be viewed as estimates at best. Since the follow-up was short-term, we expect some of these patients to still undergo revision arthroplasty for any reason at a longer follow-up. However, it is the only study on the clinical and radiographic outcomes of this hip implant in patients <20 years of age.

CONCLUSION

THA with a short uncemented femoral stem in patients <20 years of age with advanced hip osteoarthritis obtained clinical, functional and radiographic outcomes comparable to those already published, with the particularity that it is a less invasive procedure and preserves bone stock.

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

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Prevalence and Outcomes of Unexpected Positive Cultures in Presumed Aseptic Revision Total Hip Arthroplasty

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ABSTRACT

Introduction: Periprosthetic infection rates are sometimes underestimated, given that many cases of presumed aseptic failure may be due to unrecognized infection. The objectives of this study were: 1) to estimate the prevalence of unexpected positive intraoperative cultures; 2) to determine if any of the patient's comorbidities or risk factors were related to the presence of unexpected positive cultures; 3) to determine the implant survival during a follow-up of at least 12 months. **Materials and Methods:** A retrospective and observational study was carried out where, through electronic medical records, all revision total hip arthroplasties (THAs) from a single institution between 2014 and 2021 were identified. **Results:** Out of 49 single-stage revision THAs, 9 patients (18.4%) had an unexpected positive culture. The isolated microorganisms were *Staphylococcus aureus* (3), *Pseudomonas aeruginosa* (1), *Staphylococcus lugdunensis* (1), *Staphylococcus epidermidis* (2), *Staphylococcus haemolyticus* (1), *Streptococcus epidermidis* (1). In addition, when we evaluated the comorbidities of the patients, none had statistical significance in favoring unexpected positive cultures in aseptic revisions. We discovered that 2% of our sample with a follow-up period of 49 months developed reinfection. **Conclusion:** Our study showed a prevalence of unexpected positive cultures of 18.4%. None of the risk factors reported in the literature was associated with a higher risk of unexpected positive cultures, except for high ESR values. Our findings in the analyzed sample suggest that unexpected positive cultures in presumably aseptic revisions do not have significant consequences on implant survival, as found in the literature.

Keywords: hip arthroplasty; hip revision surgery; microorganism; periprosthetic infections.

Level of Evidence: III

Prevalencia y resultados de cultivos positivos inesperados en revisiones de reemplazo total de cadera presumiblemente asépticas

RESUMEN

Introducción: Las tasas de infección periprotésica, a veces, son subestimadas, ya que muchos casos de presunta falla aséptica pueden deberse a una infección no reconocida. Los objetivos de este estudio fueron: 1) estimar la prevalencia de cultivos positivos intraoperatorios inesperados, 2) determinar si las comorbilidades o los factores de riesgos de los pacientes tuvieron relación con la presencia de cultivos positivos inesperados, 3) determinar la supervivencia del implante en un seguimiento mínimo de 12 meses. **Materiales y Métodos:** Se realizó un estudio retrospectivo y observacional. En las historias clínicas electrónicas, se identificaron todas las revisiones de artroplastia total de cadera de una única institución entre 2014 y 2021. **Resultados:** De las 49 revisiones de artroplastia total de cadera en un tiempo, 9 pacientes (18,4%) tuvieron un resultado positivo inesperado. Los microorganismos aislados fueron: *Staphylococcus aureus* (3), *Pseudomonas aeruginosa* (1), *Staphylococcus lugdunensis* (1), *Staphylococcus epidermidis* (2), *Staphylococcus haemolyticus* (1), *Streptococcus epidermidis* (1). Ninguna comorbilidad tuvo significancia estadística para favorecer cultivos positivos inesperados en las revisiones asépticas. El 2% de la muestra, con un período de seguimiento de 49 meses, se reinfectó. **Conclusiones:** Nuestro estudio arrojó una prevalencia de cultivos positivos inesperados del 18,4%. Ninguno de los factores de riesgo reportados en la bibliografía se asoció con un mayor riesgo de cultivos positivos inesperados, excepto los niveles altos de velocidad de eritrosedimentación glomerular. Nuestros hallazgos son compatibles con los publicados y sugieren que los cultivos positivos inesperados en revisiones presumiblemente asépticas no tienen consecuencias significativas en la supervivencia del implante.

Palabras clave: Artroplastia de cadera; revisión de cadera; microorganismo; infecciones periprotésicas.

Nivel de Evidencia: III

Level of Evidence: III

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INTRODUCTION

The prevalence of primary and revision total hip arthroplasties (THA) increased substantially over time, it is higher in women than in men, and increases progressively with age.[1] The total number of revision hip arthroplasties performed in 2005 is expected to double by 2026.[2]

Revision THAs are carried out for multiple reasons. Registry data has indicated that 12% of hip and knee arthroplasty patients undergo revision surgery within 10 years of their initial surgery.[3]

It is imperative to rule out an infection as a possible etiology before a revision, because the treatment becomes completely different. There is still no perfect test to diagnose periprosthetic infection (PPI)[4] and it is important to note that PPI rates are sometimes underestimated, as many cases of presumed aseptic failure may be due to unrecognized infection.[5]

Unexpected positive intraoperative cultures of microorganisms obtained during a presumed aseptic THA review present a substantial challenge to the surgeon and his or her team.[4] Published prevalence varies considerably (4% to 38%, mean 10.5%)[5] and the infection-free implant survivorship rate and optimal treatment remain unclear.[6,7]

The objectives of this study were: 1) to estimate the prevalence of unexpected positive intraoperative cultures in presumably aseptic THA revisions, 2) to determine if there is a relationship between comorbidities or risk factors of patients with the presence of an unexpected positive culture, 3) to determine implant survivorship in these patients with at least 12 months of follow-up.

MATERIALS AND METHODS

We carried out a retrospective and observational study. We identified all revision THAs in the electronic medical records of a single institution that took place between 2014 and 2021.

Surgical records were reviewed to identify revision THAs performed for aseptic indications. Cleaning and debridement cases with implant retention and two-stage revisions were excluded from the analysis. We consider a revision to be initially aseptic based on the clinical symptoms (afebrile patient, no inflammatory signs of the wound, absence of fistula and secretion) and blood tests with normal values of white blood cells, glomerular filtration rate (GFR) and C-reactive protein (CRP), and analysis of joint puncture fluid with <3000 white blood cells and <80% polymorphonuclear cells.

Fifty-eight revisions for aseptic causes were identified in a total of 120 all-cause THA revisions (Figure 1). We excluded aseptic revisions with no available intraoperative cultures (n = 9) in order to establish a true cohort and estimate the prevalence of unexpected positive intraoperative findings, yielding 49 aseptic revisions with available culture data. In nine of the 49 aseptic revisions, at least one microorganism was isolated in solid culture media or culture broths.

All patients had at least one year of follow-up after the aseptic revision procedure.

Microorganisms were classified into three types: virulent, indolent, and miscellaneous/contaminants (Table 1). Management of unexpected positive intraoperative cultures was determined on the basis of the organism isolated. In accordance with the indication of the Infectious Disease Service of the institution, the patients were treated in the short term (8-12 weeks) if they met any of the following criteria: 1) one or more positive cultures for virulent organisms and fungi, and 2) two or more positive cultures for indolent organisms. In addition, the decrease in inflammatory parameters, GFR, and CRP was taken into account to define the end of antibiotic therapy.

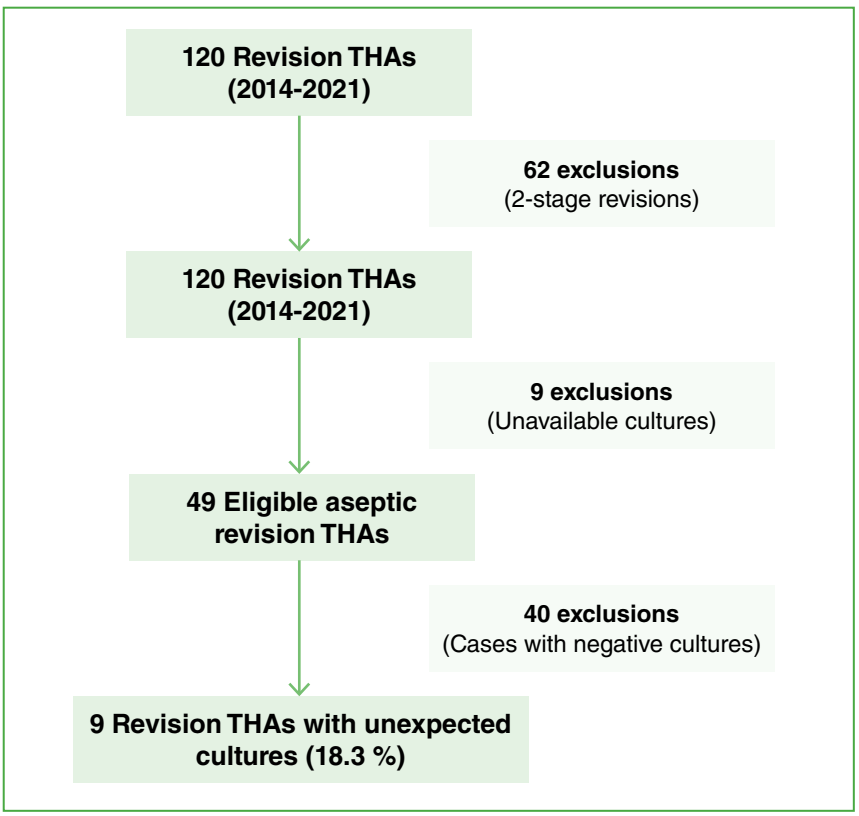

Figure 1. Flowchart showing selectable total hip arthroplasty revisions and the number of unexpected positive intraoperative cultures.

Table 1. Classification of microorganisms

Category	Group	Microorganism
Virulent	Gram-positive cocci	*Streptococcus viridans* (1) *Staphylococcus aureus* (3) *Enterococcus* (0)
	Gram negative	*Pseudomonas aeruginosa* (1) *Klebsiella pneumoniae* (0) *Escherichia coli* (0)
Indolent	Gram-positive cocci coagulase-negative *Staphylococcus aureus* *Propionibacterium acnes*	 *Staphylococcus epidermis* (2) *Staphylococcus haemolyticus* (1) *Staphylococcus lugdunensis* (1)
Miscellaneous/ Contaminant	Possible contaminant – Gram-positive cocci	Other coagulase-negative *Staphylococcus aureus*

RESULTS

The sample consisted of 49 patients, 61.2% of them were women, with a mean age of 66 years (range 30-86). Of the 49 single-stage total hip revisions, nine patients (18.4%) had an unexpected positive intraoperative culture. The reasons for revision were: presumed aseptic loosening (59.2%), periprosthetic fracture (24.5%), instability (12.2%) and polyethylene wear (4.1%) (Table 2).

Table 2. General characteristics of the patients

Variables	Categories	Number of patients	Percentage
Sex	Female	30	61.2
	Male	19	38.8
Age, mean (SD)		66.0 (14.4)	
ASA	1	2	4.1
	2	38	77.6
	3	9	18.4
Reason for revision	Aseptic loosening	29	59.2
	Periprosthetic fracture	12	24.5
	Instability	6	12.2
	Polyethylene wear	2	4.1

SD = standard deviation, ASA = American Society of Anesthesiologists.

The mean surgery time was 167 min (range 90-270). The mean time from primary THA to revision was 10 years (standard deviation [SD] = 6.3) and the mean follow-up time after revision was 30 months (range 12-80).

The isolated microorganisms are summarized in Table 1. Eight of the nine patients had two or more positive samples, one patient had only one positive sample. The decision on the specific antibiotic therapy for each patient and the duration of treatment was always made in conjunction with the Infectious Diseases Service. We did not carry out an analysis of the antibiotic therapy selected for each patient and its results because it exceeded the objectives of the study.

When CRP and GFR values were analyzed, the mean CRP was 1.1 (SD = 2.2) with values between 0.11 and 9.51. When comparing the CRP value between patients who had either positive or negative cultures, it was observed that the mean CRP was higher if germs had been isolated (2.39 vs. 0.80, respectively); however, the difference between these values did not have statistical significance (Table 3). Mean preoperative GFR levels were 21.8 (SD = 21.6) (range 1-103). When differentiating between patients with positive cultures and those without positive cultures, this parameter was higher in the former (mean 38.6 vs. 18.1, respectively), with a statistically significant difference (Table 3).

Table 3. Preoperative C-reactive protein and glomerular filtration rate values according to culture results.

	Culture	Mean	SD	Minimum	Maximum	p
C-reactive protein	Negative (n = 40)	0.80	1.98	0.11	9.51	0.053
	Positive (n = 9)	2.39	2.95	0.13	8.14	
Glomerular filtration rate	Negative (n = 40)	18.1	17.0	1	101	**0.044**
	Positive (n = 9)	38.6	31.6	3	103	

SD = standard deviation.

When evaluating patients' comorbidities and risk factors (rheumatoid arthritis, diabetes, obesity, smoking), none were associated with unexpectedly positive cultures. Neither were age and sex characteristics (Table 4).

Table 4. Distribution of the cultures according to the type of revision

Variables	Categories	Negative	Positive	p
Sex	Female	24	6	0.711
	Male	16	3	
Age		65.9 ± 15.1	66.3 ± 11.7	0.826
Diabetes	No	34	9	0.215
	Yes	6	0	
Rheumatoid arthritis	No	36	8	0.921
	Yes	4	1	
Body mass index >25 (obese/ overweight)	No	29	5	0.319
	Yes	11	4	

One patient (2.04%) of the sample, with a follow-up of 49 months, suffered a reinfection (Figure 2). An unexpected positive culture for coagulase-negative *Staphylococcus* was detected in two intraoperative samples. The patient is currently receiving suppressive antibiotic treatment due to his comorbidities and age. The rest of the patients with positive cultures (8 cases) have not had infection in the follow-up time.

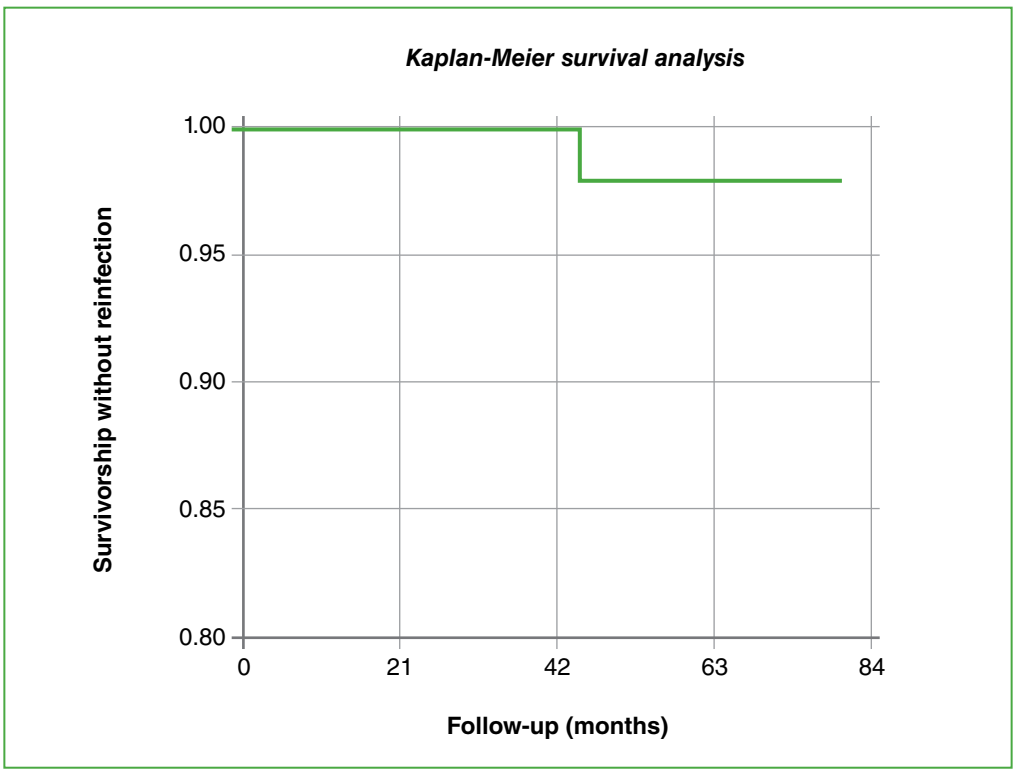

Figure 2. Kaplan-Meier curve showing implant survivorship without reinfection.

DISCUSSION

There is no consensus on the diagnostic criteria for PPIs; therefore, diagnosis and management of positive intraoperative cultures from presumably aseptic THA revisions are difficult.

Currently, PPI is diagnosed using the criteria of the Musculoskeletal Infection Society or the International Consensus Meeting.[8] The recommendation of the Infectious Disease Society of America on single positive cultures is to treat only highly virulent pathogens, such as *Staphylococcus aureus*.[5]

Current evidence suggests that a single positive culture in presumably aseptic revisions is associated with an increased risk of reinfections and re-screening. Milandt et al.[9] studied 54 hip arthroplasties and found that a single positive culture is a risk factor for re-revision. Our results indicated that 2.04% of the sample (n = 49) had a reinfection; however, when only patients with unexpectedly positive cultures (n = 9) were analyzed, that number increased to 11.11%.

The published prevalence of PPI is highly variable, this may be due to differences in pre-, intra- and postoperative management, and the lack of standardized criteria for the diagnosis of PPI and its treatment. Early aseptic loosening has been reported to be associated with unidentifiable PPIs.[8] Our analysis revealed that the main reason for THA revision was aseptic loosening (59.2%), eight of the nine patients with unexpectedly positive cultures underwent revision for this reason.

In this series, the infection-free implant survival time was 80 months, a considerably longer period than those published in other studies (from 26 to 66 months).[8]

Benign prostatic hyperplasia, male sex, obesity, elevated CRP, and adverse reaction to metal have been associated with an increased risk of prosthesis failure due to PPI.[8] In our results, none of these parameters had statistical significance in favoring unexpected positive cultures in these aseptic revisions, except for elevated GFR values. These differences may be due to the small sample size.

The results obtained suggest that unexpected positive cultures in presumably aseptic revisions are not significant in implant survivorship, data compatible with what has been published in other studies.[10,11] However, all the patients in the series received antibiotic treatment regardless of the criteria accepted by the Musculoskeletal Infection Society for the diagnosis of PPI.

As limitations of the study, we can highlight: 1) its retrospective nature and the size of the sample, 2) the fact that the technique used for the analysis of the cultures was direct examination of solid cultures or culture broths (at that moment, other methods that would have improved the infection detection technique, such as implant sonication, were not available), 3) that the number of samples sent varied considerably between patients, so there could be false negative results.

CONCLUSIONS

18.4% of the presumably aseptic THA revisions presented positive cultures and, in our series, there was no relationship with any comorbidity or risk factor of the patient. After the previous clinical and biochemical study, and the appropriate antibiotic treatment, we consider that unexpected positive cultures had no impact on implant survival. However, it is important to note that all patients with positive cultures were prescribed antibiotic treatment. For this reason, we affirm that an unexpected positive culture of low-virulence pathogens should not be disregarded as a simple contaminant and we recommend a minimum antibiotic treatment of two to three months with clinical and laboratory controls. On the other hand, based on the analysis of the results, we believe it is of fundamental importance to exhaust the pre-surgical diagnostic instances to define whether a revision surgery is aseptic or not, in order to obtain minimal or null percentages of unexpected positive cultures. A clinical analysis with exhaustive laboratory parameters and a pre-surgical joint puncture must be performed on all patients undergoing revisions. It is also very important to take a minimum of 3-5 intraoperative samples for the physical-chemical and bacteriological study.

More large-scale studies with diagnostic and treatment protocols are required to obtain more reliable results on the subject.

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

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Osteosynthesis in Vancouver type B1 and C Periprosthetic Hip Fractures of the Femur. A Multicenter Analysis

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ABSTRACT

Introduction: Our objective was to analyze the results of osteosynthesis treatment in patients with Vancouver type B1 and C fractures, evaluate complications, reinterventions and the mortality rate in this group. **Materials and Methods:** Multicenter, retrospective study. A database was established that included 53 patients with Vancouver type B1 and C periprosthetic femoral fractures treated with osteosynthesis from 2008 to 2021, who were evaluated in two high-complexity hospital centers. **Results:** The most used proximal fixation was bicortical screws and wire loops. The type of fracture according to the Vancouver classification correlated with a significant value in the use of interfragmentary compression screws (p 0.001), with a total of 13 patients (24.52%), 9 in Vancouver type C fractures. Mean consolidation was 4 months, with a mean Harris Hip Score of 68. Twelve patients (22.64%) had complications: delayed union (7 cases; 13.2%), failed osteosynthesis with fracture at the distal level of the stem (one case; 1.88%), one new osteosynthesis due to failure at the level of the osteosynthesis material (one case; 1.88%), and three deaths (5.66%). **Conclusions:** The management of periprosthetic femoral fractures is a complex and challenging issue. Osteosynthesis treatment is a successful method that requires the application of current principles of minimally invasive techniques that, together with stable proximal fixation, improve the chances of success.

Keywords: periprosthetic femoral fractures; osteosynthesis; Vancouver classification.

Level of Evidence: IV

Osteosíntesis en fracturas femorales periprotésicas de cadera Vancouver tipos B1 y C. Análisis multicéntrico

RESUMEN

Introducción: Nuestro objetivo fue analizar los resultados del tratamiento con osteosíntesis en pacientes con fracturas Vancouver tipos B1 y C, evaluar las complicaciones, las reintervenciones y la tasa de mortalidad en este grupo. **Materiales y Métodos:** Estudio multicéntrico, retrospectivo. Se estableció una base de datos que incluía a 53 pacientes con fracturas periprotésicas de fémur Vancouver tipos B1 y C tratadas con osteosíntesis, desde 2008 hasta 2021, en dos centros hospitalarios de alta complejidad. **Resultados:** La fijación proximal más utilizada fue con tornillos bicorticales más lazadas de alambre. El tipo de fractura según la clasificación de Vancouver se correlacionó con un valor significativo en el uso de tornillos de compresión interfragmentaria (p 0,001), con un total de 13 pacientes (24,52%), 9 en fracturas Vancouver tipo C. El tiempo de consolidación promedio fue de 4 meses, con un puntaje promedio del *Harris Hip Score* de 68. Doce pacientes (22,64%) tuvieron complicaciones: retraso de la consolidación (7 casos; 13,2%), falla de la osteosíntesis con trazo de fractura a nivel distal del tallo (un caso; 1,88%), una nueva osteosíntesis por falla a nivel del material de osteosíntesis (un caso; 1,88%) y tres fallecieron (5,66%). **Conclusiones:** El manejo de las fracturas femorales periprotésicas es un tema complejo y desafiante. El tratamiento con osteosíntesis constituye un método exitoso que requiere de la aplicación de principios actuales de técnicas mínimamente invasivas que, junto con una fijación proximal estable, mejoran las posibilidades de éxito.

Palabras clave: Fractura femoral periprotésica; osteosíntesis, clasificación de Vancouver.

Nivel de Evidencia: IV

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INTRODUCTION

The incidence of periprosthetic femoral fractures has been estimated to range between 1.5% and 4%.[1,2] According to the Swedish Registry, periprosthetic fractures are the third most frequent cause of hip revision after aseptic loosening and infection.[3]

Faced with a periprosthetic fracture, the treatment options are osteosynthesis or revision of the prosthesis. The correct interpretation of the fracture and the evaluation of the patient will allow selecting the most appropriate type of treatment. In this sense, the Vancouver[2] classification allows us to select the treatment of choice, analyzing the site of the fracture, the stability of the implant and the quality of the surrounding bone material.

The most critical point in this evaluation is to distinguish between fractures with a fixed prosthetic component (B1) and those with a loose component (B2 and B3). An incorrect interpretation could lead us to perform an osteosynthesis on a loose prosthesis, a situation associated with a high failure rate. The treatment of a periprosthetic hip fracture represents a challenge for the surgeon, since it usually occurs in an emergency setting, in fragile patients with poor bone quality. Its correct resolution will require both knowledge of osteosynthesis and arthroplasty.

Our objective was to analyze the results and basic principles of the osteosynthesis treatment of Vancouver periprosthetic femoral fractures types B1 and C, and also to evaluate the complications, reinterventions and the mortality rate in this group of patients.

MATERIALS AND METHODS

After obtaining the approval of the respective ethics committees, a multicenter database was established and a series of patients diagnosed with periprosthetic femoral fracture from 2008 to 2021 treated in two high-complexity hospital centers was retrospectively evaluated.

The inclusion criteria were: patients with Vancouver type B and C periprosthetic femoral fractures, treated with osteosynthesis and with a follow-up of >1 year.

Patients with Vancouver type B2 and B3 fractures, those with <1-year follow-up, those who were not ambulant before the fracture, and those who required revision surgery for infection, loosening, or instability were excluded.

Demographic data, as well as information on the functional evolution of the series, were extracted from the database. The number of previous surgeries, the type of prosthesis, the cementation of the stem, the reduction technique and the fracture pattern were evaluated. Regarding osteosynthesis, the type and length of the plate, the density of the screws, the presence of interfragmentary compression screws and the type of proximal fixation were analyzed. The types of proximal fixation were: bicortical screws, bicortical screws with cerclage wire or cable, and monocortical screws with cerclage wire or cerclage wire only. Other assessments included the use of allograft, failures, consolidation time, and perioperative mortality rate.

The patients were evaluated clinically and radiologically until the time of fracture union. Clinical and functional evaluations were carried out with the Harris Hip Score six months after surgery.

Radiographs taken before surgery, immediately postoperatively, and at each subsequent visit, at 3 weeks, and at 3, 6, and 12 months were analyzed. Postoperative radiographs were analyzed for possible implant failure and fracture healing. Fracture union was defined as bony bridging across major fracture lines visible on serial radiographs.

Descriptive analyses were performed tabulating the variables as mean ± standard deviation (SD) in the case of quantitative variables, and as frequency (%) for categorical variables. In all cases, a significance level of 0.05 was established. The InfoStat program (v. 2020) was used.

RESULTS

The final sample consisted of 53 patients with a diagnosis of periprosthetic femoral fracture who met the inclusion criteria. 75.5% were female. The mean age was 82.1 years (SD = 9.8; range 55-97) (Table 1).

77.4% of the sample had only had one previous surgery, while the remaining 22.6% had had two or more surgeries. The primary diagnosis for total hip replacement was osteoarthritis in most cases, other relevant diagnoses were medial hip fractures and interprosthetic fractures.

66% had a fracture with a Vancouver type B1 fixed prosthetic component and the rest, Vancouver type C. In 83%, a cemented stem prosthesis had been placed, and 92.5% of them were polished.

Table 1. Demographic data

Variable	
Number of cases	53
Mean age, years (range)	82.1 (55-97)
Sex Female Male	 41 12
Previous surgeries, mean (range)	1 (1-8)
Vancouver Classification B1 C	 35 18
Fracture pattern Simple Comminuted	45 8

The fracture pattern was simple in 84.9% and comminuted in the rest.

Combined cable-plate systems were used in 47.5% of surgeries, followed in order of frequency by locking condylar plates (34%). In the remaining cases, double plates, trochanteric hook plates and locked lateral plates were used (18.5%).

No significant differences were found in the distribution of patients according to the Harris Hip Score and the type of proximal fixation (p 0.366) (Table 2).

Table 2. Distribution of the sample according to the Harris Hip Score and the type of proximal fixation.

Proximal fixation type	Mean	SD	Minimum	Maximum	p
Bicortical screws + wire (n = 35)	66.5	10.6	45	90	0.366
Monocortical screws + wire (n = 9)	71.1	10.4	60	95	
Bicortical screws (n = 5)	78.2	9.6	72	95	
Wire only (n = 4)	70.8	11.6	54	80	

SD = standard deviation.

Regarding the distribution values according to the Vancouver classification and the type of proximal fixation, a significant relationship was found (p 0.003) (Table 3). For patients with periprosthetic Vancouver types B1 and C fractures, the most commonly used proximal fixation was with bicortical screws and cerclage wire, and bicortical screw fixation alone was used in patients with Vancouver type C fractures.

Table 3. Distribution of the sample according to the Vancouver classification and the type of proximal fixation.

Proximal fixation type	Vancouver B1 (n = 35)			Vancouver C (n = 18)		
	Number of patients	Percentage	Failures	Number of patients	Percentage	Failures
Bicortical screws + wire	23	65.7	2	12	66.7	4
Monocortical screws + wire	8	22.9	1	1	5.6	0
Bicortical screws	0	0.0	0	5	27.8	1
Wiring only	4	11.4	3	--	--	--

The distribution values regarding the type of proximal fixation and complications did not obtain a significant relationship; the highest failure rate was recorded in proximal fixation with wire alone (3 of the 4 patients operated on with this method).

The type of fracture according to the Vancouver classification correlated with a significant value in the use of interfragmentary compression screws (p 0.001) (13 patients, 24.52%) and, for the most part, they were Vancouver type C fractures (9 cases, 16.98%).

The average fracture healing time was 4 months (SD = 1.6, range 3-10) with a mean Harris Hip Score of 68. The consolidation rate was 94%.

Twelve patients (22.64%) had complications: delayed consolidation (7 cases, 13.2%), failed osteosynthesis with a fracture line at the distal level of the stem (one case, 1.88%), new osteosynthesis due to failure of the osteosynthesis material (one case, 1.88%), and three patients died (5.66%): a 78-year-old overweight woman who had a bilateral periprosthetic fracture secondary to a fall from her own height; a 93-year-old woman with multiple comorbidities, who died one year after surgery; and a man who died three years after the operation.

None of the seven patients with delayed union required another operation and the fracture healed after regular check-ups and serial radiographs at 7 months (4 cases), 8, 9 and 10 months, respectively, the last case was a surgery requiring allograft. The patient with a fracture line at the distal level of the stem treated with a locked lateral plate had an unfavorable evolution with a break at the level of the implant and was finally treated with a revision prosthesis and distal fixation with allograft, and a correct consolidation was achieved after four months (Figure 1). Lastly, the patient with osteosynthesis failure was operated on again with a replacement of the osteosynthesis and allograft; nine months after surgery, there were signs of consolidation.

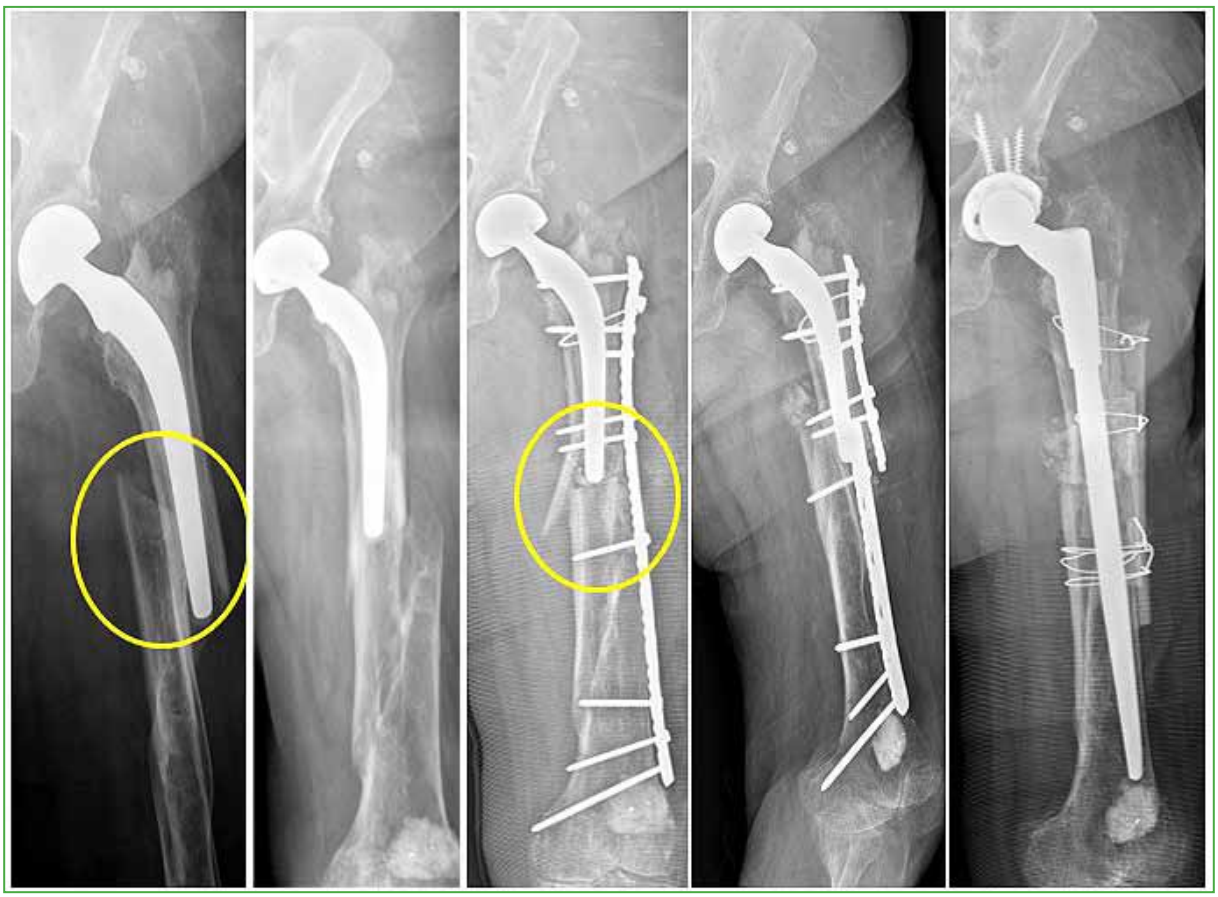

Figure 1. Periprosthetic femoral fracture with fracture line at stem level, treated with osteosynthesis and failure. Revision with distal fixation prosthesis and allograft.

DISCUSSION

Currently, there are several surgical treatment options for Vancouver type B1 and C fractures.[4] Open reduction and internal fixation with locking plates has been a standard method of treatment for these fractures.[5] Sen et al.[6] treated 12 patients with Vancouver type B1 periprosthetic fractures with open reduction and internal fixation using locked dynamic compression plates, 10 fractures healed in an average period of seven months and the Harris Hip Score was 85. In our series, the mean time to consolidation was four months (SD = 1.6), with a Harris Hip Score of 68.

The addition of allograft plates can provide immediate mechanical stability and improve fracture healing and increase bone stock.[7-9] Haddad et al. reported a 98% healing rate of 40 femoral periprosthetic fractures treated with allograft alone or in combination with a plate, which had both a mechanical and a biological function that led to a high rate of union. However, they required extensive surgical exposure with soft tissue dissection, disrupting the blood supply to the fractures.[7] In our series, plates and allograft had been used in 9.4% of the patients and the average time of consolidation was 5.83 months. In 2001, Krettek et al.[10] described the minimally invasive plate osteosynthesis (MIPO) technique that incorporates indirect reduction and percutaneous insertion of plates and screws that minimize the extent of soft tissue dissection (Figure 2). With this technological advance added to the MIPO technique, surgeons have the principles of internal fixation and dynamic compression in the same implant. In this way, bleeding, large dissections and surgical time are reduced and, consequently, their derived complications.[10-12]

Figure 2. Reduction and osteosynthesis of a periprosthetic hip fracture using the MIPO technique.

It is important to evaluate the setup configuration at the proximal level to achieve a correct fixation of the implant. Hoffmann et al.[13] proposed three configurations and the most effective to provide good stability is the use of bicortical screws, followed by unicortical screws plus cerclage wire and, finally, three loops of cerclage wire. In this study, bicortical screw placement achieved maximum load to failure and maximum torsional-sagittal bending stiffness. Additional unicortical screws increased axial stiffness in comparison to cable fixation alone. The system construct failed at the cable site and there was no bone damage. In daily practice, these assemblies can be more easily checked.[13] In the study by Fulkerson et al,[14] early failure of cyclically loaded unicortical locking screws was also observed, as well as greater displacement under axial loading compared to bicortical screws.

In our series, we achieved a better union rate and a lower failure rate in patients with more stable proximal fixation using bicortical screws, followed by those treated with bicortical screws and cerclage wire, compared with those in whom monocortical screws or only cerclage wire were used (Figure 3). In addition, we recorded a higher failure rate when we used only proximal fixation with wire in patients with Vancouver type B1 periprosthetic fractures. Despite not obtaining a significant relationship between the two, there would be a tendency to fail when using this configuration, resulting in less stability.

Figure 3. Reduction and osteosynthesis with a long locked plate and proximal fixation using monocortical screws and cerclage wire.

Although there is sufficient support in the literature on how to treat the different types of femoral periprosthetic fractures according to the Vancouver classification, certain patterns require special attention. For example, although type B1 fractures, which have stable implants, are generally treated with fixation, type B1 fractures with short oblique or transverse fractures at the tip of a cemented stem or just above the cement plug have a high nonunion or failure rate.[15,16]Pavlou et al. demonstrated that this type of pattern treated with plate fixation took longer to heal than fractures treated with revision (mean 12 and 4.5 months, respectively).[16] This could be attributed to the decrease of the fracture area, increased torque, and high stress in these short oblique or transverse

fractures.[12]One patient in our series was treated by revision with a distal fixation prosthesis and allograft due to primary osteosynthesis failure. For these 'problematic fractures', stem revision has been shown to achieve good results and is recommended.[7,16-18]

Lastly, regarding the correct mounting of the osteosynthesis for the treatment of these fractures, long plates that extend from the greater trochanter to the distal femur are recommended to prevent secondary fractures.[19] The length and distribution of the screws have been studied extensively and are documented in the article by Stoffel et al.[19] For example, for simple lines they are at least 8 to 10 times the length of the fracture line and for comminuted lines they are 2 to 3 times the length of the comminution, including a symmetrical distribution of screws and, ideally, using 50% of the plate holes. Another point to consider is the overlap of the implant on the proximal prosthesis, mainly in Vancouver type C fractures, which must include at least 6 cm, as published by Kubiak et al.[20] According to what was reported in our series and based on a consolidation rate of 94% with an acceptable rate of complications, we recommend the use of long 4.5-mm LCP plates and a fixation with six screws (0.5 distribution) as the ideal setting, plus a minimum implant overlap of 6 cm.

The limitations of this study are the short-term follow-up and the lack of a control group in a more homogeneous group, since we included two groups of patients with Vancouver type B1 and type C fractures, in whom fractures with the same pattern were not always treated under the same principles, mainly with the use of interfragmentary compression screws in patients with Vancouver type C fracture. In addition, difficulties arose with the follow-up of these patients when collecting their data, because many had died, since it is mainly a complication in elderly people.

Despite this, we distinguish its strengths: it includes a considerable number of patients when compared to national series, it is a multicenter study, and it provides a descriptive analysis of the results.

CONCLUSIONS

The management of periprosthetic femoral fractures is a complex and challenging issue. Osteosynthesis treatment is a successful method that requires the application of current principles of minimally invasive techniques, which together with a stable proximal fixation improve the chances of success of surgery.

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

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Is Tranexamic Acid Safe in Total Knee Replacement Surgery in Patients with Coronary Artery Disease?

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ABSTRACT

Introduction: Tranexamic acid (TXA) reduces blood loss and need for a transfusion after total knee arthroplasty (TKA). However, patients with a history of coronary artery (CA) stent placement might be at increased risk for thromboembolic complications. **Materials and Methods:** We performed a retrospective analysis of patients with a history of coronary stenting who had undergone primary and revision TKA and received preoperative TXA. A comparison was made with a group of patients without coronary stenting. The presence of any clinical or electrocardiographic changes of acute coronary occlusion, thromboembolic events (TEE), blood transfusion, and pre- and postoperative hemoglobin levels were analyzed. **Results:** 57 patients underwent 59 TKA surgeries (56 primary and 3 revisions) with a history of coronary stenting at least 1 year before arthroplasty. One patient presented symptoms of acute coronary syndrome and electrocardiogram (ECG) changes. There were no differences in the number of thromboembolic events. Only 1 patient received red blood cell transfusion in the control group. Relative bleeding was lower in the coronary group regardless of chronic use of aspirin and clopidogrel before surgery (2.09 vs 3.06 in the control group; p=0.01). In high-risk patients, TXA was not associated with higher TEEs. **Conclusions:** Although TXA seemed safe and effective in this database review of patients with previous placement of CAS; a larger prospective trial is warranted to confirm these results.
Keywords: tranexamic acid; total knee arthroplasty; coronary disease.
Level of Evidence: IV

¿Es seguro el ácido tranexámico en la cirugía de reemplazo total de rodilla de pacientes con enfermedad coronaria?

RESUMEN

Introducción: El ácido tranexámico reduce la pérdida sanguínea y los requerimientos de transfusiones luego de un reemplazo total de rodilla. Una de sus contraindicaciones relativas son los antecedentes de colocación de prótesis intravasculares coronarias, por un supuesto aumento de eventos tromboembólicos. **Materiales y Métodos:** Análisis retrospectivo de pacientes sometidos a un reemplazo total de rodilla primario y de revisión que recibieron ácido tranexámico y tenían antecedente de colocación de prótesis intravascular coronaria. Se los comparó con un grupo sin estas prótesis. Se analizó la presencia de cualquier cambio clínico o electrocardiográfico de oclusión coronaria aguda, eventos tromboembólicos, el requerimiento de transfusión sanguínea y el nivel de hemoglobina pre y posoperatorio. **Resultados:** 57 pacientes (59 cirugías, 56 reemplazos primarios y 3 revisiones) con colocación de prótesis intravascular coronaria, al menos, un año antes de la artroplastia. Un paciente tuvo síntomas de síndrome coronario agudo y cambios en el electrocardiograma. No hubo diferencias en la cantidad de eventos tromboembólicos. Solo un paciente del grupo de control recibió una transfusión de glóbulos rojos. El sangrado relativo fue menor en el grupo coronario independientemente del uso crónico de aspirina y clopidogrel antes de la cirugía (2,09 vs. 3,06 grupo de control; p = 0,01). En pacientes del alto riesgo, el ácido tranexámico no se asoció con más eventos tromboembólico. **Conclusiones:** El ácido tranexámico impresionó ser seguro y efectivo en nuestro grupo de pacientes con prótesis intravasculares coronarias; sin embargo, se necesita un estudio prospectivo con más casos para confirmar estos resultados.
Palabras clave: Ácido tranexámico; reemplazo total de rodilla; coronariopatía.
Nivel de Evidencia: IV

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INTRODUCTION

Postoperative bleeding is a common complication after total knee replacement (TKR), often requiring transfusion of packed red blood cells. Historically, the estimated bleeding after a TKR was 2 liters, which often required transfusions in a very high percentage of patients.[1,2] Currently, multiple protocols have been developed for the management of blood loss in joint replacement surgery. Many of these protocols include the administration of drugs that reduce bleeding by acting at the level of the coagulation cascade.[3-5]

Tranexamic acid (TXA) began to be used in cardiac surgery during the 1980s, along with other antifibrinolytic agents, and its use has gained popularity in orthopedic surgery in recent years with good results. It is a synthetic derivative of lysine with pure antifibrinolytic activity that stops the fibrinolysis system, preventing fibrin degradation (Figure 1).[5-7]

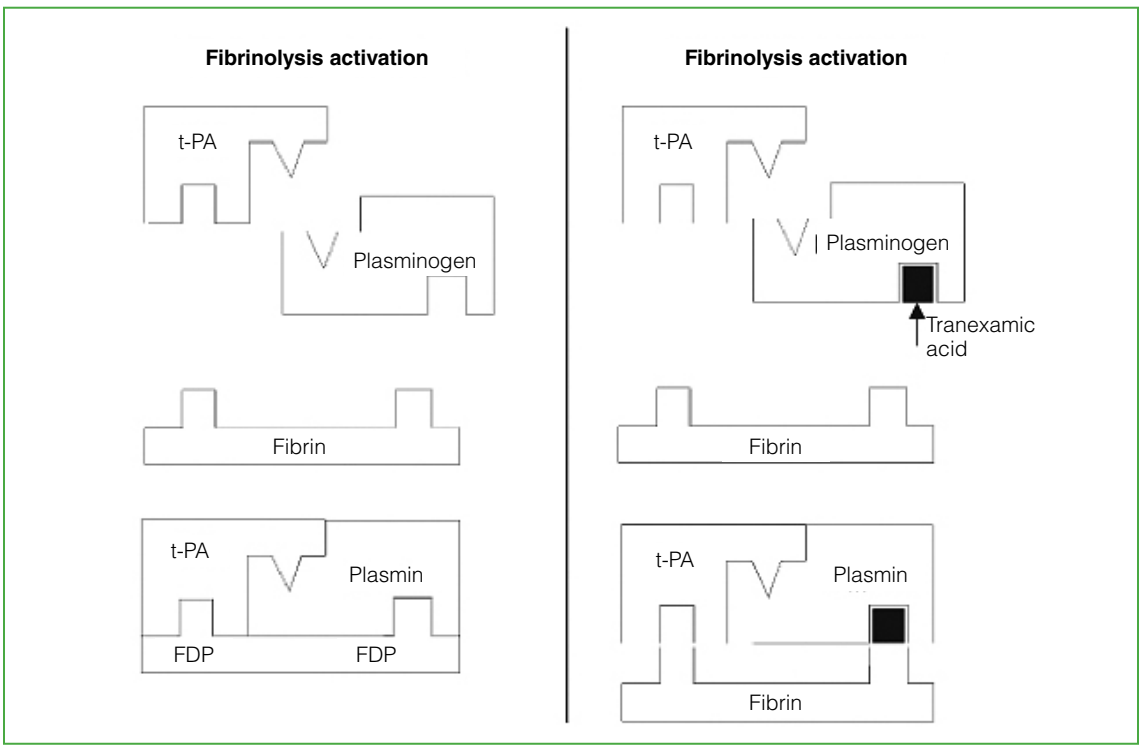

Figure 1. Diagram showing the mechanism of action of tranexamic acid in the coagulation cascade.
t-PA = tissue plasminogen activator, FDP = fibrin degradation products

The half-life of intravenous TXA is 2 hours. After a 15 mg/kg dose, its plasma concentration remains above the effective plasma concentration required to inhibit fibrinolysis (13 µg/ml) for 4 to 6 hours. On the other hand, TXA easily penetrates large joints; in joint fluid, it reaches a concentration comparable to that in plasma within 15 min of intravenous administration. It is metabolized by the kidney. The only absolute contraindication to the administration of TXA is allergy.[7]

Multiple prospective studies with patients undergoing TKR have shown a reduction in blood loss and packed red blood cell transfusion rates with TXA, and this has been substantiated by several meta-analyses, including a recent study examining efficacy and safety of TXA in TKR.[5,8] An increase in thromboembolic or cardiovascular complications has not been demonstrated in TXA trials, but these studies usually exclude patients with multiple comorbidities or known risk factors that could increase the risk of thromboembolic events.[8-10]

As a result of these limitations, it is not yet clear whether TXA increases the risk of postoperative thromboembolic events in patients with known coronary artery disease and a history of coronary artery stent placement.

The main objective of this study was to determine whether the use of TXA in patients undergoing primary or revision TKR with a history of coronary artery disease increased the incidence of acute ischemic cardiac events within 30 days of surgery. As a secondary objective, the risk of bleeding in patients with a history of coronary artery stenting compared with a control group was evaluated.

MATERIALS AND METHODS

A retrospective review was carried out in our institutional database of the medical records of patients who underwent primary or revision TKR between March 2012 and April 2015 and who were administered TXA. Questionnaires were recorded electronically, such as the functional and objective Knee Society Score (KSS), the Knee injury and Osteoarthritis Outcome Score (KOOS), in addition to the visual analog pain scale to assess surgical results, as well as patient satisfaction. In addition, we recorded the demographic data of the patients (age, sex, height, weight and body mass index), the date of operation, the surgeon, the side of the surgery (right, left or bilateral), the type of surgery (primary or revision) and risk factors, such as diabetes, smoking and relevant pathological history (cardiovascular, renal or oncological disease).

To evaluate the main objective, we recorded the incidence of acute coronary events within 30 days of knee surgery in patients with a history of coronary artery stenting with more than one year of evolution. A coronary event was defined as any clinical presentation, hospitalization or intervention due to an acute coronary occlusion event.

Estimated intraoperative blood loss was recorded, and preoperative hemoglobin level was compared with that of controls at 24 and 48 h postoperatively in patients undergoing primary replacement. These results were compared with those of a paired control group of patients without a history of coronary artery stenting. A transfusion of packed red blood cells was indicated for patients with hemoglobin levels <8 g/dl or <10 g/dl and clinical symptoms of anemia.

Before the operation, all the patients regularly took acetylsalicylic acid and did not discontinue it for surgery. Any other oral anticoagulant agent was discontinued 10 days before the intervention. The surgeries were performed through a medial parapatellar approach without a hemostatic cuff. The standard administration protocol for TXA is the infusion of 1000 mg in 50 cc of physiological solution, 30 min before the incision. All patients were clinically monitored for 48 h to detect any clinical evidence related to acute arterial occlusion.

Since all were taking aspirin and clopidogrel, and none had a history of thromboembolism, they were given 100 mg of aspirin every 12 h for 4 weeks as thromboprophylaxis, and then resumed their usual dose of both agents.

Statistical analysis included a standard t-test to compare both groups. Relative bleeding was calculated based on the drop in hemoglobin and hematocrit values before and after surgery at 48 h for each group separately, and they were compared with each other.

RESULTS

During the study period, 56 primary TKRs were performed in 54 patients and three revisions in patients with a history of coronary artery disease and coronary stent placement. The control group included 51 patients with 51 primary TKRs. Table 1 details the characteristics of the groups.

One patient attended the hospital emergency department with acute coronary symptoms 30 days after the operation. He was a male with a stent in the circumflex coronary artery placed two years before the TKR, with regular check-ups and with no other relevant history. Before the procedure, the hemoglobin level was 12.7 mg/dl, with a postoperative control of 10.7 mg/dl at 24 hours. He consulted due to chest pain seven days after the operation, studies were performed that revealed electrocardiographic changes compatible with ischemia. During the angiography, the patency of the previous stent and the acute occlusion of another vessel (right coronary artery) were verified; therefore, recanalization was carried out with a new stent (Figure 2). He evolved favorably and was discharged after 48 hours, without complications with the recovery of his knee.

Table 1. Demographic data.

	Coronary Group	Control Group	p
Female sex	17	20	0.625
Male sex	37	31	0.225
Age (mean)	71.8	70.9	0.874
BMI	30.12	29.7	0.945

BMI = body mass index. There is no evidence of differences between the two groups.

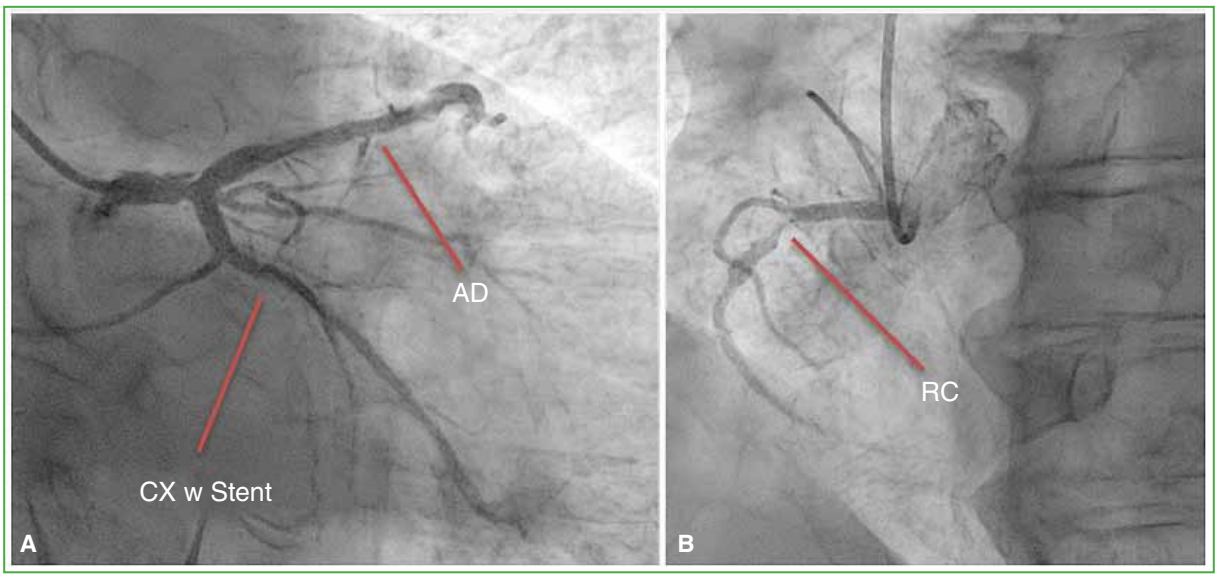

Figure 2. Coronary angiography images with stent in the circumflex artery (**A**) and obstruction of the right coronary artery (**B**).

Regarding the evaluation of the secondary objective of the study, the relative bleeding was measured with hemoglobin and hematocrit levels, and their fall 48 hours after surgery (Table 2).

Table 2. Hemoglobin and hematocrit levels before surgery and at 48 h.

	Coronary Group	Control Group	p
Preoperative hemoglobin, mg/dl	13.19	13.25	0.96
Preoperative hematocrit, %	40	39.9	0.89
Hemoglobin day 2, mg/dl	11.1	10.19	0.01
Hematocrit day 2, %	32.8	30.53	0.03

Relative bleeding was significantly lower in the coronary group.

DISCUSSION

TXA has been a great contribution because it reduces the need for blood transfusions in patients undergoing joint replacement. Its use has been popularized since 2010 with multiple studies in the field of orthopedics, both in joint replacement surgery and in acute trauma.[10,11] Its routine administration is endorsed by several societies, such as the *American Association of Hip and Knee Surgeons* (AAHKS) and the *American Academy of Orthopedics Surgeons* (AAOS), as well as *The Hip Society* and *The Knee Society*.[8,11,12] At the national level, some studies, such as that by Bidolegui et al., have also provided data on the safety of TXA in TKR without a hemostatic cuff.[9]

In trials such as CRASH-2 (Clinical Randomisation of Antifibrinolytic in Significant Head Injury), a significant difference was found in the mortality rate due to bleeding events in patients who had received TXA compared to placebo in the context of polytrauma.[13] In the field of joint replacements, Mayo Clinic studies demonstrated the safety and benefits of TXA in patients with a history of deep vein thrombosis and pulmonary thromboembolism, as well as in ASA III and IV patients.[10,12,14,15] However, the administration of antifibrinolytic agents to patients with coronary artery disease remains a relative contraindication.

No ischemic events were observed on previous stents in our study group. TXA was effective in preventing relative bleeding, minimizing the risk of coronary events due to anemia.

Certain hemodynamic stress factors (effect of anesthesia on the cardiovascular system, bleeding, arrhythmias, and hypoxia) can increase the risk of acute coronary events in this type of surgery. The risk of suffering an acute coronary event in the context of a knee joint replacement is low (between 0.18% and 0.25% according to reports in the literature).[16-20] This risk is at its highest in the first two weeks after the operation.

It is important to note that this higher-risk group of patients receives more aggressive prophylaxis for thromboembolic events than the general population, due to their usual antiplatelet therapies, and it is essential that patients restore full antiplatelet therapy as soon as possible after the operation.[17]

Another important factor is knowing the dosage and the different routes of administration of TXA. It can be administered not only intravenously, but also by oral and topical routes. The intravenous dose is 15 mg/kg of weight or directly 1 g, 30 min before the approach. When used orally, 2 g are given 2 hours preoperatively and 1 g at 3 and 9 hours postoperatively. Regarding its topical use, it is applied at a concentration of 3 g diluted in 50 cc of physiological solution, left to act for 5 min and then washed with physiological solution.[4,21-26] According to published scientific evidence, there are no differences in the therapeutic levels achieved in the blood, regardless of the route of administration. These results suggest that the systemic effects of TXA do not appear to be dangerous, as previously thought, in this group of patients and that it is potentially safe in patients with coronary artery stents.

This study has several limitations, such as its retrospective design and its limited number of patients.

CONCLUSIONS

Many surgeons and anesthesiologists are cautious about the use of TXA in patients considered to be at high risk, due to its pharmacological properties. However, our results show that its administration is safe and does not generate a higher risk of occlusion of coronary artery stents. We believe that patients with a history of coronary artery disease should undergo extensive and thorough preoperative evaluation, since their risk of developing atherosclerotic lesions in other vessels is high. In the future, prospective randomized studies may provide data on the benefits of its use and guarantee the safety of TXA in these patients.

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Knee Arthroplasty in Patients With Poliomyelitis and Extensor Mechanism Deficiency. Review and Experience in Nine Cases

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ABSTRACT

Objectives: To report the clinical and functional outcomes of patients affected with post-polio syndrome treated with total knee arthroplasty, evaluating whether the choice of the prosthesis is conditioned by the quadriceps functional deficit. **Materials and Methods:** patients with post-polio syndrome were evaluated in their muscle deficit condition and with functional tests such as the 10-meter walk test, 2-minute walk test and timed up and go test, as well as Knee Society Score preoperatively and 1 year after knee arthroplasty. **Results:** All patients significantly improved functional values that directly impacted their quality of life. The Knee Society Score did not present significant differences between the most severe cases with quadriceps deficit with recurvatum and those with less involvement, but the functional tests did show a significant difference between these subgroups. **Conclusions:** Total knee arthroplasty is a valid treatment alternative in this complex pathology, providing the patient with pain relief, recovery of function and improving their quality of life. The restoration of stability through constrained prosthetic designs is a key factor in the recovery of a functional gait pattern in patients with recurvatum. Patients with quadriceps strength who overcome the resistance of gravity have functional outcomes comparable to those of patients without post-polio syndrome and do not require hinged prostheses.

Keywords: poliomyelitis; total knee arthroplasty; rotating hinge.
Level of Evidence: IV

Artroplastia de rodilla en pacientes con poliomielitis y déficit de extensores. Revisión y experiencia en nueve casos

RESUMEN

Objetivos: Comunicar los resultados clínicos y funcionales de pacientes con síndrome pospolio sometidos a una artroplastia total de rodilla y evaluar si la elección de la prótesis está condicionada por el déficit funcional del cuádriceps. **Materiales y Métodos:** Se evaluó a pacientes con síndrome pospolio en su condición de déficit muscular y con escalas funcionales de tiempo de caminata en 10 m, distancia caminada en 2 min, y tiempo levántate y anda, y el Knee Society Score antes de la artroplastia de rodilla y un año después. **Resultados:** Los valores funcionales que impactaban directamente en la calidad de vida mejoraron notablemente en todos los pacientes. No se hallaron diferencias significativas en el Knee Society Score entre los casos más graves con déficit del cuádriceps con recurvatum y aquellos con menor afectación, pero las escalas funcionales sí mostraron una diferencia significativa entre estos subgrupos. **Conclusiones:** La artroplastia total de rodilla es una alternativa terapéutica válida en esta compleja enfermedad, que logra aliviar el dolor, recupera la función y mejora la calidad de vida. La restauración de la estabilidad mediante diseños de prótesis constreñidas es un factor clave en la recuperación de un patrón de marcha funcional en los pacientes con recurvatum. Los pacientes con fuerza de cuádriceps que vencen la resistencia de la gravedad tienen un resultado funcional equiparable al de los pacientes sin síndrome pospolio y no requieren prótesis abisagradas.

Palabras clave: Poliomielitis; artroplastia total de rodilla; bisagra rotatoria.
Nivel de Evidencia: IV

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INTRODUCTION

Poliomyelitis or "infantile paralysis" is a disease caused by an enterovirus transmitted by the fecal-oral route and is currently eradicated in our country.[1] In most cases, the infection is asymptomatic or only causes a flu-like state, but one in 200 patients develops a severe form with involvement of the motor neurons of the central nervous system that leaves flaccid muscle paralysis as a sequel. In Argentina, important epidemics occurred in 1953 and 1956 (Incidence: 33 cases/100,000 inhab.), and many patients suffered sequelae, such as mild to paralytic motor neurological involvement. This group with post-polio syndrome (PPS) with flaccid paralysis has adapted their lives to living with a motor deficit, and has managed to cope quite well with their disability, although typically, after the 5th to 6th decade of life, the progression of joint damage generates pain and gait limitation due to the progression of the recurvatum deformity. Degenerative joint disease subjected to unusual eccentric forces causes joint pain and functional limitations[2] to such a degree that walking is almost completely impossible. Total knee arthroplasty is a valid alternative for these patients to recover that ability.[3] It is a technically demanding procedure associated with various difficulties, such as atypical joint deformity (Figure 1), genu recurvatum and instability, low patella (Figure 2), hypoplastic femur and tibia with narrow spinal canals, and quadriceps functional deficit.[4]

Figure 1. Atypical joint deformity.

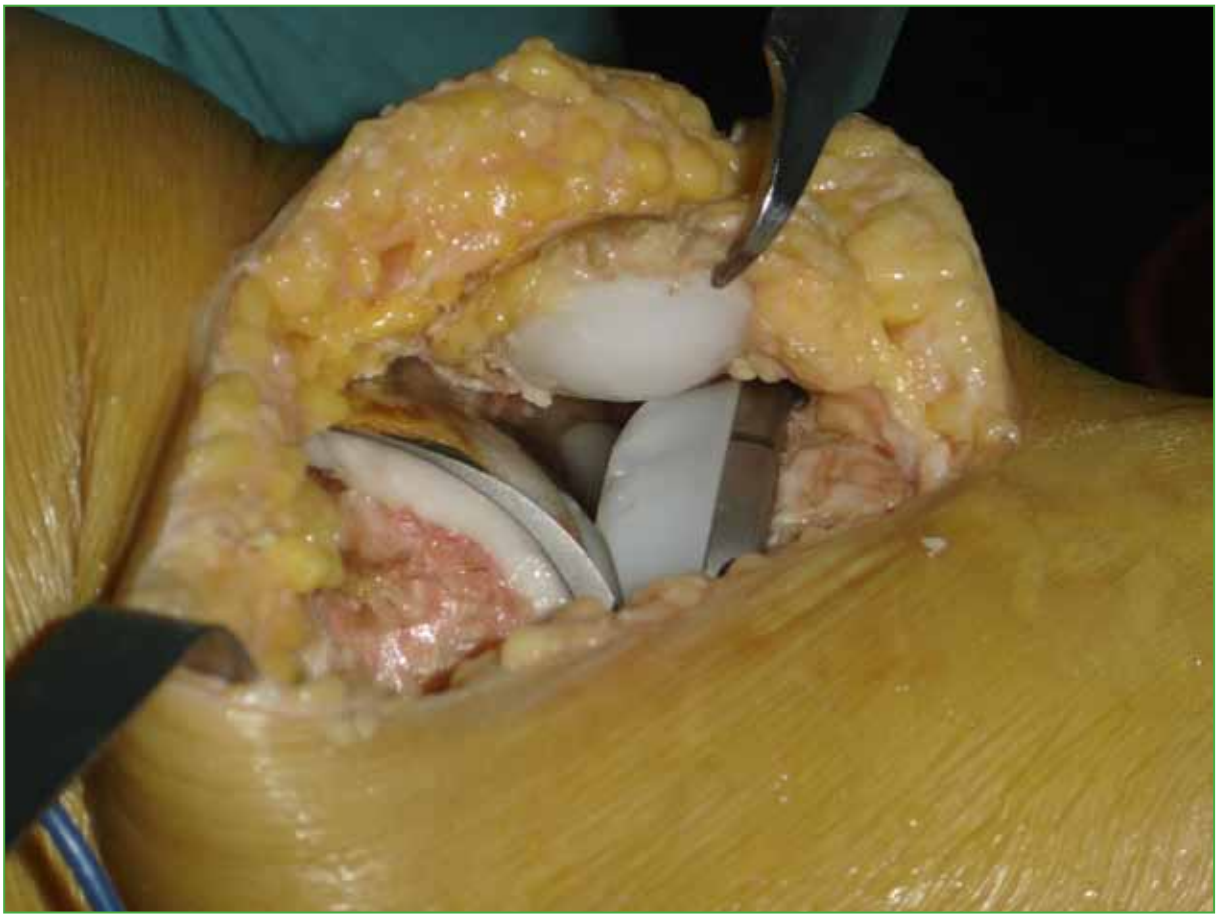

Figure 2. Low patella.

OBJECTIVES

To report the clinical and functional outcomes of nine knee arthroplasties in seven patients with PPS whose quadriceps strength did not exceed the resistance of gravity and who received a constrained rotating-hinge prosthesis; and in two patients with antigravity strength who received a posterior stabilized prosthesis, and to assess the differences between these groups.

MATERIALS AND METHODS

We retrospectively reviewed the knee arthroplasties performed in patients with moderate or severe PPS, with quadriceps extension deficit against gravity, operated between 2006 and 2016.

Functional tests[2]

- Functionality was determined with tests aimed at this disease: 10-m walk test (10MWT): the time needed to walk 10 meters at a comfortable speed, tracked with a stopwatch.
- 2-minute walk test[5] (2MWT): the distance traveled in meters walked at a comfortable speed in 2 minutes, tracked with a stopwatch.
- Timed up and go test (TUG): it is the time needed to get up from a chair from a sitting position, walk 3 m, return and sit down again while the time is tracked with a stopwatch.

The mean follow-up time was 85 months (range 20-180). The Knee Society Score and functional evaluation tests were used preoperatively and one year after surgery.

In all cases, a rotating hinge prosthesis (Endomodel®; Link, Germany) was used (Figure 3), except in two cases with antigravity quadriceps strength who received a posterior stabilized prosthesis (Scorpio ®, Stryker, USA)

Figure 3. Endo-Model® hinged prosthesis (Link, Germany).

Surgical technique

Patients with quadriceps insufficiency underwent a median longitudinal approach and medial capsulotomy, except for one case in which the V-Y quadriceps technique was used. Freehand saw cuts were carefully made over the osteoporotic atrophic bone (Figure 4) anticipating unusual deformities and hypoplasia of the femur and tibia linked to the sequelae of poliomyelitis. The distal cut was intentionally limited at the expense of the condyles to decrease the space in extension and limit the recurvatum (Figure 5). All the rotating hinges were cemented with a plug, pulsatile lavage and a retrograde cementing gun.

After surgery, an early rehabilitation protocol started with partial weight-bearing on the operated limb and ambulation with a walker for four weeks, before moving on to a cane. In the two patients who had quadriceps strength against gravity, the standard technique was used and a posterior stabilized prosthesis was placed.

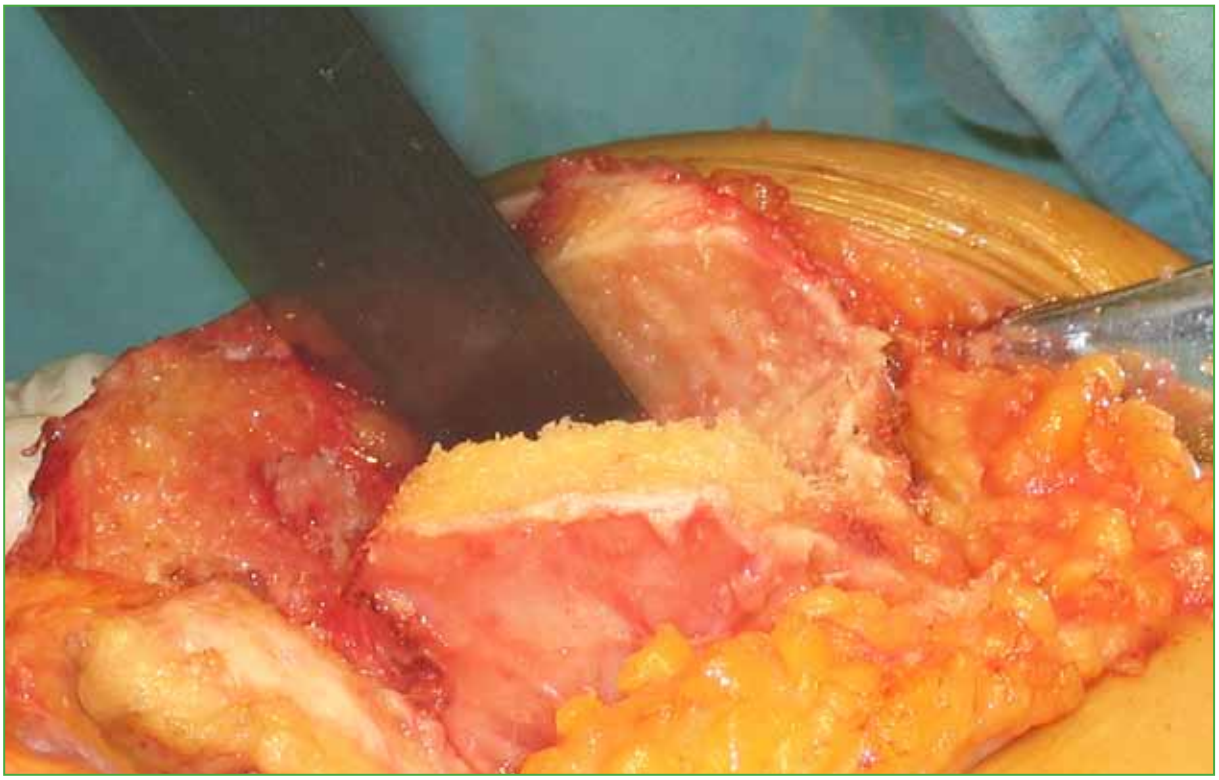

Figure 4. Osteoporotic atrophic bone.

Figure 5. Recurvatum limitation.

RESULTS

Nine arthroplasties in seven patients with PPS, operated between 2006 and 2016, were retrospectively reviewed (Table 1). Five were women and two were men, with a mean age of 62 years (range 52-73) when they underwent surgery. In this population, seven knees had moderate to severe post-polio sequelae with quadriceps extension deficit against gravity (77%): four of them had a grade 1/5 quadriceps muscle deficit according to the Medical Research Council (Table 2) with recurvatum, three had grade 3/5 knees; and two knees (22%) retained grade 4/5 antigravity extension. Clinical results were evaluated with the Knee Society Score (KSS) and the functional KSS before surgery and one year later. Scores <60 are considered poor.

KSS improved markedly in all patients, from a mean of 22 (range 13-43) preoperatively to 87 (range 80-100) postoperatively; and the functional KSS, from 24 before the intervention to 77 two years after the intervention. (Table 2). The range of motion was always >110°.

Table 1. Patient data.

Patient	Surgery	MRC	Age/year of surgery	Follow-up (months)
AF	May 2006	1	54/2006	20
MRG	June 2014	4	63/2014	34
AP	August 2008	1	70/2008	18
LM	September 2017	1	69/2015	48
MG (left knee)	September 2006	3	52/2007	180
MG (right knee)	November 2007	3	58/2008	166
PJ (left knee)	August 2008	3	64/2008	120
PJ (right knee)	September 2015	4	71/2015	36
MN	May 2008	3	58/2008	120
			62	82.44

MRC = Medical Research Council.

Table 2. Medical Research Council Scale

0	No muscle contraction
1	Flicker or trace contraction
2	Active movement if gravity is eliminated
3	Active movement against gravity
4	Active movement against gravity and some resistance
5	Active movement against gravity and full resistance

Clinical outcomes

The KSS did not present significant differences between the most severe cases treated with hinged prostheses and those with less compromise with muscular control and posterior stabilized prosthesis, at the end of follow-up. In four of the nine arthroplasties, the results were excellent (from 80 to 100) and in five, good (from 70 to 79). Function scores improved substantially in all cases, although the patients without antigravity quadriceps strength did not have excellent results (>80 points) in any case by contrast with the two patients who had sequelae of polio with less involvement (Table 3). The limitation of hyperextension by reducing the gap in extension did not generate difficulties in walking, as published in some studies. Regarding the specific functional tests, the values that directly impact quality of life improved markedly in all cases. The TUG test yielded mean preoperative values of 16.1 s (range 9.9-20.7) and improved to 13.2 s (range 8.9-20.7) postoperatively. The 10MWT value was 15.9 s before surgery (range 8.9-30) and 12.5 (range 7.7-21) after surgery, the 2MWT was 64 m (range 29-136) before surgery and improved to a mean of 107 m (range 47-168) after it (Table 4). No radiographic signs of loosening were observed two years after the intervention. Radiographic persistence of low patella in severe cases did not result in impaired range of motion.

Table 3. Knee Society Score (KSS).

Pre/postoperative KSS	29/84	28/100	13/80	14/80	13/83	15/85	13/94	43/100	14/80
Pre/postoperative F KSS	15/65	40/90	15/65	15/70	15/65	20/65	30/80	50/90	15/65
Global KSS	22/82	35/95	14/72	14/75	14/74	17/75	21/87	46/95	14/72

Table 4. Results in specific functional scales

Preoperative TUG (seconds)	Postoperative TUG (seconds)	Preoperative 10MWT (seconds)	Postoperative 10MWT (seconds)	Preoperative 2MWT (meters)	Postoperative 2MWT (meters)
20	17.3	14.7	12.5	62	97
11.3	9.1	9.9	7.7	90	159
15.2	12.3	14.5	12.8	39	89
19	13	19	15	29	80
23.2	20.7	30	21	35	47
20.7	18.7	21	15	47	80
11.7	9.4	10.5	8.3	99	149
9.9	8.9	8.9	7.8	136	168
14	10.1	14.8	12.4	45	98
16.1	**13.2**	**15.9**	**12.5**	**64**	**107**

Functional scales: TUG = timed up and go, 10MWT = 10-meter walk test, 2MWT = 2-minute walk test.

DISCUSSION

PPS is a condition that generates a severe disability that increases functional limitations from the 5th decade of life. The progression of the associated deformities (hyperextension and recurvatum, misalignment, deterioration of the joint surfaces) and instability cause an inefficient and painful gait. These patients, who had learned to live with the initial neurological sequelae, gradually began to lose the ability to move and suffered pain that, until then, had not represented a problem.

Total knee arthroplasty is a therapeutic alternative that relieves pain and restores the ability to move, which improves quality of life. By correcting these variables, restoring stability and limiting hyperextension, the functional capacity of the knee is restored and pain is mitigated. This is seen by performing simple and concrete functional tests that emulate the basic motion abilities of daily life. These abilities clearly improved in all patients in the cohort, and are consistent with the results reported in the few published scientific studies on the subject.[6-9]

Being able to raise the leg against gravity and some resistance marks a limit between two clearly differentiated groups. Those who do not have this ability require constrained implants (rotating hinge) and specific surgical actions, such as trying to achieve a tight extension gap to limit the recurvatum. In turn, naturally, they do not achieve high functional scores given the neurological limitation of poliomyelitis *per se*. However, the gain in functional capacity is evident and allows them to recover a highly satisfactory standard of living, with a good functional KSS. Patients with sufficient antigravity strength are treated with the conventional total knee replacement technique, achieving results comparable to those of patients without this condition.

CONCLUSIONS

Total knee arthroplasty is a valid therapeutic alternative in this complex disease, as it relieves pain, recovers function and improves quality of life. The strength of the quadriceps regarding the ability to move the leg against gravity is an important value in determining the choice of prosthesis. Restoration of stability using constrained prosthesis designs is a key factor in the recovery of a functional gait pattern in hyperextension patients. Patients with quadriceps strength against gravity have functional outcomes comparable to those without PFS and do not require constrained prostheses.

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

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Use of 3D Cups in Severe Acetabular Defects

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ABSTRACT

Introduction: Given the increase in hip arthroplasties in the last century, serious acetabular defects are increasingly frequent events. Their treatment represents a real challenge, due to the bone deficit and poor bone quality that these patients usually present. **Materials and Methods:** Six patients treated between 2016 and 2021 are presented. Five cases of pelvic discontinuity due to failed revisions, classified as Paprosky type IIIB, and one transverse fracture of the acetabulum, a possible treatment option in cases of osteoporotic patients. **Results:** The patients treated with this multidisciplinary technique were followed up for an average of 20 months, and none of them presented postoperative complications. The results evaluated by analogous scales are promising and invite us to establish this procedure as the gold standard. **Conclusions:** Strict evaluation is necessary for acetabular defects. The inclusion of medical IT makes it possible to study the need to use bank grafting and to manufacture custom-made multiporous trabecular titanium/tantalum implants, which is ideal for achieving osseointegration, added to the possibility of planning the direction and length of the screws to the remaining bone, according to its quality. The cementation of a dual mobility cup inside the customized implant reduces the risk of dislocation and overload of the latter, by eliminating metal-metal friction.

Keywords: Pelvic discontinuity; 3D cup; dual mobility; reconstructive acetabular revision; severe acetabular defects
Level of Evidence: IIIB

Utilización de cotilos 3D en defectos acetabulares graves

RESUMEN

Introducción: Ante el aumento de las artroplastias de cadera en el último siglo, los defectos acetabulares graves son eventos cada vez más frecuentes. Su tratamiento representa un verdadero desafío, debido al déficit y pobre calidad ósea, con la que cuentan habitualmente estos pacientes. **Materiales y Métodos:** Se presentan 6 pacientes tratados entre 2016 y 2021. Cinco casos de disrupción pélvica por revisiones fallidas, clasificadas como tipo IIIB de Paprosky y una fractura transversal de acetábulo, posible opción de tratamiento en casos de pacientes osteoporóticos. **Resultados:** Los pacientes tratados con esta técnica multidisciplinaria fueron seguidos durante un promedio de 20 meses, ninguno presentó complicaciones postoperatorias. Los resultados valorados por escalas análogas son prometedores e invitan a establecer éste procedimiento como el estándar de oro. **Conclusiones:** La evaluación estricta es necesaria en los defectos acetabulares. La inclusión de ingeniería informática médica permite estudiar la necesidad de utilización de injerto de banco, fabricar implantes a medida de titanio/tantalio trabecular multiporoso lo que es ideal para lograr la osteointegración, sumado a la posibilidad de planificar dirección y longitud de tornillos al hueso remanente, según su calidad. La cementación de un cotilo de doble movilidad, dentro del implante customizado, disminuye el riesgo de luxación y de sobrecarga de este último, al eliminar la fricción metal-metal.

Palabras clave: Disrupción pélvica; cotilo 3D; doble movilidad; revisión acetabular reconstructiva; defectos acetabulares graves.
Nivel de Evidencia: IIIB

INTRODUCTION

Hip arthroplasty is one of the most successful surgeries of the 20th century, as it relieves pain, corrects deformities, and improves joint function.

Acetabular component failure is a frequent and complex scenario faced by the hip surgeon. Most failures occur due to aseptic loosening, but other possible causes include infection, recurrent dislocation, periprosthetic fracture, component incompatibility, wear, and osteolysis.

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The revision has become a challenge, due to the loss of bone tissue and its quality. The difficulty in reconstruction is related to identifying the location and characteristics of residual viable bone. Once the pattern of the bone defect has been identified by radiographic analysis, its staging facilitates the appropriate choice of treatment.

Paprosky classified acetabular defects into three types. We will focus on type III, which is subclassified into IIIA, and is characterized by superior migration of the femoral component of more than 3 cm, moderate lysis of the teardrop, and intact Kohler's line; unlike type IIIB, which typically presents a medial migration that causes a discontinuity of Kohler's line, associated with severe lysis of the teardrop and the ischium.[1] In our series, we include the description of an acetabulum fracture in an elderly man.

Some of the most widely used techniques to solve these serious bone defects are the use of block structural allograft, antiprotrusio cage, and custom implants. With regard to antiprotrusio cages, mechanical failures have been published with rates of up to 15% in a medium-term follow-up, in addition to sciatic nerve neuropraxia, loss of implant fixation, and fracture of the fixation wing. Acetabular reconstruction with structural allograft achieves variable outcomes, with rates of mechanical failure of up to 70% of the component and migration.[2]

The high failure rates generated the need to develop new implants with enhanced biological and mechanical properties.

Faced with this problem, a technique was developed which is capable of analyzing the defect in detail and reconstructing the acetabulum using a custom-made implant, with trabecular titanium, which fits into the remaining anatomy, in order to achieve implant stability and restore the functionality of the joint.[3]

The objective of this study was to carry out a literature search on the characteristics of acetabular revision with custom 3D components, associated with the cementation of a dual mobility cup, and its functional and radiographic outcomes, regarding the cases treated in our hospital, for Paprosky type IIIB defects and acetabulum fractures.

MATERIALS AND METHODS

Between 2016 and 2021, five cases of pelvic discontinuity due to failed revisions, classified as Paprosky type IIIB, and one transverse fracture of the acetabulum were treated.

We included patients with failed acetabular reconstructions and bone defects of such magnitude that the use of classical methods, such as grafts or antiprotrusio cages, was not possible. The average age of the patients was 75.3 years and the average follow-up is 20 months (continues today).

In the preoperative interviews, the Harris Hip Score and the Merle d'Aubigné and Postel evaluation scale were applied.[3,4]

According to the protocol, panoramic anteroposterior radiographs of both hips, as well as inlet and outlet, alar oblique, and obturator oblique pelvic radiographs were taken (Figure 1A, C, E, G, H, I, K).

Subsequently, a computed tomography with 1-2 mm slices of the entire pelvis was performed. The images were analyzed with a program to represent it three-dimensionally.

The next step was to calculate the acetabular radial bone loss: it was performed using a computerized method that uses computed tomography, processing the image and generating a 3D anatomical reconstruction.[5] This reconstruction allows studying the density and quality of the remaining bone tissue, thus determining the bone support of the implant to be created. In addition, the direction and length of the fixation screws to be used in the ischium, ilium and pubis sectors were programmed, taking into account the quality of the bone and its possible fixation.

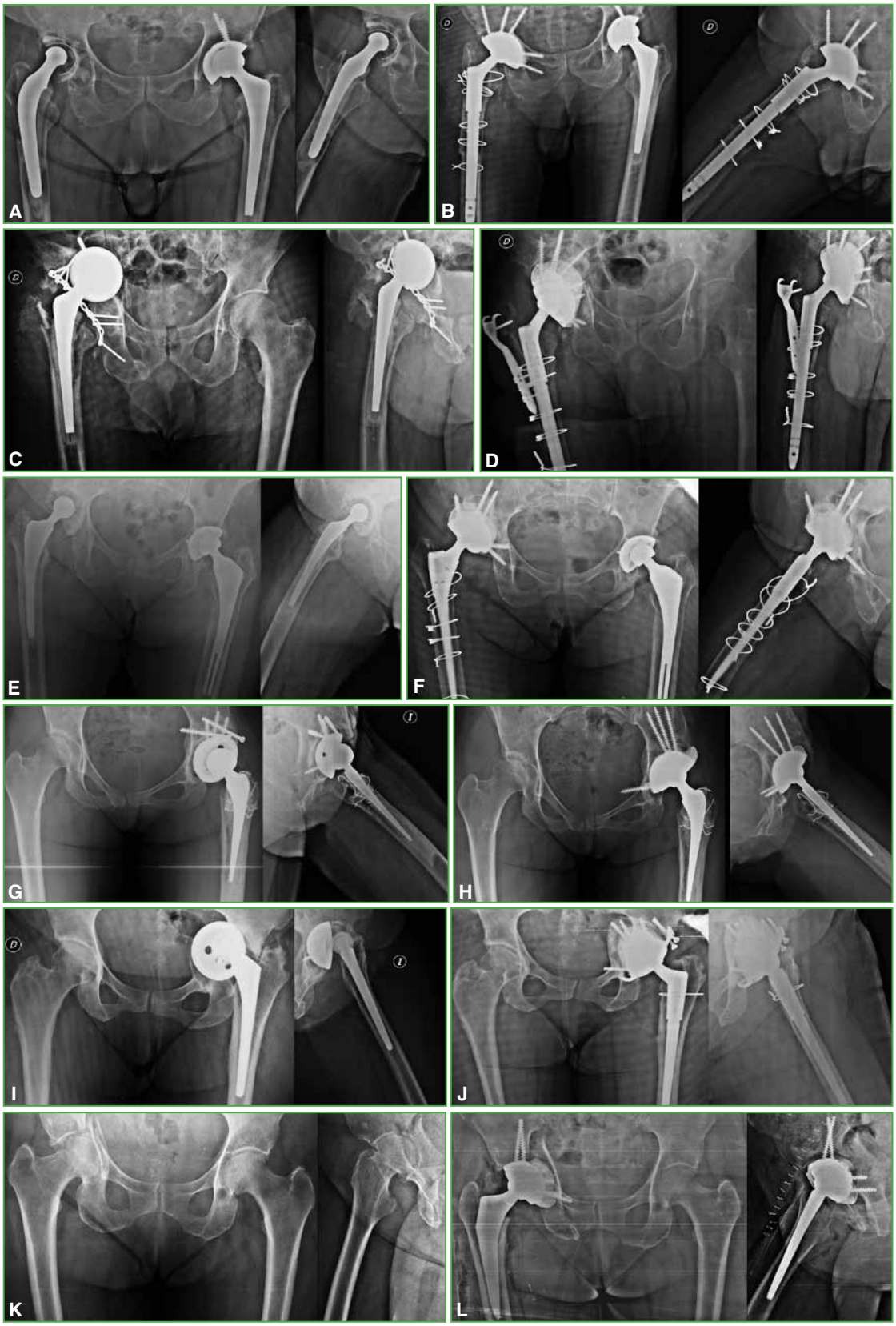

Figure 1. Preoperative anteroposterior and lateral hip radiographs of the treated cases. **A and B.** Case 1. **C and D.** Case 2. **E and F.** Case 3. **G and H.** Case 4. **I and J.** Case 5. **K and L.** Case 7. The description of each patient is detailed in Table 1.

Table. Description of the six cases treated with 3D implants and dual mobility cups.

Patient/ sex/ age	Revision cause	Paprosky classification	Number of revision	Stem revision	Use of graft	Preoperative HHS	Preoperative Merle d'Aubigné and Postel score	Complications to date	Postoperative HHS	Postoperative Merle d'Aubigné and Postel score
1/F/45	Aseptic loosening	IIIB	1	Yes	Yes	39	7	X	87	15
2/F/76	Septic loosening	IIIB	3	Yes	Yes	29	4	X	80	13
3/F/84	Aseptic loosening	IIIB	1	Yes	Yes	23	3	X	91	17
4/M/92	Septic loosening	IIIB	3	Yes	Yes	22	4	X	78	12
5/M/82	Aseptic loosening	IIIB	1	Yes	Yes	21	3	X	83	14
6/F/73	Acetabular fracture	X	X	X	Yes	X	X	X	86	15

M = male, F = female, HHS = *Harris Hip Score.*

It was an interdisciplinary work, during which the surgeon carried out a constant exchange with the computer engineers, focused especially on optimizing the inclination and anteversion, and determining the center of rotation (Figure 2).

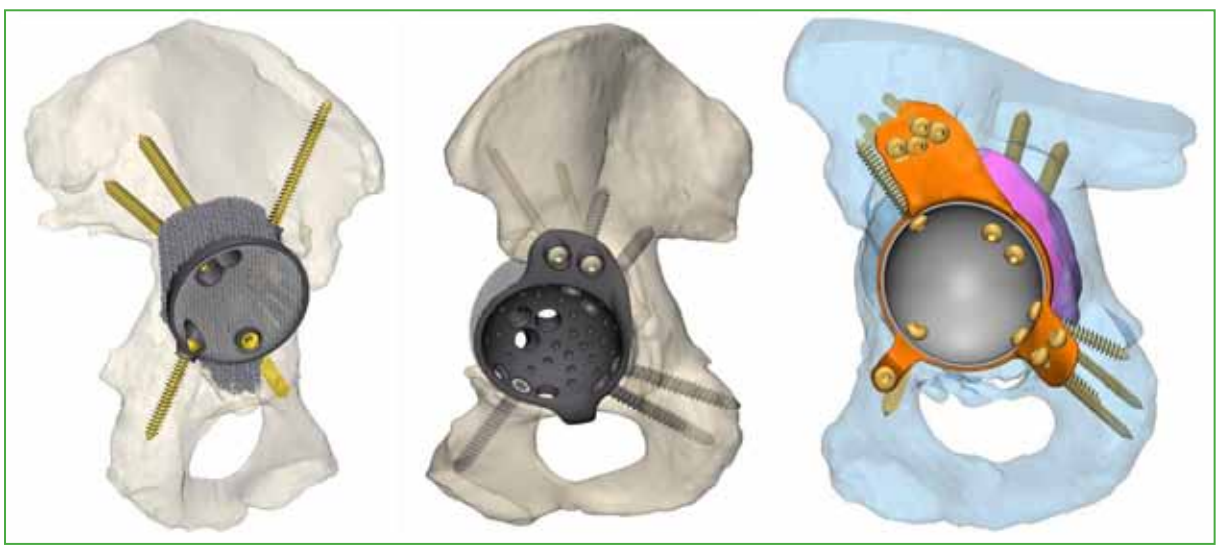

Figure 2. 3D rendering and planning of the 3D cup and example fixation screws.

In all cases, the posterolateral approach was used and the femoral component was revised. After a careful release and dissection of the soft tissues, the acetabular defect was exposed and filled with bone graft, always from a bone bank. In this way, the comorbidity of taking the iliac crest graft is avoided, providing bone structure to the deficit.

During surgery, the surgeon is provided with a trial anatomical mold, the 3D monitors allow locating the defect, the position of the custom component, the screws to be placed, the length and the direction (Figure 3).

Figure 3. Example of a mold for preoperative planning and the mold used in Case 1 surgery.

The material used for the construction of the custom cups was always trabecular titanium, due to its high coefficient of friction that allows it to provide initial primary stability and, subsequently, due to its high three-dimensional porosity, osseointegration, and secondary biological fixation (Figure 4).[2,6,7]

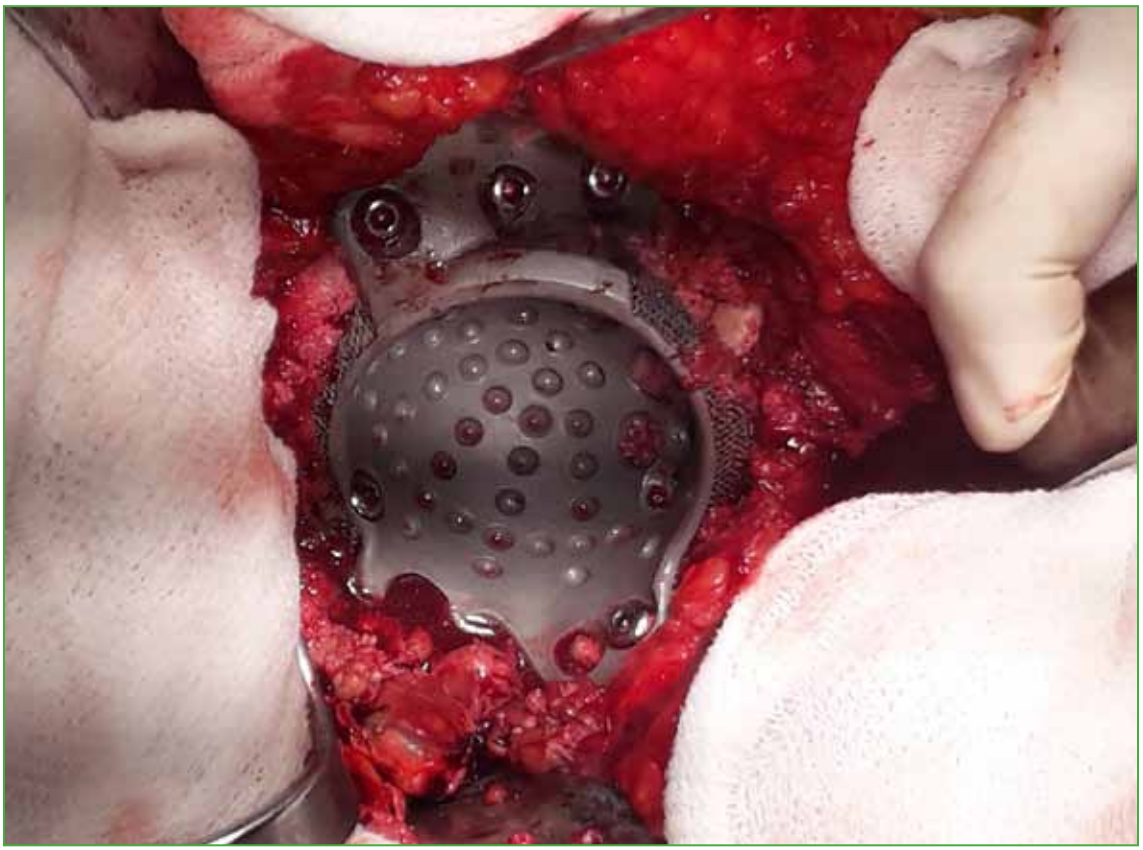

Figure 4. Intraoperative image of the three-dimensional cup used as a restrictor. It allows to fill spaces and provides biological fixation due to its manufacture in tantalum (Case 3).

Next, in the custom acetabulum, a dual mobility cup was cemented, increasing the head-neck ratio and establishing two articulating surfaces that provided greater stability, preventing overloading of the 3D acetabular implant and reducing targeted wear of the cross-linked polyethylene liner (Figure 5).

The dual mobility cup has an important use in patients with a high risk of dislocation, for example, those undergoing oncological resection surgeries,[8] with hip-spine pathology or previous lumbosacral arthrodesis,[9] with intracapsular fractures[10] and revision cases such as those presented in this study.[11] An intact gluteus medius muscle is essential; if affected, the use of a constrained cup is suggested. In all cases, the correct length and joint range of motion were confirmed, and the reinsertion of the gluteus medius was performed.

Figure 5. Intraoperative image of the cementation of the dual mobility cup within the three-dimensional implant. This makes it possible to reduce the overload on the latter and reduce the risk of dislocation, one of the most frequent complications when using the 3D cup.

RESULTS

The average hospitalization time was three days and the clinical-surgical evolution of the patients was good. Six of them started weight-bearing 24 h after surgery, assisted by a walker, supplemented with active-passive range of motion exercises and muscle strengthening. Upon discharge, anti-dislocation measures, physiokinesis treatment, analgesics and anticoagulation/aggregation agents were prescribed as appropriate.

The first control was performed three weeks after surgery and, at that time, the mechanical sutures were removed given the good evolution of the surgical wound. Preventive measures for dislocation were maintained until the next consultation.

The following controls were performed with radiographs at 6 weeks, 2 and 3 months. The discontinuation of the walker and the use of Canadian crutches with weight-bearing were indicated. At the sixth month, weight-bearing support was withdrawn and controls were established every six months (Figure 1B, D, F, H, J, L). So far, no post-operative complications have been recorded.

DISCUSSION

The treatment of a massive acetabular bone deficit is a complex scenario in hip revision. The way to treat this defect is a matter of controversy; the multiple procedures described, such as the use of Jumbo cups,[12] structural grafts,[13] or reconstruction cells,[14] among others, have not achieved favorable long-term outcomes.

On the other hand, custom-made acetabular implants have the advantage of providing stability to these large defects, while at the same time allowing the use of bone graft as a complement with the expectation of biological fixation.

Christie et al. followed up 67 patients treated with 3D implants for 53 months. The Harris Hip Score improved from 33 before surgery to 82 at the end of follow-up. The authors stated that revision was not necessary in any case; however, the main complication was instability and dislocation of the prosthesis.[15]

On the other hand, Holt and Dennis published data on 26 patients with Paprosky type IIIB deficiency. The Harris Hip Score improved from 39 to 78 and the success rate was 88%. Three patients presented aseptic loosening due to failed fixation of the ischial screws and two due to dislocations treated by closed reduction.[16]

Joshi et al. carried out revisions on 27 patients with an average evolution of 2.3 to 5.3 years, according to the Charnley score modified by Merle d'Aubigné and Postel. They described the great complexity of the procedure, but reported fewer dislocations after including femoral revision in all cases.[17]

Lastly, Wind et al. published a retrospective review of 19 patients treated for Paprosky types IIIA and B acetabular deficits, five of whom suffered prosthesis dislocation. 65% of the cases in their cohort were successful, which the authors considered an unfavorable result.[18]

According to what has been published, the dislocation of the prosthesis is one of the possible and frequent complications of the treatment of acetabular defects using 3D implants, in addition to loosening.

In this situation, the use of dual mobility cups, as described in this series of patients, will reduce the overload of the customized implant, provide a greater range of motion and less polyethylene wear, and reduce the risk of dislocation of the prosthesis, one of the main complications described in the literature.

The treatment of Paprosky type IIIA and B acetabular bone defects has become a real challenge in total hip replacement revision surgeries.

Historically, the literature has described high rates of complications, especially loosening, in the results of the reconstruction of these massive defects using classic techniques, such as the use of Jumbo cups, bone grafts or reconstruction cages, among others.

The management of this condition through 3D implants created with computer engineering have founded a new paradigm. This procedure requires a deeper study of each case, preoperative planning, and high technical demand. The published results are encouraging, since it practically eliminates the typical loosening of other types of procedures. However, instability has become its main complication.

Based on this problem, the cementation of dual mobility cups in 3D implants was implemented, practically eliminating the risks of instability and, in turn, reducing overload. The international literature in this regard is minimal. Baauw et al. published a series of 12 cases with a minimum follow-up of 18 months. None of the patients presented loosening and only one suffered a dislocation, in which the femoral stem had not been revised.

In Argentina, too, the literature is scarce; there is a study by Belzino et al. from 2020.[19] The main limitation of this study is the limited series of cases, directly attributable to the fact that it is a rare condition. The standardization and streamlining of this therapeutic method are of vital importance given the exponential increase in hip arthroplasties in the world, as a possible resolution in cases of catastrophic progression.

CONCLUSIONS

This article described a detailed approach to the analysis carried out by the hip team and its medical IT collaborators to develop a customized titanium implant that allowed optimal bone anchors to be placed with screws in the areas of greatest fixation, depending on the particular remaining bone tissue of each patient, and the use of dual mobility cup cementation to reduce the incidence of instability, the main complication in the treatment of Paprosky type IIIA and B acetabular defects with custom-made implants.

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

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Instability Risk Factors in Total Hip Arthroplasty for Femoral Neck Fracture

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ABSTRACT

Introduction: One of the most relevant complications of total hip arthroplasty (THA) in the treatment of fractures is a dislocation rate of 10%, which is 5 times higher than that of THA for osteoarthritis. Our objective was to determine the dislocation rate in patients treated with THA due to femoral neck fracture and to evaluate the cause of dislocation. **Materials and Methods:** We carried out a retrospective study on 110 THAs in patients with femoral neck fractures (the average age was 69 years, and 71% were women). The type of fixation of the prosthesis, the size of the head, the offset, and the surgical approach were evaluated. The angle of acetabular inclination and anteversion and the comorbidities were measured. **Results:** 72% of surgeries were performed through the posterolateral approach. The anterolateral approach is associated with a 7° more vertical cup (p=0.001). 65.4% of the heads were 32 mm. 15% of the small heads (22 and 28mm) (3/20) and only 1% of the large heads (1/90) dislocated (p=0.0027). No 36-mm heads were dislocated. Depression, Parkinson's, and Alzheimer's disease were the most frequent neurological comorbidities. **Conclusions:** Small-diameter heads, in combination with poor positioning of the prosthesis and neurocognitive diseases, are associated with greater instability. Using prosthetic heads with a diameter of 36 mm and a correct orientation of the components is sufficient to ensure stability.

Keywords: Total hip replacement; instability; risk factors; hip fracture.

Level of Evidence: III

Factores de riesgo de inestabilidad en el reemplazo total de cadera por fractura medial de cadera

RESUMEN

Introducción: Una de las complicaciones más importantes de la artroplastia total de cadera en el tratamiento de las fracturas es la luxación, con una tasa del 10%, cinco veces mayor que la de la artroplastia total de cadera para osteoartrosis. El objetivo de este estudio fue conocer nuestra incidencia de luxación en pacientes sometidos a artroplastia total de cadera por fractura del cuello femoral y evaluar la causa de la luxación. **Materiales y Métodos:** Estudio retrospectivo en 110 pacientes sometidos a artroplastia total de cadera por fractura medial de cadera (edad promedio 69 años; 71% mujeres). Se evaluaron el tipo de fijación de la prótesis, el tamaño de la cabeza, el *offset* y el abordaje quirúrgico. Se midieron los ángulos de inclinación y de anteversión acetabulares y se registraron las comorbilidades. **Resultados:** El 72% de las cirugías fueron por vía posterolateral. La vía anterolateral se asoció con una copa 7° más vertical (p = 0,001). El 65,4% de las cabezas eran de 32 mm. El 15% (3/20) de las cabezas chicas (22 y 28 mm) y el 1% (1/90) de las grandes se luxaron (p = 0,0027). No se luxó ninguna cabeza de 36 mm. Las comorbilidades neurológicas más frecuentes fueron depresión, Parkinson y Alzheimer. **Conclusiones:** Las cabezas de pequeño diámetro junto con el mal posicionamiento de la prótesis y las enfermedades neurocognitivas se asocian a una inestabilidad mayor. El uso de cabezas de 36 mm y la correcta orientación de los componentes son suficientes para asegurar la estabilidad.

Palabras clave: Reemplazo total de cadera; inestabilidad; factores de riesgo; fractura de cadera.

Nivel de Evidencia: III

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INTRODUCTION

Approximately half of hip fractures correspond to a displaced femoral neck fracture (Garden types III or IV) of the subcapital region. These are associated with impaired mobility, loss of function, personal dependence, and are important causes of morbidity and mortality in the elderly.[1,2]

Surgical treatment options include internal fixation (not recommended in the elderly), hemiarthroplasty, and total hip arthroplasty (THA).

THA has been shown to lead to lower reoperation rates, less pain, better functional outcomes, and better ranges of motion than hemiarthroplasty. However, one of the most relevant complications of THA in the treatment of fractures is a dislocation rate of 10%, five times higher than that of THA for osteoarthritis, due to the combination of muscular insufficiency, cognitive and neurological disorders, and recurrent falls that characterize this patient population.[3,4] Obesity, excessive alcohol consumption, a posterolateral approach, neurodegenerative diseases, malposition of components and lumbar arthrodesis are risk factors for THA dislocation.

In recent years, large diameter heads, highly cross-linked polyethylene, and dual mobility designs have been shown to reduce osteolysis and the risk of dislocation.[5]

Currently, there is a tendency to indicate a dual mobility THA in primary surgery for displaced femoral neck fractures; however, we believe that the correct placement of the components of a conventional THA with a 36mm head and the restoration of abductor tension provide complete range of motion and sufficient stability in patients without comorbidities.

The objective of this study was to determine the dislocation rate in patients treated with THA for femoral neck fracture and to assess the cause of the dislocation.

MATERIALS AND METHODS

We carried out a retrospective study between January 2012 and May 2020. A total of 268 femoral neck fractures and 110 THAs were identified in 108 patients (Figure 1).

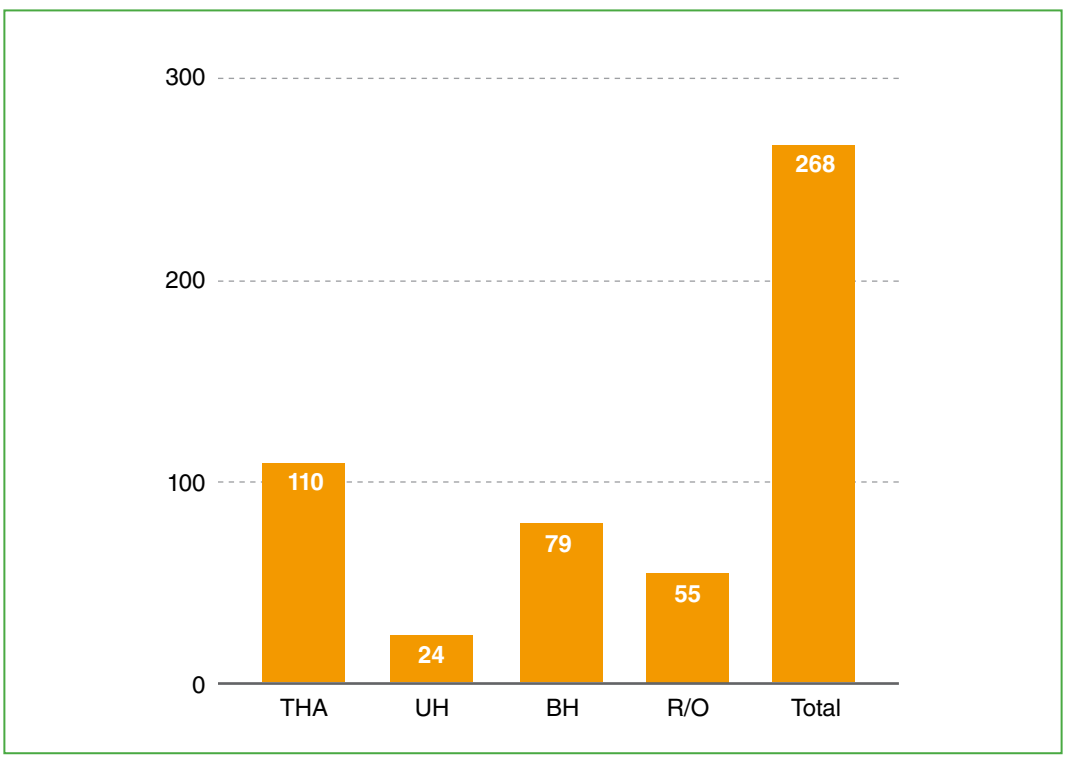

Figura 1. Total number of femoral neck fractures and treatments performed. THA = total hip arthroplasty, UH = unipolar hemiarthroplasty, BH = bipolar hemiarthroplasty. R/O = reduction and osteosynthesis.

The average age of the patients at the moment of surgery was 69 years, 78 were women (71%) and 32 men (29%). 50% were over 70 years old. The affected side was the right side in 51% and two patients had a bilateral fracture, both with a one-year difference between the fractures. According to Garden's classification,[6] 50% of fractures were type IV and 40% were type III. (Table 1).

Table 1. Demographics of the serie

Sex	
Female	78 (71%)
Male	32 (29%)
Age (mean)	69.31 (range 37-95)
Side	
Right	56 (51%)
Left	54 (49%)
Fracture type	
Garden I	5 (4.55%)
Garden II	6 (5.45%)
Garden III	44 (40%)
Garden IV	55 (50%)

We recorded the data on the type of prosthesis, including head size, offset, type of fixation, and surgical approach. Acetabular inclination and anteversion angles were measured according to the Pradhan[7] method with the Carestream® system. Likewise, we recorded the follow-up time as well as important comorbidities and complications derived from surgery, with special interest in dislocation.

Statistical Analysis

We performed an exploratory analysis (summary of measurements, frequency distribution tables and graphs – box plots, bar plots and histograms) of the patient sample, characterizing by sex, age, and the variables investigated.

RESULTS

The average follow-up was 35 months, with a minimum of 12 months in 54 patients and a maximum of 96 months in another four.

Each surgeon chose the surgical approach based on their individual experience. 72% of the surgeries were performed through the posterolateral approach and 28% through the anterolateral approach. There were no statistically significant differences when comparing the approach with respect to age, sex, operated side and Garden classification (p = 0.206, 0.809, 0.905 and 0.421, respectively).

Most of the prostheses (73%) were hybrid (cemented femoral stem with uncemented acetabular cup), followed by cemented (14%) and uncemented (13%) prostheses.

Regarding the femoral offset, 78% was high offset and only 22% was standard, the predominant size of the head was 32 mm (65.4% of cases), followed by 28 mm (17 .3%) and the 36mm (16.4%). There was a single 22mm-diameter head.

When evaluating the position of the acetabular cup, the average inclination was 43.39° (standard deviation [SD] 8.13) and the average anteversion was 15.16° (SD 8.80). (Table 2).

When the different variables were correlated, the anterolateral approach was associated with a more vertical cup (mean 48.42°) than the posterolateral approach (mean 41.42°), with statistical significance (p = 0.001) (Figure 2). Similarly, the anterolateral approach was associated with a more anteverse cup (16.19°; SD 9.6) versus 14.75° (SD 8.47) for the posterolateral approach, but without statistical significance (p = 0.44).

Table 2. Summary of the approaches, components and orientation of the prosthesis.

Approach	
Posterolateral	79 (72%)
Anterolateral	31 (28%)
Prosthesis type	
Hybrid	80 (73%)
Cemented	16 (14%)
Uncemented	14 (13%)
Offset	
High offset	86 (78%)
Standard	24 (22%)
Head	
22 mm	1 (0.9%)
28 mm	19 (17.3%)
32 mm	72 (65.4%)
36 mm	18 (16.4%)
Acetabular cup	
Inclination	43.39° (range 22°-75°)
Anteversion	15.16° (range 0°-42°)

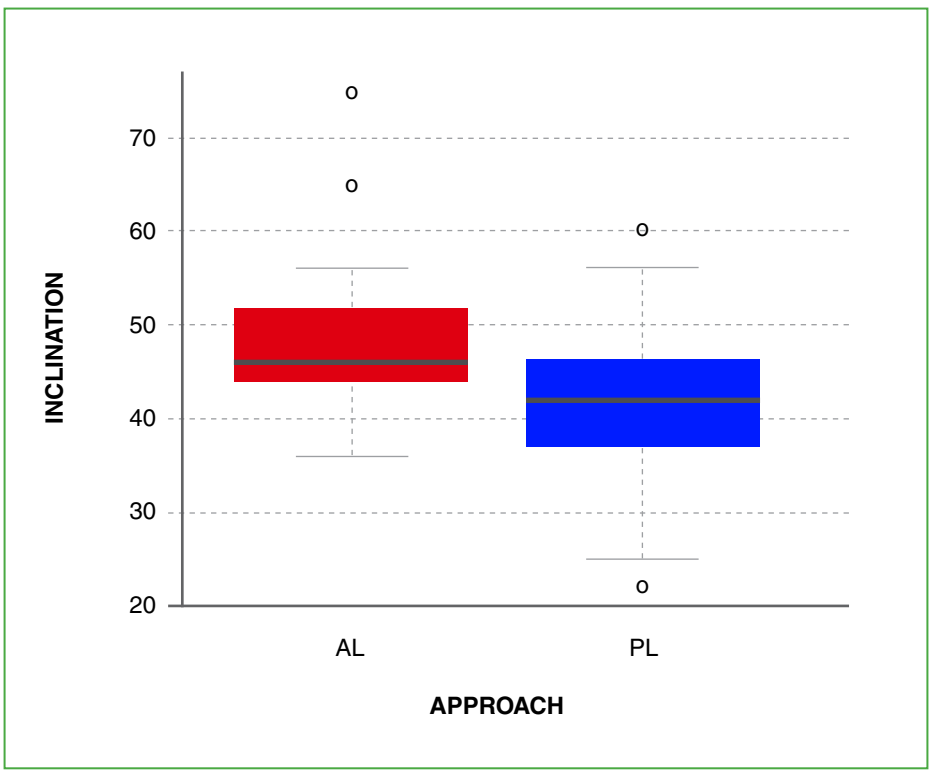

Figura 2. Statistical significance between the approach and the inclination of the acetabular cup (p = 0.001).

There were no significant differences between cup positioning and fixation type.

38% of the patients had relevant comorbidities (n = 42). The most frequent neurological comorbidities were depression, Parkinson's disease ,and Alzheimer's disease (all of these patients were under neurological or psychiatric treatment). Rheumatoid arthritis was the most common rheumatologic disease (5.45%). Four patients were receiving hemodialysis, three of them had a pathological hip fracture (Table 3).

Table 3. Patient comorbidities.

Neurological comorbidities	n = 23	Non-neurological comorbidities	n = 19
Depression	8	Rheumatoid arthritis	6
Parkinson's disease	4	Hemodialysis	4
Alzheimer's disease	3	Chronic kidney disease	2
Epilepsy	2	Breast cancer	2
Cerebrovascular accident (crural hemiparesis)	2	Multiple myeloma	1
Down syndrome + autism	1	Prostate cancer	1
Dementia	1	Pancreatic cancer	1
Lower limb paraparesis	1	Non-hodgkin's lymphoma	1
Axonal polyneuropathy	1		

Surgery-related complications are described in Table 4, excluding dislocations.

Table 4. Complications, not including dislocations.

Complications	n = 8
Pulmonary thromboembolism	1
Deep vein thrombosis	1
Acetabular loosening	1
Aseptic femoral loosening	1
Acetabular fracture + deep infection (DAIR)	1
Periprosthetic fracture (Vancouver B2)	1
Superficial infection	1
Deep infection (two-stage revision)	1

DAIR = debridement, antibiotics and implant retention

Dislocation

3.6% of the patients suffered some episode of dislocation. When correlating the dislocations with the other variables analyzed, no statistically significant differences were found in terms of age, sex, the operated side or the type of fracture. (Table 5).

Regarding the surgical approach, the four patients who suffered a dislocation were operated by the posterolateral approach; however, this was not statistically significant (p = 0.209).

No significant differences were found in the type of fixation and the offset between the dislocations. In relation to the size of the head, a significant difference was found between the groups: 15% of the small heads (22 and 28 mm) and only 1% of the large ones dislocated (p = 0.0027). No 36-mm head dislocated.

When correlating dislocations with the position of the acetabular cup, there were no statistically significant differences for inclination (p = 0.614) and anteversion (p = 0.810); however, dislocation was associated with an average 3.5° greater inclination, and one of those cups was oriented at 60°.

There were two cases of dislocation in two patients with a 28 mm head and cup with minimal anteversion (1° and 8°).

Finally, two patients had a single episode of dislocation one month after surgery: one had stage 4 Parkinson's disease, excessive acetabular anteversion (23°), and a 32-mm head. The other patient had Down syndrome with autism, an excessive acetabular inclination (60°), and a 22-mm head.

Table 5. Correlation between dislocation and the different variables.

Variables		Without dislocation (n = 106)	With dislocation (n = 4)	p
Age (years)		69.4 ± 11.7	68.3 ± 20.5	0.7192
Sex	Male	31 (97%)	1 (3%)	0.8564
	Female	75 (96%)	3 (4%)	
Side	Right	54 (96%)	2 (4%)	0.9704
	Left	52 (96%)	2 (4%)	
Garden	Types I-II	11 (100%)	0 (0%)	0.4971
	Types III-IV	95 (96%)	4 (4%)	
Approach	Anterolateral	31 (100%)	0 (0%)	0.2019
	Posterolateral	75 (95%)	4 (5%)	
Fixation	Cemented	15 (94%)	1 (6%)	0.5775
	Hybrid	78 (98%)	2 (3%)	
	Uncemented	13 (93%)	1 (7%)	
Head size	22-28 mm	17 (85%)	3 (15%)	0.0027
	32-36 mm	89 (99%)	1 (1%)	
Inclination		43.3 ± 8.1	46.8 ± 9.5	0.6145
Anteversion		15.2 ± 8.8	14.0 ± 11.3	0.8107
Comorbidities	No	71 (99%)	1 (1%)	0.0830
	Yes	32 (96%)	3 (8%)	

There was a statistically significant association between small heads and dislocation (p = 0.0027).

DISCUSSION

Risk factors for instability in THA are multifactorial and may be patient-specific, related to surgical variables (choice of approach, position of components), or related to the implant (type of fixation, femoral head diameter, retentiveness).

Instability remains one of the leading causes of hospital readmission and the leading cause of revision surgery both in the United States and in most European countries, and its economic cost after a primary THA dislocation can rise to 148%.[8] Modifications in surgical technique (eg, anterior surgical approach, posterior soft-tissue repair in the posterior approach, restoration of abductor tension, and incorporation of larger diameter femoral heads) decrease the risk of postoperative instability after a THA.

Many patient-related factors are associated with a higher risk of dislocation, including female gender, older age, prior hip surgery, neuromuscular and cognitive disorders, excessive alcohol use, abductor weakness, surgical approach, malpositioning of the components, failure to restore leg length, preservation of the abductor mechanism, capsular repair, femoral-acetabular impingement, and surgeon experience.[5]

In the literature, there is no agreement regarding age as a predisposing factor for dislocation. Byström et al.[9] stated that patients >80 years of age had a 4.5 times higher risk of suffering a dislocation, while Berry[10] reported that, in people >70 years of age, the risk was 1.3 times higher. In our study, there were no significant differences when analyzing the relationship between age and dislocation episodes.

There is much evidence that, in the posterolateral approach, the repair of the posterior muscle plane and capsule provides more prosthetic stability. In a study of patients with femoral neck fractures treated with THA by the posterolateral approach, Kwon et al.[11] reported a 14% incidence of dislocations in the group without posterior plane repair and 12% in those with repair. Posterior plane repair increases stability and the need for more force to reach the dislocation of the prosthesis.[12] Mufarrih et al.[5] recommend implementing the anterolateral approach as standard practice for patients at a higher risk of dislocation, including those with a femoral neck fracture. In our series, all the dislocations occurred in patients operated by the posterolateral approach, but this did not have statistical significance.

Two implant-related risk factors are femoral head size and head-neck ratio, which may be more modifiable than the patient-related factors already listed.

In randomized controlled trials, larger femoral heads ≥36mm have resulted in a lower incidence of dislocation on both primary and revision THA, but should be used with caution as larger diameter heads have more volumetric wear, which should be taken into account, especially in young patients (<70 years).

The dual mobility joint combines the "low friction" principle with a 22-mm diameter head, popularized by Charnley with the McKee-Farrar concept of using a larger diameter femoral head to improve stability. The objective of the dual articulation is to achieve the greatest possible range of motion by reducing wear. The polyethylene insert is made mobile within a metal cup (with mirror polished surface) with a head, also mobile in that insert, but constrained.

Some current studies show the superiority of dual mobility THA for treating displaced femoral neck fractures in patients at high risk of prosthesis dislocation.[1-3] In our Department, we do not perform any dual mobility THA in patients with displaced fractures of the femoral neck and, according to the analysis of the results, the cases of instability were due to a poor surgical technique in the orientation of the components or a poor selection of the implant in patients with a high risk of dislocation of the prosthesis (neurocognitive and psychiatric diseases).

CONCLUSIONS

Although the dislocation of a THA in patients with femoral neck fracture is due to multiple factors, small diameter heads together with poor positioning of the prosthesis and neurocognitive diseases are associated with greater instability. 36-mm diameter heads and proper component orientation are sufficient to ensure stability. However, the use of dual mobility cups could be considered when the risk of dislocation is higher (patients with neurocognitive disorders).

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

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Total Hip Arthroplasty in a Patient with Paget's Disease. Case Report

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ABSTRACT

Introduction: Paget's disease is a metabolic disorder of unknown etiology, secondary to an increase in the function of osteoclasts and the consequent response of osteoblasts to excessive bone formation. It most commonly involves the proximal femur and is often diagnosed incidentally. We present the case of a woman with a history of Paget's disease and nonunion of the left hip, with indications for a total left hip prosthesis and a single episode of dislocation, without subsequent complications and an adequate evolution. **Conclusion:** Surgical management in cases of hip fracture allows to restore walking and improves the quality of life of patients with Paget's disease. Despite being a pathology that makes patient management difficult, Paget's disease is not a contraindication for total hip arthroplasty and allows the improvement of pain and restoration of functionality.

Keywords: Paget's disease, total hip arthroplasty, bisphosphonates, hip, surgery, dislocation.
Level of Evidence: IV

Artroplastia total de cadera en paciente con enfermedad de Paget. Presentación de un caso

RESUMEN

Introducción: La enfermedad de Paget es un trastorno metabólico de etiología desconocida, secundario a un incremento en la función de los osteoclastos y la consecuente respuesta de los osteoblastos a la formación exagerada de hueso. Compromete con mayor frecuencia el fémur proximal y, a menudo, se diagnostica incidentalmente. Se presenta el caso de una mujer con antecedente de enfermedad de Paget y pseudoartrosis de cadera izquierda, con indicaciones de prótesis total de cadera izquierda y un episodio único de luxación, sin complicaciones posteriores y una adecuada evolución. **Conclusión:** El manejo quirúrgico en casos de fractura de cadera permite restablecer la marcha y mejorar la calidad de vida de los pacientes con enfermedad de Paget. A pesar de ser una patología que dificulta el manejo de los pacientes, la enfermedad de Paget no es una contraindicación para la artroplastia total de cadera y permite mejorar el dolor y recuperar la funcionalidad.

Palabras clave: enfermedad de Paget, artroplastia total de cadera, bifosfonatos, cadera, cirugía, luxación.
Nivel de Evidencia: IV

INTRODUCTION

Paget disease is a metabolic disorder secondary to an increase in the function of osteoclasts and the consequent response of osteoblasts to excessive bone formation. Of unknown etiology and multifactorial behavior, Paget disease most often involves the proximal femur and is diagnosed, in most cases, incidentally due to increased alkaline phosphatase or radiological findings. The cornerstone of management is antiresorptive therapy with bisphosphonates and, in cases of fractures, internal fixation or even total hip arthroplasty becomes an alternative to improve the patient's quality of life.

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The purpose of this paper is to present the short-term evolution (3 years) of a patient with Paget disease undergoing total hip arthroplasty after internal fixation failure with a long intramedullary nail for the management of a subtrochanteric fracture. We aim to provide a therapeutic alternative in cases of fractures with pseudarthrosis or nonunion.

CLINICAL CASE

A 63-year-old woman residing in the city of Medellin, Colombia. She was an independent worker with a previous diagnosis of Paget disease with polyostotic presentation, diagnosed incidentally due to radiological findings and family history. In 2015, the patient suffered a fall from her own height and a subtrochanteric fracture of the left hip was verified, which was given surgical management at another institution. We consider that the fracture occurred in a previously pathological bone compromised by Paget disease (Figures 1 and 2).

Figure 1. Subtrochanteric fracture of the left hip in pathological femur, with radiological findings suggestive of Paget disease (cotton wool appearance).

Figure 2. Postoperative control radiograph of osteosynthesis of the proximal femur with a long locking intramedullary nail.

During the postoperative evolution, due to the presence of pseudarthrosis (diagnosed 6 months after the operation and managed in another institution), the osteosynthesis material (locking intramedullary nail) was removed and the femoral head was resected, so a resection arthroplasty remained (Figures 3 and 4).

In 2016, the patient consulted at the institution due to persistent severe pain and gait limitation in the left hip, with a control radiograph showing massive bone loss in the proximal femur, a healthy surgical scar, and no signs of infection. After evaluation by multiple specialists and assessment by the *Centro de Cuidado Clínico de Reemplazos Articulares* [Joint Replacement Clinical Care Center], the patient was considered eligible for surgery and a total left hip replacement was scheduled.

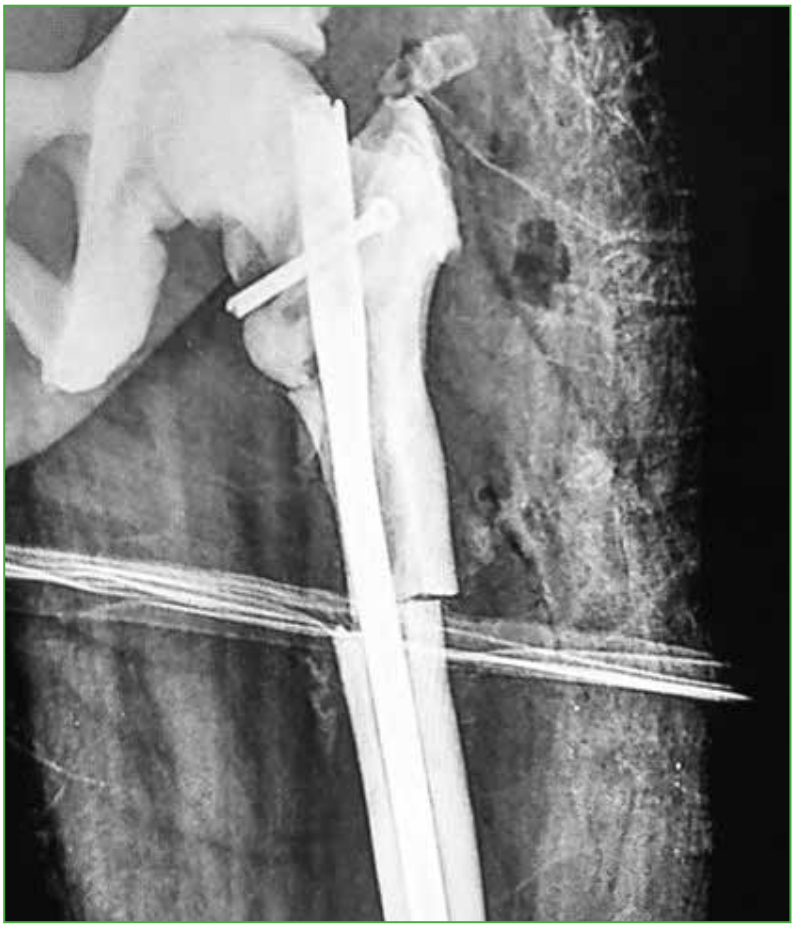

Figure 3. Fracture nonunion, osteolysis of the medial cortical bone of the proximal fragment of the femur and an image suggesting a fracture of the femoral neck.

Figure 4. Postoperative control radiograph of removal of osteosynthesis material plus interposition arthroplasty with resection of the femoral head.

In February 2018, said intervention was performed together with a corrective osteotomy of the proximal femur and proximal ostectomy at the level of the trochanter through a posterolateral approach, without complications. A 44 x 28 uncemented acetabulum was implanted, together with 4 acetabular fixation screws, a 44 x 28 highly cross-linked polyethylene insert, a 140 mm x 13 mm uncemented revision stem with proximal metaphysis, with a wing for the fixation of the hip abductor mechanism and a 28M cobalt-chromium head (Figure 5).

Figure 5. Postoperative control radiograph of total left hip prosthesis plus osteotomy and ostectomy of the proximal femur.

In March 2018, the patient consulted the emergency department of the institution due to intense pain in the left hip, shortening of the limb and limitations in weight-bearing and walking, with no history of a fall. The control radiograph showed a posterior dislocation of the total left hip prosthesis (Figure 6). After several attempts at closed reduction of the dislocation under general anesthesia and due to the persistence of instability, an open reduction of the prosthesis dislocation was performed, with an intraoperative finding of disinsertion of the hip abductor mechanism, with no signs of infection or loosening of the components. Therefore, the repair and new fixation to the metaphysis flap of the femoral stem were performed, without complications (Figure 7).

After open reduction, the patient presented a satisfactory clinical and radiological evolution (3-year follow-up), with occasional mild pain, range of motion from 0 to 110°, abduction of 30°, internal rotation of 20°, and external rotation of 20°. She walks with a cane and has returned to work activities. To date, she has not had any other episodes of dislocation and control radiographs at 1 year and 3 years show no signs of loosening or osteolysis (Figure 8).

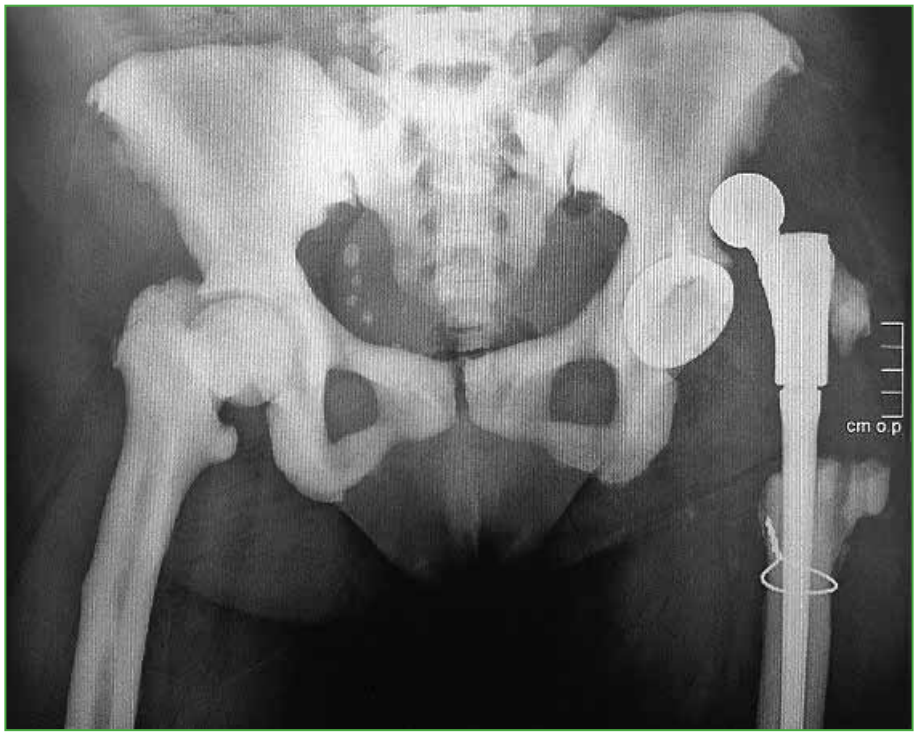

Figure 6. Posterior dislocation of total left hip prosthesis, with no history of falls.

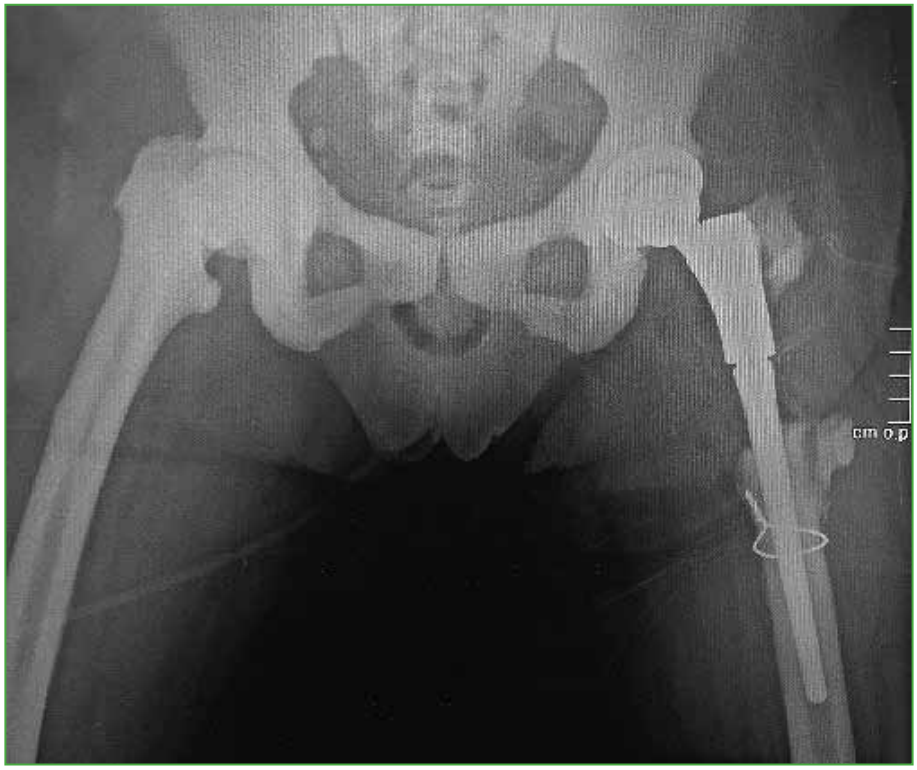

Figure 7. Postoperative control radiograph of open reduction of dislocation and reattachment of the hip abductor mechanism.

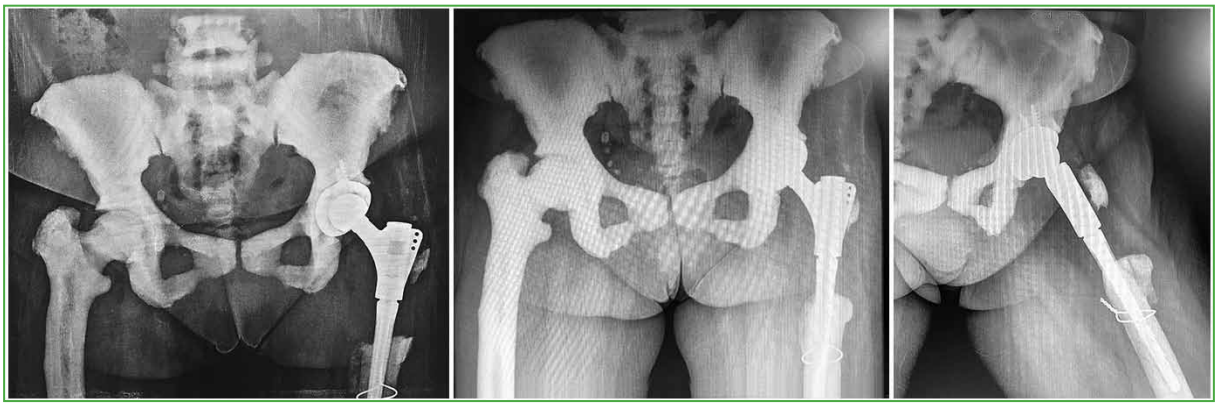

Figure 8. From left to right: Postoperative control radiograph a year later, without dislocations, loosening or osteolysis. Postoperative control radiograph at 3 years, without loosening or osteolysis of the prosthesis.

DISCUSSION

Paget disease or osteitis deformans, first described by Sir James Paget in 1877 at St. Bartholomew's, in London,[1,2] is a metabolic disorder secondary to an increase in the function of osteoclasts and the consequent exaggerated response of osteoblasts to bone formation, which leads to a complete loss of bone homeostasis.[1] The prevalence is higher in patients older than 55 years and in countries such as Great Britain (3-5%), the United States, Canada, Australia and New Zealand.[1]

The etiology is still unknown, but the most accepted hypothesis is that latent infection by viruses of the *Paramyxoviridae* family (measles virus, respiratory syncytial virus, canine distemper virus) in genetically predisposed individuals can trigger the disease.[3] Approximately 15% of patients have a family history of the disease, which is due to autosomal dominant inheritance with incomplete penetrance, where almost half of the patients have a family history and 5-10% of those with disease *de novo* have a mutation in the SQSTM1 gene, encoded in p62 and responsible for a protein production that is fundamental in the regulation of osteoclast function.[4]

However, it is known that some external factors can influence the development of the disease, which assumes a multifactorial behavior, where the patient's nutrition, exposure to infections and sedentary lifestyle can play an important role.[4]

Under physiological conditions, the human skeleton undergoes complete remodeling every 2 to 4 years, with the appearance of 3-5 active osteoclast nuclei in each anatomical region, but in patients with Paget disease, osteoclasts increase their activity by almost 9 times, as well as increasing in number (10 to 100 times more than normal), which leads to the formation of approximately 100 nuclei of osteoclastic activity, which by positive feedback allow increased recruitment of osteoblasts and the consequent formation of bone matrix.[1,5,6]

Although both osteoclastic and osteoblastic activities occur in the disease, three well-differentiated phases explain its pathophysiology and can occur simultaneously in different anatomical sites. In the first phase or osteolytic phase, there is an increase in bone resorption and hypervascularization. In phase two or mixed phase (osteoblastic/osteoclastic), in addition to constant bone resorption by osteoclasts, there is an increase in the formation of new bone matrix by osteoblasts. However, the mineralization of this matrix is not adequate, which leads to the replacement of lamellar bone by random bone tissue, with less deforming capacity and resistance. In phase three or the sclerotic phase, osteoclastic activity decreases, leading to the formation of disordered, dense, and sclerotic bone tissue.[1,7]

In most patients, the diagnosis of Paget disease is incidental, either due to the finding of increased alkaline phosphatase levels or the characteristic radiological findings, with 20-25% of cases being asymptomatic. However, many patients may present bone pain, skeletal deformities, fractures, deafness, symptoms of nerve compression or headache due to skull deformity, symptoms that are related to the involvement of a single bone (monoostotic form) or several bones (polyostotic form).

Regarding bone pain, it must be taken into account that it increases with rest, it is predominantly nocturnal, improves with activity and is very difficult to manage with analgesics, which is why, in many cases, it leads to the initial suspicion of an oncological condition. It should be noted that the most common tumor in patients with Paget's disease is osteosarcoma, with an incidence of 0.2-1%.[1]

The characteristic bone deformities are tibia antecurvatum (saber tibia) and femoral antecurvatum and latero-curvatum (shepherd crook), which explains the frequency in the location of fractures in these patients, which may be traumatic or pathological. These occur more frequently distal to the lesser trochanter in the femur (20-80%)[8] and in the proximal third of the tibia. Pelvic involvement is usually asymptomatic, except when the hip joint is involved and there is acetabular protrusion.[9,10]

Other clinical manifestations include cardiovascular complications associated with decreased peripheral vascular resistance and increased cardiac output, nephrolithiasis, hypercalcemia and hyperuricemia, among others.

As already mentioned, patients with Paget's disease have increased levels of alkaline phosphatase, which are closely related to the extent and severity of the disease. However, some patients may present normal or slightly elevated values. In order to rule out false positives, bone-specific alkaline phosphatase should be measured and liver function tests performed.[11] Serum calcium and 25-hydroxy vitamin D levels are usually normal.

Radiological findings include, in the first phase, well-defined areas of osteolysis; in the second phase, areas with cotton wool appearance, which indicate mixed bone activity; and, in the third phase, bone with sclerotic characteristics become more predominant than lytic images. Although radiographs represent a great diagnostic aid, the best diagnostic aid to identify polyostotic presentation is bone scintigraphy.[12]

Regarding treatment, the cornerstone is antiresorptive therapy with bisphosphonates (zoledronic acid, pamidronate, alendronate, risedronate), which is indicated in specific circumstances: 1. symptomatic patients with active bone lesions; 2. as prophylaxis in patients with evidence of active lesions in high-risk areas (weight-bearing bones or sites of potential nerve compression); 3. alkaline phosphatase levels 2 to 4 times the upper limit; 4. before surgery, when the procedure involves bone tissue affected by the disease; and 5. hypercalcemia secondary to immobilization.[1]

In cases of adverse reactions to bisphosphonates due to gastrointestinal symptoms, atypical fractures, atrial fibrillation, osteonecrosis of the jaw, hypocalcaemia or musculoskeletal pain, or when their use is contraindicated (stage IV and V renal failure, pregnancy), therapy with calcitonin SC can be chosen, which has already been approved by the FDA.[1]

It should be noted that all patients with fractures must be managed comprehensively, in order to improve their quality of life and achieve rapid return of the patient to their daily activities, which reduces subsequent complications. It must be taken into account that, due to the pathophysiology of the disease and bone biomechanical differences, many of the fractures, whether treated orthopedically or with internal fixation, may present delayed consolidation (average of 26-42 weeks to consolidate),[13,14] nonunion or even failure, which represents a challenge for the treating physician,[13] as described in this report.

Taking into account the case of our patient, total hip arthroplasty, both cemented and uncemented, has resulted in very good functional outcomes. However, bone hypervascularity, sclerotic tissue, and profuse bleeding during surgery have been shown to limit cement penetration and interdigitation, leading to increased risk of long-term loosening of cemented prostheses,[15,16] which causes almost 15% of revisions in these patients.[8,15,17] This situation has led to an increase in the use of uncemented implants and the pre- and postoperative use of antiresorptive therapy, which allows a decrease in disease activity and bleeding, reduces pain and lowers the rate of long-term complications.[18,19] For this reason, and due to the condition of the femoral bone tissue in the case presented, we decided to perform an uncemented total hip arthroplasty with revision stem, secondary to the removal of the previously implanted osteosynthesis material. This also allowed us to avoid both intraoperative and postoperative complications, which are more prevalent in these patients (as was the case of dislocation or detachment of the hip abductor mechanism). The careful selection and use of implants allow proper management of these complications and their minimization in the future.

CONCLUSIONS

Paget disease is not a contraindication for total arthroplasties, despite being a pathology that makes it difficult to manage patients with a history of fracture. Even though this condition increases the complexity of the procedure due to bone quality, bone physiological characteristics and the high risk of complications, total arthroplasties are indicated in order to improve the patient's quality of life and, as far as possible, achieve the disappearance of pain and functional limitations.

The purpose of this article was to present a surgical alternative for patients with this type of comorbidities and its adequate evolution, which allows us to increase the range of possibilities in patients who would otherwise be treated with femoral head resection (Girdlestone arthroplasty) and protected support.

However, the high risk of intra- and postoperative complications cannot be underestimated, so the management of these patients must be in expert hands in order to minimize these risks, ensure the success of the procedure, and appropriately manage possible eventualities in the future such as pain, loosening or even infection.

Ethical considerations

The patient gave her informed consent and the study was authorized and approved by the research ethics committee of Clínica el Rosario - Sede Centro, Medellin, Colombia.

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Cementation of a Dual Mobility Cup in a Fixed Uncemented Cup for the Treatment of Recurrent Dislocation. Short-term Results

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ABSTRACT

Introduction. Total hip replacement (THR) is the most successful arthroplasty to date, but it is not exempt from complications, such as prosthetic instability. Dual mobility (DM) cups are a treatment option in the resolution of THR with recurrent dislocations due to instability. The objective of the study was to evaluate the results of cementing a DM component in a previous, stable uncemented cup, in a patient with recurrent dislocation undergoing revision THR. A patient with uncemented THR with distal fixation after failed osteosynthesis, who presented episodes of recurrent dislocations, was treated by revision with a cemented DM implant inside a fixed uncemented primary cup and a proximal femoral module with extended offset, preserving tension, length and reducibility of the prosthesis. Resolution of the prosthetic instability was achieved and the patient did not present any episodes of dislocation, obtaining good outcomes in the short term. The Harris Hip Score went from 4/80 preoperatively to 61/80, 73/80, and 76/80 at 3, 6, and 9 months after surgery, respectively. **Conclusion:** Cementation of a DM cup in a previously stable cup appears to be a viable option to treat and prevent instability after revision THR.

Keywords: Dual mobility, total hip replacement, recurrent dislocation.

Level of evidence: IV

Cementado de una copa de doble movilidad dentro de un cotilo no cementado fijo para el tratamiento de una luxación recurrente. Resultados a corto plazo

RESUMEN

Introducción: El reemplazo total de cadera (RTC) es la artroplastia más exitosa hasta el momento, no exenta de complicaciones, como la inestabilidad protésica. Las copas de doble movilidad (DM) constituyen una opción de tratamiento en la resolución del RTC con luxaciones recidivantes por inestabilidad. Se presenta el caso de una paciente a la que se le había practicado un RTC no cementado de fijación distal, después de una osteosíntesis fallida. Debido a que la paciente presentó episodios de luxaciones recurrentes, se decidió tratarla mediante revisión con implante de DM cementado dentro de un cotilo primario no cementado fijo y el uso de un módulo femoral proximal con offset extendido, preservando la tensión, la longitud y la reductibilidad de la prótesis. Se logró la resolución de la inestabilidad protésica y la paciente no presentó más episodios de luxación, con buenos resultados a corto plazo. El score de Harris pasó de 4/80 en el prequirúrgico a 61/80, 73/80 y 76/80 a los 3, 6 y 9 meses del posoperatorio, respectivamente. **Conclusión**: La cementación de un cotilo DM en una copa previamente bien fijada parece una opción viable para tratar y prevenir la inestabilidad después del RTC de revisión.

Palabras clave: doble movilidad, reemplazo total de cadera, luxación recurrente.

Nivel de Evidencia: IV

INTRODUCTION

Total hip replacement (THR) was described as "the operation of the century" in an article published in 2007 by the medical journal *The Lancet*[1] due to its impact on the patient's quality of life. However, this procedure is

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not exempt from possible complications that are difficult to resolve; one of them is prosthetic instability with recurrent dislocations. The incidence of dislocation after primary total hip replacement has been reported from 0.4% to 5.8%, and this rate is even higher after prosthetic revision, from 4% to 30%.[2] Dislocation has become the main reason for revision in the first year after a hip replacement.[3] Several risk factors for dislocation have been recognized, including previous surgeries, tissue damage, advanced age, neuromuscular diseases, cognitive impairment, prior instability, component malpositioning, abnormalities in the abductor apparatus, and rigid lower spine.[4,5] In patients at high risk of recurrent instability, proper management remains controversial. Although large femoral heads or constrained inserts are surgical options to manage this problem, high failure rates have been reported.[6,7]

Dual mobility (DM) cups are useful devices that allow for a large head-to-neck ratio and effective head size that increases jump distance, allowing for a greater range of motion than conventional femoral heads. Several studies have suggested the use of DM components as a tool to prevent the risk of dislocation in revision surgery, with successful results.[8,9] The risk of dislocations is significantly reduced by using a DM cup.[10] The greatest concern about this type of implant was polyethylene wear in the long-term follow-up, but recent studies concluded that polyethylene wear was comparable to standard expectations.[11]

The aim of this case report is to evaluate the short-term results of cementing a DM cup within a previously fixed uncemented cup for the treatment of recurrent dislocation.

CLINICAL CASE

We present the case of a 66-year-old woman with a history of alcoholism, hypertension and failed osteosynthesis with a cephalomedullary nail due to an intertrochanteric fracture of the right hip (AO 31-A3.1), performed in 2017 (Figure 1).

Figure 1. Osteosynthesis failure in hip fracture.

This complication was treated with a cementless total hip replacement with a modular distal fixation prosthesis in 2019 (Figure 2), due to the loss of the fixation area in the proximal femur.

Figure 2. Total cementless hip replacement with modular distal fixation prosthesis.

After this last operation, the patient presented recurrent episodes of prosthetic dislocation from the second postoperative month, a total of 4 episodes, the first 3 treated with closed reduction. In the fourth episode of dislocation, bloodless reduction was not possible (Figure 3), and the joint remained dislocated until the prosthetic revision, which was carried out 9 months after the operation. The preservation of the osseointegrated uncemented cup was verified and a dual mobility cup was cemented in it. In turn, the proximal module of the femoral component was replaced, which gave us the possibility of a greater offset–an advantage linked to the modularity of the stem–preserving the tension, length, and reducibility of the prosthesis.

Figure 3. Irreducible prosthetic dislocation. R: right.

With the first revision, the offset of the contralateral hip was reproduced and a length discrepancy of 4 mm was observed, predominantly in the operated hip. Regarding the acetabular cup, an inclination of 42.5° and an anteversion of 16.7° were found, evidenced by Liaw's method.[12] In addition, no signs of loosening were seen in any of the components (Figure 4). A rigid spine was ruled out by radiography of the lumbosacral spine with the patient standing and sitting, measuring the sacral inclination.

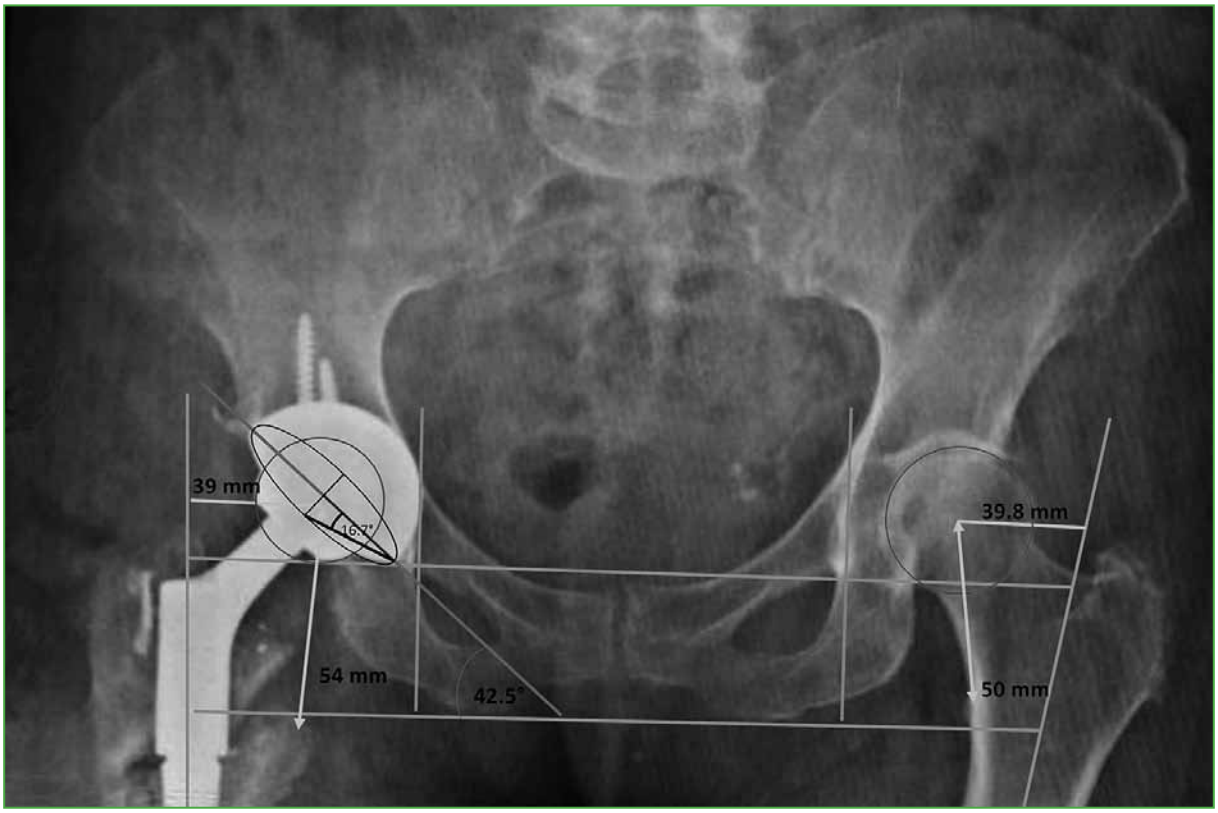

Figure 4. Preoperative radiographic analysis.

Preoperative antibiotic prophylaxis was indicated, in addition to tranexamic acid at the time of anesthetic induction and at wound closure.

With the patient under spinal anesthesia in strict left lateral decubitus, the prosthesis was accessed through a posterolateral approach to the hip and the implant is found to be dislocated. The proximal module of the femoral component was removed to increase the working field. The consolidation of the greater trochanter was confirmed intraoperatively, given that, radiologically, it showed pseudarthrosis. The polyethylene was removed from the acetabular component, verifying the correct orientation and stability of the previously implanted uncemented cup (Figure 5) and the screws were removed from the cup, to use the holes as retentions for cementation. Due to the smooth finish of the internal surface of the retained metal cover, we roughened it with a tungsten carbide bit, which increases the resistance to cemented fixation by up to 20%.[13] To prevent metal debris from remaining in the joint, the area was covered with gauzes and subsequently profusely washed.

Figure 5. Fixed uncemented cup. P proximal, D distal, PO posterior, A anterior.

A 44 mm trial cup is placed (Figure 6). It is verified that its dimensions will allow leaving 2-3 mm for the cement layer, which was previously confirmed in the pre-surgical planning (Figure 7). Cement with antibiotic (gentamicin + vancomycin) was used to reduce the probability of infection.

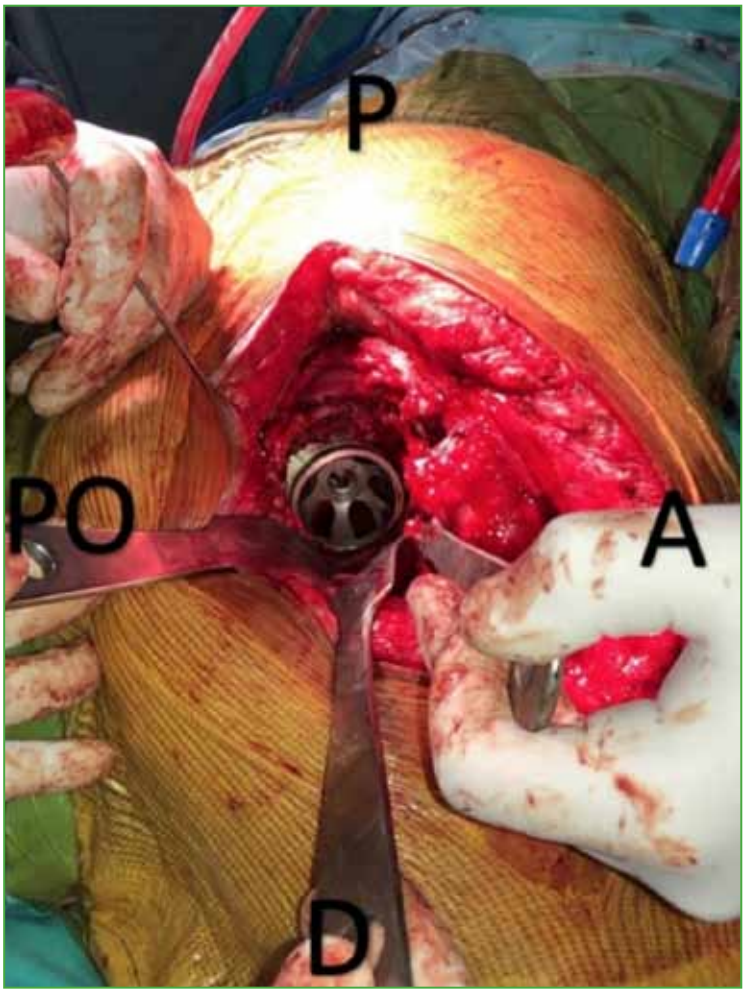

Figure 6. Trial 44mm DM cup.
P proximal, D distal, PO posterior, A anterior.

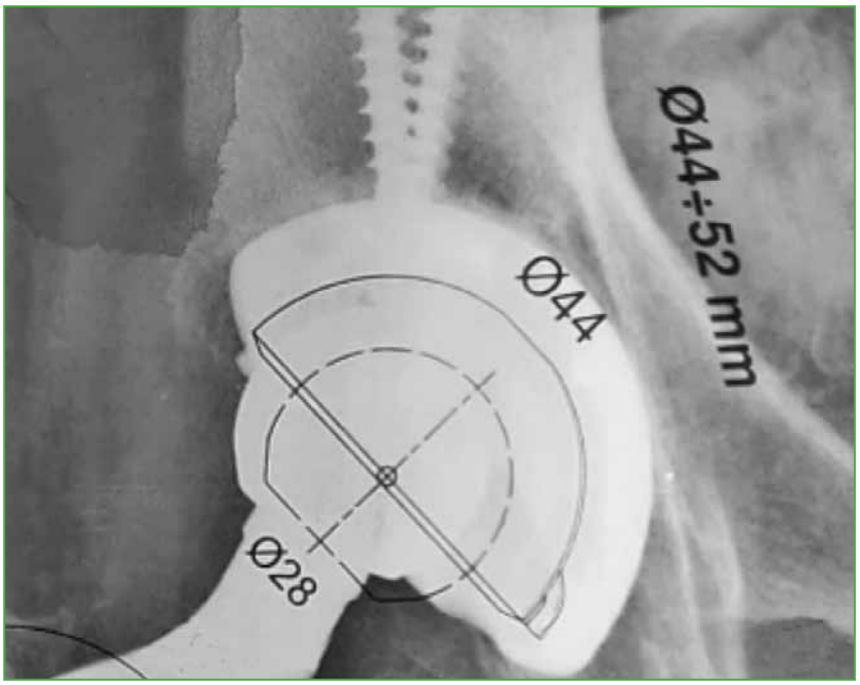

Figure 7. Radiological planning of the cup.

Its advantage is the possibility of cementing with an orientation independent from the pre-existing fixed cup. The dual mobility cemented cup was placed at the desired angle of anteversion and inclination using manual and centralized pressure, with care to prevent the component from touching the bottom of the metal cup, until the cement set.

Then, due to the acetabular extrusion generated with the new cemented component, the proximal femoral module was replaced by one of an immediately inferior length; therefore, the length of the limb was adjusted with the reduction in the size of the proximal femoral modular component and the offset was increased to optimize soft tissue tension.

Before the procedure, the stability of the components was verified by evaluating their fixation using Engh's[14] criteria and it was corroborated intraoperatively. Stability was tested with the trial components by performing flexion, extension, abduction, and rotation maneuvers.

The reduction was performed with the definitive components, the complete stability of the implant was verified. A joint drainage was left for 48 hours and the closure was carried out by planes up to the skin.

Postoperative analgesia began with ropivacaine infiltration of the wound during wound closure and continued with intravenous ketorolac in combination with oral acetaminophen. This multimodal pain management facilitates physical and rehabilitation therapy, which is essential to maintain joint range of motion, thus speeding hospital discharge and reducing the risk of deep vein thrombosis, along with the administration of enoxaparin for 30 days.

In the case described, some details that facilitated its resolution are highlighted: 1- having an osseointegrated cup of adequate size (54 mm), enough to allow the cementation of a dual mobility cup in its smallest diameter (44 mm, which could be found in the country); we were able to corroborate this during pre-surgical planning using the classic method, with real-size printed radiographs and templates of the components to be implanted; 2- preserving the uncemented cup is an advantage, because it maintains the patient's acetabular bone stock; 3- the versatility offered by a modular stem, with which the length of the proximal module could be changed (from one of 60 mm to one of 50 mm) (Figure 8); and 4- having the option of extending the offset to achieve the reduction of the prosthesis and the best tension of the abductor apparatus, without compromising the length of the limb, thus favoring prosthetic stability. Modular femoral revision components allow the surgeon to perform more precise intraoperative adjustments in anteversion and sizing, resulting in lower dislocation rates and improved stability.[15]

Figure 8. Length variability of the proximal component of the femur.

Series	Cervicodiaphyseal angle	Length
120362540	125°	40 mm
120362550	125°	50 mm
120362560	125°	60 mm
120362570	125°	70 mm
120362540	135°	40 mm
120362550	135°	50 mm
120362560	135°	60 mm
120362570	135°	70 mm

Regarding the results, the resolution of the prosthetic instability was achieved, without new episodes of dislocation to date. The patient restarted her rehabilitation with ambulation 48 hours after surgery using two Canadian crutches for 3 weeks, then she walked with a single crutch for another 3 weeks, until she achieved independent ambulation. The revision of the implant was carried out in order to corroborate the preservation of the bone stock and the correct balance of the soft tissues and the length of the affected limb (Figure 9). A 24-month follow-up was carried out and the evolution was evaluated using the modified Harris Hip score : the estimated score was 4/80 (poor result) in the preoperative period, and this changed to 61/80, 73/80 and 76 /80 at 3, 6 and 9 months after surgery, respectively, which is considered an excellent result. Regarding the level of ambulation, the functional outcome showed large changes between the pre- and postoperative evaluations. The patient walks without the need for orthopedic devices and without pain, there is no discrepancy in her limbs and she has not presented new episodes of dislocation.

Figure 9. Immediate post-surgical outcome.

In the post-surgical radiological analysis of the plate, an increase in the horizontal offset was evidenced, which went from 39 mm to 42 mm due to the use of the extended offset . This was determined by the method by Bellova et al.,[16] in which a line is drawn joining the independent centers of rotation of the uncemented cup and the DM cup. Having an independent orientation, the DM cup has a 41.3° inclination, different from the uncemented cup (42.7°), which optimizes the inclination and anteversion. Limb discrepancy was improved to a difference of only 1 mm (Figure 10). In the radiographic evaluation 24 months after the procedure, the complete consolidation of the proximal femur was evidenced and no changes were found in the inclination, anteversion and offset values, nor signs of loosening in the interface between the uncemented cup and the DM cup. Similarly, no signs of loosening were observed in any of the components (Figure 11).

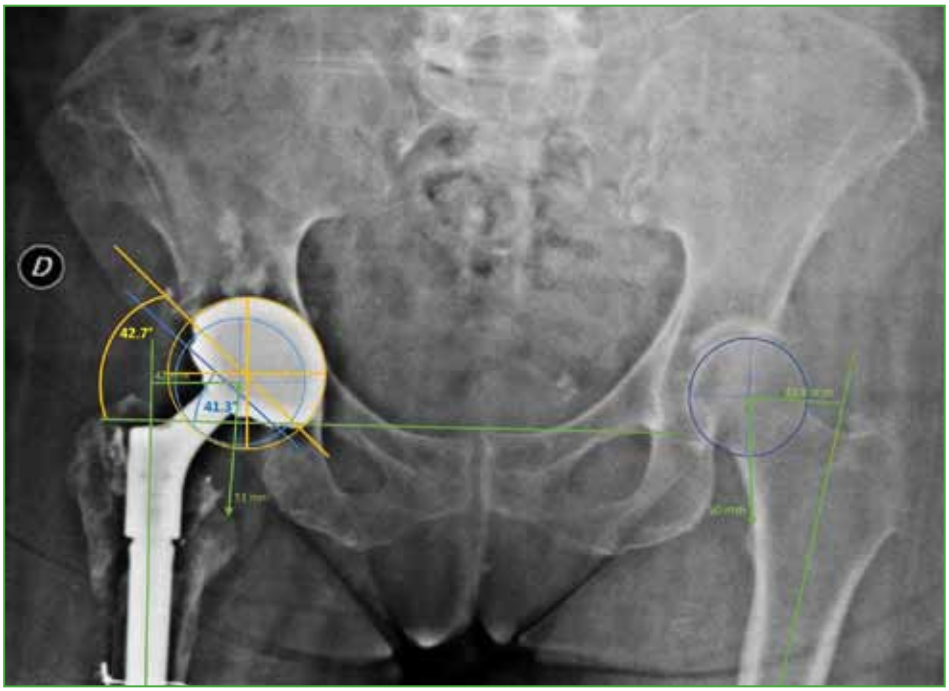

Figure 10. Postoperative radiographic evaluation.

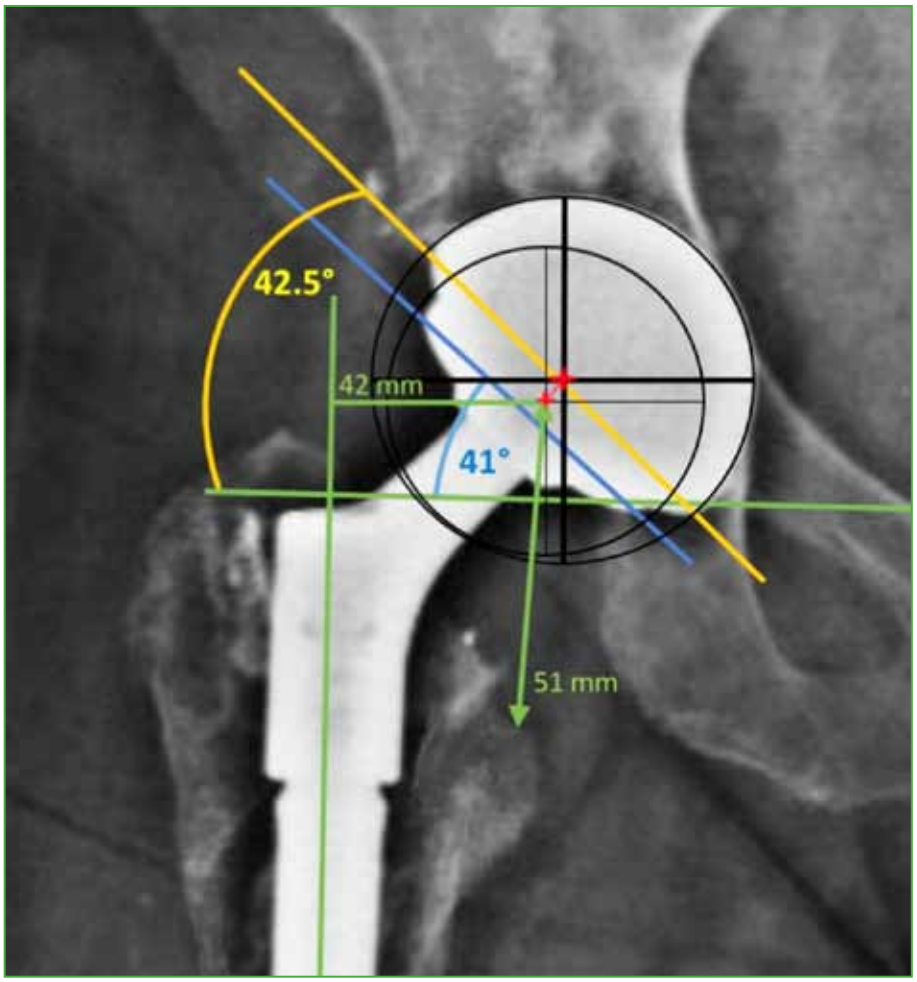

Figure 11. Radiographic evaluation 24 months after surgery.

DISCUSSION

This case report indicates that the technique of cementing a DM cup inside a fixed uncemented cup, or "cup-in-cup" technique, could be an option in cases of recurrent dislocation or high-risk patients, at least in the short term.

This technique has been proposed as an alternative to conventional revision to shorten surgical time. This is because removal of an uncemented metal component can create substantial technical challenges for the surgeon, related to disruption of a secure bone-implant interface and potential bone loss. The preservation of the uncemented cup aims to reduce blood loss, bone damage and general perioperative morbidity, which is essential in patients with high surgical risk.

Wegrzyn et al.[17] first proposed the cementation of a dual mobility cup in a well-fixed metal component with biomechanical validation of this construction. There is growing evidence in the literature of excellent results with DM systems in preventing dislocations and reinterventions after a revision THR, especially after a previously unstable THR.[18]

One of the most critical factors in achieving adequate stability after a primary or revision THR is the position of the components, especially the acetabular cup. Wera et al.[19] found that one of the most frequent etiologies was malposition of the cup and suggested revision of the acetabulum to achieve an adequate position. Rogers et al.[20] reported that stability was successfully achieved in 73% of the patients who underwent revision due to malposition of the acetabular component. In contrast, in patients with unknown causes of dislocation, the success rate was only 33%.

In a series of 355 revision THRs, Hartzler et al.[21] found a dislocation rate of 3% in patients treated with DM implants, compared to 10% in patients treated with a 40-mm femoral head. Furthermore, reoperation for any cause was less frequent in the DM cohort (6%) than in the 40mm femoral head cohort (15%).

Brüggemann et al.[22] reported a lower dislocation rate when using DM cups compared to polyethylene liners cemented in porous tantalum. Dislocation-free survival at 4 years was 99% (only 1 patient had dislocation) in the DM group, while in the polyethylene group, success was only 88%.

Another cause of dislocation is the deficiency of the abductor apparatus. When this mechanism is absent or severely deficient, DM cups may not be effective and the use of a constrained insert is generally recommended.[19]

In hip arthroplasty, revision surgeries have a large increase in morbidity and mortality and a lower success rate than primary surgeries. Recurrent dislocations are a frequent cause of prosthetic revision; in these cases, achieving the least damage, the greatest preservation of bone stock and the fastest recovery of the patient are the measures of success. Knowing the cause of the previous instability greatly facilitates surgical planning; If this information is not available, it is necessary to have a wide range of resolutions at the time of surgery.

On the other hand, it is important to consider that THR after failed internal fixation of the proximal femur is associated with a high risk of implant dislocation.[23] Failure of an extracapsular proximal femoral fracture fixation carries a higher risk of complications than that of an intracapsular fracture, with worse outcomes for salvage THR surgery, especially in terms of implant stability.[24] It is estimated that primary THRs performed as salvage against failed osteosynthesis with a cephalomedullary nail have up to twice as many postoperative dislocations compared to primary THRs (8.1% vs. 4.5%).[25]

The use of DM cups seems to be a good alternative when there is prosthetic instability. In the case presented, the proximal module of the femoral implant was modified; the offset achieved went from 39 mm to 42 mm and the change in the module made it possible to compensate for length. Furthermore, the angle of inclination achieved with the DM cup was 41.3° compared to 42.7° with the uncemented cup. This variation of 1.4° should not be considered influential in reducing the rate of dislocation. Therefore, it could be inferred that, due to its own characteristics, already referred to by other authors, the DM cup is a valid alternative for the management of prosthetic instability.

CONCLUSION

Although the follow-up of the case described is still short, the cementation of a DM cup in a previously well-fixed cup seems to be a viable option to treat and prevent instability after revision THR. In addition, the preservation of the uncemented cup is an advantage for maintaining bone stock and shortening surgical time in high-risk patients.

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Acute Traumatic Avulsion of the Gluteus Medius Muscle in a Patient With no History of Hip Pain: A Case Report

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ABSTRACT
Introduction: We report a clinical case of a woman with a complete acute avulsion of the gluteus medius muscle at its distal insertion in the greater trochanter, with an evolution of fewer than 24 hours from the onset of peritrochanteric pain and in the absence of a clear trigger or documented chronic degenerative wear. Anteroposterior (AP) pelvis and lateral hip radiographs were taken during her evaluation in the emergency department given the suspected diagnosis, with subsequent confirmation of the findings with magnetic resonance imaging (MRI). The patient was treated with a reconstructive surgical technique within the first week of the injury with excellent clinical and functional outcomes. **Conclusion:** Acute traumatic avulsion of the gluteus medius muscle is a pathology with a low incidence, which means that the available evidence to guide its management is scarce. This clinical case is presented with the intention of exposing the clinical and diagnostic approach to this entity and showing a management option with satisfactory results.
Keywords: hip; pain; gluteus; avulsion.
Level of Evidence: IV

Avulsión traumática aguda del músculo glúteo medio en una paciente sin antecedente de dolor de cadera: presentación de un caso

RESUMEN
Introducción: Se presenta el caso clínico de una mujer con avulsión aguda completa del glúteo medio en su inserción distal en el trocánter mayor, con cuadro de evolución menor de 24 horas desde la aparición del dolor peritrocantérico, en ausencia de un claro desencadenante o desgaste crónico degenerativo documentado. En la evaluación por urgencias ante la sospecha diagnóstica, se hace radiografía anteroposterior (AP) de pelvis y lateral de la cadera afectada, con posterior confirmación de hallazgos por resonancia magnética nuclear (RMN). El tratamiento se realiza mediante una técnica quirúrgica reconstructiva dentro de la primera semana de la lesión, con excelentes resultados clínicos y funcionales. **Conclusión:** La avulsión traumática aguda del músculo glúteo medio es una patología con una baja incidencia, lo que hace que la evidencia disponible para guiar su manejo sea escasa. Se presenta este caso clínico con la intención de exponer el abordaje clínico y diagnóstico de esta entidad y mostrar una opción de manejo con resultados satisfactorios.
Palabras clave: cadera; dolor; glúteo; avulsión.
Nivel de Evidencia: IV

INTRODUCTION

Greater trochanteric pain syndrome is an entity characterized by pain in the lateral aspect of the hip. Less commonly, the pain radiates to the thigh and knee, aggravated by walking, climbing stairs, or bearing weight. This syndrome is a common reason for orthopedic consultation, with significant impacts on quality of life, and is more common in women between 40 and 60 years of age.[1] The incidence of this condition in the general population is unknown.[2] Most of these cases present as secondary to chronic degenerative processes and are associated with the presence of trochanteric bursitis, but with recent scientific advances and MRI images, it has been recognized that the avulsion of the tendons of the gluteus medius and gluteus minimus is a common cause of recalcitrant pain in the peritrochanteric region.[3]

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The diagnosis of greater trochanteric pain syndrome is based on clinical suspicion by imaging, initially with an AP pelvis radiograph plus lateral hip radiograph and subsequent confirmation with MRI, which is the gold standard in the evaluation and diagnosis of the pathologies at the level of the hip abductors.[4]

Regarding the treatment of this entity, taking into account that its presentation is usually chronic or associated with other procedures, such as arthroplasty, there are management options that range from conservative measures to surgical techniques, among which we find multiple options: open, arthroscopic, and reconstructive techniques, among others.

The objective of this case report was to highlight the diagnostic and therapeutic approach of a patient with acute avulsion of the gluteus medius who underwent a surgical reconstructive procedure with a gluteus maximus flap, based on the Whiteside technique, with good evolution.

CLINICAL CASE

A 57-year-old woman, stay-at-home wife, with no comorbidities or a history of connective tissue diseases or a family history of musculoskeletal disorders. The patient was admitted to the emergency service due to a clinical picture of 18 hours of evolution of acute pain in the lateral aspect of the right hip.

The patient stated that she was previously in good general condition, without referring to precipitating traumatic events or previous symptoms related to pain in the hip or back. She reported that, when attempting to stand up from a chair, she felt sudden, intense pain over the lateral aspect of her right hip, which worsened with movement, and consequently limited her walking completely.

Physical examination findings revealed normal alignment between the hip, knee, and ankle, with no edema, erythema, or ecchymosis around the hip, tenderness upon palpation, and both active and passive arcs of motion over the peripheral region of the greater trochanter as well as an impossibility for sitting and standing due to the intensity of the pain. The neurovascular evaluation of both lower limbs was normal.

AP pelvis and lateral right hip radiographs were taken, which reported a 6-mm bone fragment adjacent to the greater right trochanter, located in the soft tissues of the lateral aspect of the hip (Figure 1). Given the suspected diagnosis and the fact that the patient persisted with severe pain and limited mobility, magnetic resonance imaging was chosen over computerized axial tomography.

Figure 1. AP radiograph of the right hip.

The MRI indicated a complete rupture of the gluteus medius insertion in its posterior and lateral portion, with a disruption of the fibers that extended towards the anterior portion of the myotendinous junction, with hemorrhagic involvement within the muscle fibers and complete bone avulsion at the insertion site, in the lateral region of the gluteus medius. It is pointed out that the hyperintensity surrounding the left gluteus medius due to tendinopathy and tendinitis must be taken into account versus the associated partial injury, which must be correlated with the mechanism of trauma (Figure 2).

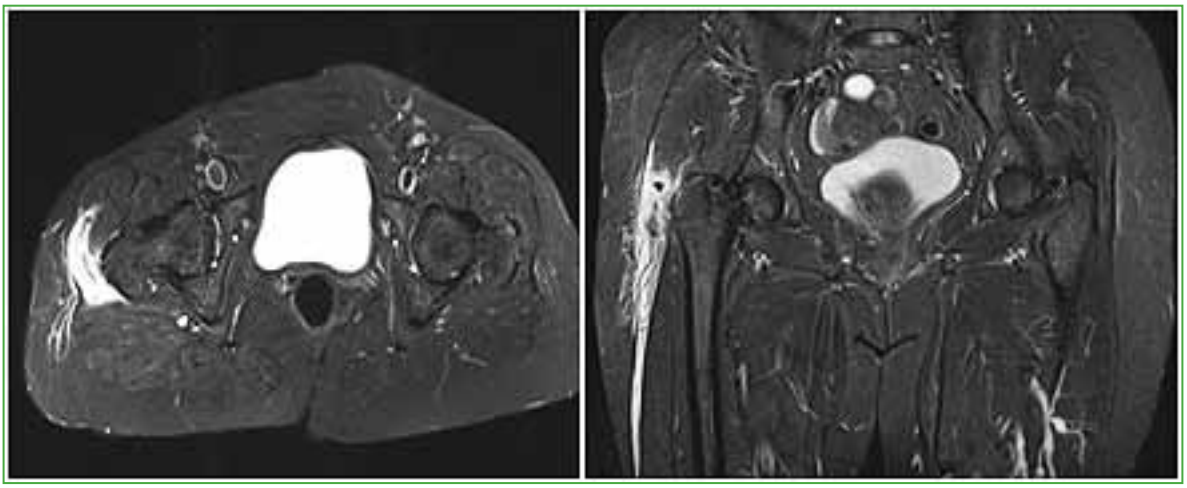

Figure 2. MRI, axial and coronal slices of the lesion.

The patient was taken to surgery and, after intraoperative evaluation, it was found that primary repair was not appropriate due to the fibrillar characteristic of the lesion. A reconstructive surgical procedure based on the Whiteside technique was then performed. A posterior approach to the hip was used, the gluteus maximus was divided into its medial muscle portion and fascia lata, then a flap of the posterior portion of the muscle was raised proximally to create a triangular muscle flap. The flap was then advanced over the femoral neck into the gap between the greater trochanter and the lateral cortex of the femur and attached to the inner surface of the anterior capsule. The vastus lateralis muscle was sutured to the distal fibrous portion of the gluteus maximus, and, with the hip abducted from 10º to 15º, the edges of the gluteus maximus were closed over the flap and the greater trochanter (Figure 3).

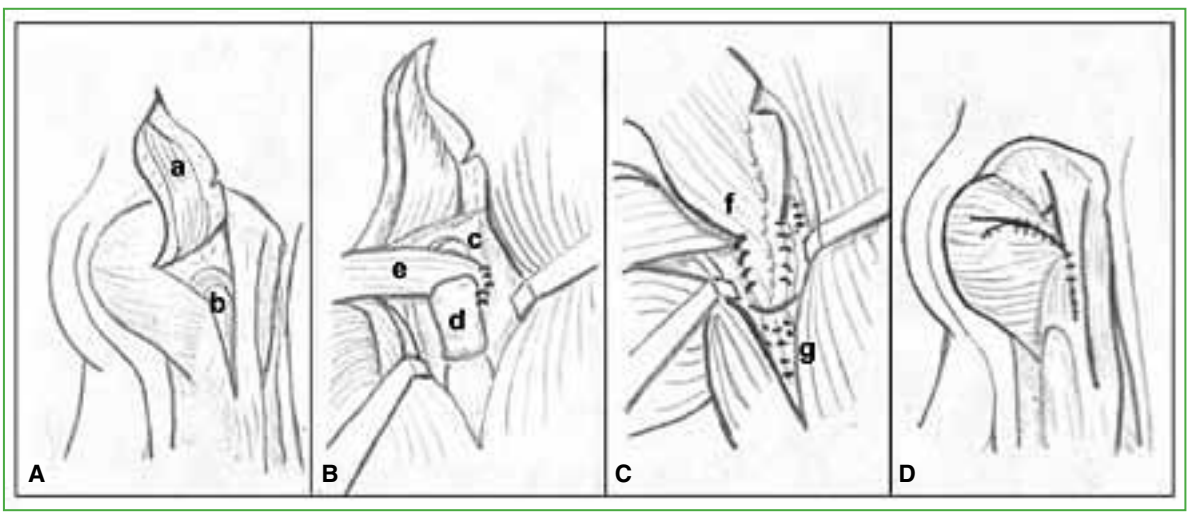

Figure 3. Scheme of the surgical technique. **A.** Posterior approach with the division of the gluteus maximus (a) until exposure of the femoral head (b). **B.** The triangular flap over the femoral neck (c) is sutured to the anterior capsule and greater trochanter (d). The posterior portion of the gluteus maximus is visualized (e). **C.** Anterior gluteus maximus suture (f) and vastus lateralis suture (g). **D.** Approach closure.
Adapted from Whiteside LA. Surgical technique: Transfer of the anterior portion of the gluteus maximus muscle for abductor deficiency of the hip. *Clin Orthop Relat Res*. 2012;470(2):503-510. https://doi.org/10.1007/s11999-011-1975-y

At follow-up, the patient had an adequate postoperative period, had no problems with the surgical wound, and achieved good pain control. The patient presented a satisfactory evolution, initially, she walked with external aids until she could completely do without them. At the 6-month control, a good clinical evolution was documented. The patient reported that she had occasional pain that did not require the use of analgesics. She did not have any limitations in her activities of daily living, the limp is minimal, she did not present Trendelenburg gait and her Harris hip score (HHS) was 89.95. She had hip motion arcs of 110º of flexion, full extension, adduction of 20º, abduction of 15º, external rotation of 30º, and internal rotation of 15º, with the last control MRI showing no recurrent lesions (Figure 4).

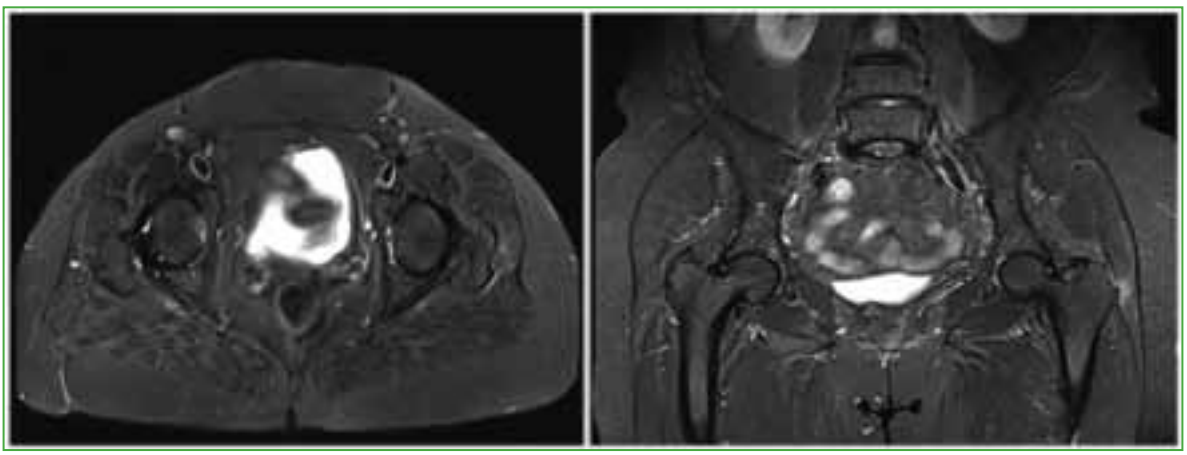

Figure 4. Axial and coronal section of NMR control.

DISCUSSION

The avulsion of the gluteus medius and gluteus minimus tendons was described by Bunker et al. and by Kagan in the late 1990s, both of whom independently coined the expression "rotator cuff tear of the hip", making the analogy with the supraspinatus and infraspinatus at the shoulder.[5,6] Although in clinical practice it can be difficult to recognize at the time of diagnosis, it usually presents with pain in the lateral aspect of the hip and, depending on the size of the lesion, is accompanied by a Trendelenburg gait, sensitivity to palpation of the affected region and limitation in abduction when evaluating ranges of motion.[7]

The acute presentation of these avulsions is rare and the exact etiology is still unknown.[8] In the literature reviewed, two cases of acute traumatic avulsions were found, both in patients older than 70 years, with satisfactory responses after surgical management, in the case of Godshaw et al.,[8] using the open technique and in the report by Stanton et al.,[9] with an arthroscopic approach. In the literature search, no cases with evolution of pain in fewer than 24 hours were found.

As a diagnostic tool, conventional radiography may initially reveal intratendinous calcifications, bursa calcifications, or enthesopathies, although these pathological changes are not detectable in most patients.[10] MRI is the gold standard for diagnosis. It allows visualizing the tendon thickening; in addition, the increase in signal strength in the T2 sequence may indicate a partial thickness tear. As for findings regarding complete tear, it is possible to observe the discontinuity of tendon fibers, both in the presence or absence of muscle retraction or atrophy.[11]

The identification of an area of hyperintensity in the T2 sequence over the superior region of the greater trochanter is the finding with the greatest sensitivity and specificity: 73% and 95%, respectively. Other direct signs of injury to the gluteus medius or minimus tendons have also been described, including edema surrounding the soft tissues, intrasubstance signal abnormality, and other indirect signs, such as submedian or subminimal bursitis and peripheral fat atrophy.[11]

Within the spectrum of greater trochanteric pain syndrome, when it is secondary to trochanteric bursitis or tendinopathy, initial management is conservative, including local measures, rest, physical therapy, and nonsteroidal anti-inflammatory drugs; when there is no clinical response, management with injectable corticosteroids can be considered, with effectiveness rates that vary between 72 and 75% in pain improvement within the first month of applying the medication.[12] In case of failure with conservative treatment or if the underlying cause is an avulsion in one of the abductor muscles of the hip, such as the gluteus medius, surgical management is performed, which includes open, reconstructive, and arthroscopic repair techniques, as well as transosseous fixations, possible augmentations, and even the use of autografts and allografts.[13]

The surgical management of this case was carried out following the technique described by Whiteside,[14] which seeks to restore the effective abduction of the hip by transferring a gluteus maximus flap, anchored to the greater trochanter with supersutures using transosseous tunnels. In the case series described by Whiteside, 9 of the 11 patients in whom this surgical procedure was performed had strong abduction of the hip against gravity, negative Trendelenburg sign, and no abductor lurch in the postoperative period, which are promising results for future studies.

In a systematic review, Chandrasekaran et al. compared the open repair technique with the arthroscopic one, and reported no differences in terms of outcomes, pain, or abduction strength.[15] In two recent publications, one by Thaunat et al. in 2021[16] and another by Nazal et al. in 2020,[17] excellent functional outcomes were reported using the arthroscopic approach.

Regarding the surgical approach, in Chicago, Illinois, Maldonado et al. repaired complete avulsions of the gluteus medius in 18 patients using a combined transfer technique of the gluteus maximus and tensor fasciae latae, with improvement in short-term follow-up, mainly on the visual analog scale of pain and on the modified Harris scale for the evaluation of the hip joint,[18] a scale developed to assess the results of hip surgeries taking into account items such as pain, gait, walking distance , the need for support, and functionality.[19] In the literature reviewed, no significant differences were found between the various surgical techniques regarding major outcomes that generate increased morbidity and a negative impact on quality of life.

In the postoperative period of both open and arthroscopic techniques, rehabilitation generally starts with low weight-bearing protected by crutches or no weight-bearing at all for the first 6 weeks, and is then followed by gradual weight-bearing, exercises, and progressive physical therapy.[20]

CONCLUSION

Acute traumatic avulsion of the gluteus medius muscle is a pathology with a low incidence, which means that the available evidence to guide its management is scarce. This clinical case is presented with the intention of exposing the clinical and diagnostic approach to this entity and showing a management option with satisfactory results.

Ethical considerations

The authors requested consent from the hospital research committee for data collection and treatment. In 2016, three of the authors of this manuscript presented only the clinical case as a poster at the 12th Latin American Meeting of Hip and Knee Surgeons. The manuscript is prepared for publication in this scientific journal.

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

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Preoperative Patient Optimization Before Hip or Knee Arthroplasty: Part 1

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ABSTRACT

Hip and knee arthroplasties are well-known effective strategies for joint osteoarthritis. Joint replacement reliably improves the quality of life for most patients when conservative measures have failed. However, these are major surgeries that carry significant risks, including the need for revision surgery. The purpose of this article is to discuss the preoperative risk parameters of the patient that can be modified before joint replacement to decrease complication risks. Recent studies have described several modifiable factors that increase the risk of postoperative complications following hip and knee replacement. These include obesity, malnutrition, tobacco use, diabetes, anemia, vitamin D deficiency, opioid use, inflammatory arthropathy, chronic kidney insufficiency, and methicillin-resistant staphylococci colonization. If we achieve preoperative optimization of these conditions, we can minimize the risk of adverse outcomes.

Keywords: Optimization - Joint replacement - Hip and Knee Arthroplasty
Level of Evidence: IV

Optimización preoperatoria del paciente antes de una artroplastia de cadera o rodilla: parte 1

RESUMEN

Las artroplastias de cadera y rodilla son estrategias que han demostrado ser efectivas en el tratamiento de la patología degenerativa articular. El reemplazo articular mejora la calidad de vida de la mayoría de los pacientes cuando el tratamiento conservador falla. Sin embargo, estas son cirugías mayores que conllevan un riesgo significativo de complicaciones, incluyendo la necesidad de una revisión. El propósito de este artículo es analizar los factores de riesgo modificables del paciente antes de la cirugía, a fin de disminuir el riesgo de complicaciones posoperatorias. Estudios recientes han descripto ciertos factores de riesgo modificables, inherentes al paciente y que incrementan la posibilidad de complicaciones posoperatorias luego de un reemplazo articular de cadera o rodilla. Estos incluyen obesidad, malnutrición, tabaquismo, diabetes, anemia, deficiencia de vitamina D, consumo de opioides, artropatías inflamatorias, insuficiencia renal crónica y colonización por estafilococo meticilino-resistente. Si conseguimos optimizar estas condiciones durante el preoperatorio, reduciremos el riesgo de complicaciones posoperatorias.

Palabras Clave: Optimización - Reemplazo articular - Artroplastia de cadera o rodilla
Nivel de Evidencia: IV

INTRODUCTION

Hip and knee joint replacements have proven to be effective treatments for advanced degenerative joint pathology; multiple studies have reported good long-term results.[1,2] A study conducted in the USA estimated that by 2030, the number of hip and knee arthroplasties will increase by 174% and 673%, respectively.[3]

Despite their success, we must understand that these are major surgeries that carry the possibility of early complications, such as infections, dislocation, loosening, deep vein thrombosis (DVT), fractures, and even death.[4]

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Regarding the latter, multiple studies have investigated the medium- and long-term mortality rate after joint replacement, and it has been estimated at up to 18%.[5]

Authors such as Sinclair et al.[6] maintain that the most critical time to assess mortality is the first 30 days after surgery, since in this period the bias of deaths from causes unrelated to arthroplasty decreases.

Recent studies have reported that there are modifiable risk factors that can increase the appearance of this type of complication. These include conditions such as obesity, malnutrition, smoking, diabetes, anemia, vitamin D deficiency, opioid use, inflammatory arthropathies, chronic renal failure (CRF) and colonization by methicillin-resistant staphylococcus (MRSA), among the most relevant.[7-9]

The purpose of this update is to analyze these modifiable factors associated with increased complications and to recommend some strategies to optimize the condition of patients before surgery. The first five factors are discussed below.

Obesity

The World Health Organization (WHO) defines this concept as a body mass index greater than 30 kg/m^2. In Argentina, 6 out of 10 adults and 30% of children suffer from obesity. This leads to an increased risk of suffering from disorders such as diabetes, high blood pressure (HBP), respiratory, kidney and liver diseases, and even immunosuppression.[10]

In addition, there is recent evidence that obesity increases the probability of requiring a hip or knee joint replacement in comparison to the population that does not suffer from this condition, given the joint overload that it generates on the aforementioned joints.[11]

Recently published systematic reviews found that in patients undergoing arthroplasty, obesity was associated with increased rates of superficial and deep infections, dislocations, reoperations, and readmissions, when compared to non-obese patients.[12,13] The technical difficulties in surgery are also described, which sometimes lead to defective cementation. They can also predispose to poor component placement and orientation, which could lead to early loosening and instability.[14]

In these patients, the association of diabetes and insulin resistance is not uncommon, with the consequent increase in the rate of infection.

Currently, the recommendation of the American Academy of Orthopedic Surgeons (AAOS) is to avoid hip or knee joint replacement in patients with a BMI >40 mg/kg^2.[15] Although there is no established BMI value to carry out this type of surgery, the ideal is for it to be <35 mg/kg^2.

We believe that these patients should be evaluated by a dietitian, an endocrinologist and, eventually, by a bariatric surgery team to determine if they can undergo this treatment. In addition, we recommend stationary cycling, swimming, and water exercises to help with physical activity.

Malnutrition

Malnutrition is another modifiable factor inherent to the patient that we must consider before performing an arthroplasty. In different reports, this condition has been associated with an increased risk of developing periprosthetic infections (PPI) and wound disorders (dehiscence, inflammation, etc.), as a consequence of a lower supply of collagen and fibroblastic proliferation.[16] Although there is no consensus in this regard, most authors agree that malnutrition can be defined based on the following criteria:

- serum albumin levels <3.5 g/dl[17]
- serum transferrin levels <200 mg/dl[18]
- total blood lymphocyte count <1500[19]

There are other anthropometric indicators, such as the circumference of the arm or leg; however, these are not very sensitive to acute deficits, since visible changes may take weeks to appear.[16]

With a basic blood test, we can get a picture of the patient's nutritional profile before surgery and, if necessary, refer them to a specialist.

Special care must be taken with patients who have undergone bariatric surgery with abrupt weight loss, since, despite presenting an apparently normal nutritional phenotype, they may present a deficient nutritional condition, which is why they should be adequately studied.[20]

Elderly patients who are eligible to undergo hip joint replacement due to fracture should also be studied for this condition and the possibility of adding dietary supplements to improve this situation should be evaluated.

Tobacco use

Tobacco use represents an epidemic that causes the death of more than 40,000 Argentines a year. Data from the Ministry of Health of the Province of Buenos Aires reported that the estimated prevalence of cigarette consumption in the population during 2021 was 23.1%.[21]

This is one of the most analyzed modifiable factors in the literature referring to elective arthroplasty of the hip or knee. Nicotine produces peripheral vasoconstriction, which generates tissue hypoxia. This condition has been associated with an increased risk of wound complications, PPIs, lower respiratory tract infections, myocardial infarction, and even an increased mortality rate.[22-25]

Some randomized studies have shown that quitting smoking 6 to 8 weeks before surgery reduces the rate of complications after hip or knee replacement by up to 65%.[26] It has been reported that, even if smoking cessation occurs up to 4 weeks before surgery, a reduction in complications of up to 20% is achieved compared to patients who continued smoking before the procedure. This should be accompanied by a two-week post-surgery suspension after the healing of the tissue The intervention (at least temporary) of quitting the smoking habit should be a recommendation in the previous interview with the patient; however, today smoking is not a contraindication.[27] It is important to inform the patient of the risk that this condition generates when undergoing this type of surgery. Prior evaluation by a pulmonologist and the use of nicotine patches can help to stop smoking during the perioperative period.

Diabetes

The last *Encuesta Nacional de Factores de Riesgo* (ENFR, in Spanish) [National Survey of Risk Factors] carried out in 2018 in our country registered that 12.7% of the population of Argentina suffers from diabetes. If we exclusively consider the Autonomous City of Buenos Aires, this percentage is represented by 8.8%.[28]

Patients with diabetes who plan to undergo hip or knee arthroplasty are at increased risk of both joint-related complications and systemic adverse events; perhaps the most studied is periprosthetic infection. There is evidence that diabetes can increase the risk of developing PPI by 1.74 times.[29] In addition, it has also been associated with worse postoperative functional outcomes.[30,31] In addition to the complications inherent to surgery, patients with diabetes are more likely to have strokes, heart failure, and peripheral vascular disease.[32,33] A diagnosis of diabetes can be reached by meeting one of the following criteria:

- Glycosylated hemoglobin (HbA1c) >6.5% (it is a marker of adherence to treatment in the last three months)
- Fasting blood glucose >126 mg/dl
- Serum glucose > 200 mg/dl

Any value above these cut-off points should be enough to at least defer the procedure. We are aware that glycemic control can sometimes be difficult, which is why a multidisciplinary approach is the most recommended strategy to establish the appropriate hygienic-dietary measures, as well as pharmacological measures, if required by the patient.

Anemia

The WHO defines anemia as a decrease in blood iron below 12 g/dl in women and 13 g/dl in men; this is a very common condition in the population.[34]

According to some reports, anemia affects almost 25% of the world's population. A study by Marin et al. reported that the prevalence in Argentina is around 26.3%.[35] Although the use of tranexamic acid has substantially changed the number of transfusions, hip and knee replacements are surgeries that involve considerable blood loss.[36] It has been estimated that between 15% and 30% of patients undergoing elective arthroplasty have anemia in preoperative controls.[37] In a recent study by Bailey et al., 5384 primary hip and knee arthroplasties were analyzed, and it was observed that 17% of the patients included presented preoperative values corresponding to anemia.[38] In these patients, the risk of requiring transfusions increased by 4.09 times, the risk of suffering postoperative complications increased by 1.42 times, and that of having a longer hospitalization increased by

19%. On the other hand, this condition has also been associated with a higher risk of developing periprosthetic infections, heart disease and even death.[39,40] In anemic patients, it is advisable to evaluate the possibility of starting iron supplementation before surgery.[41] When oral intake fails to correct serum hemoglobin values or when it is not possible to defer surgery, parenteral iron administration has also been shown to be a safe and effective strategy.[42]

FINAL CONSIDERATIONS

The five clinical conditions analyzed can be improved preoperatively, in order to reduce the risk of complications in our patients. When indicating hip or knee arthroplasties, it is the surgeon's responsibility to know and take these situations into account.

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Total Hip Replacement in Patients With Previous Osteosynthesis

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ABSTRACT

There is abundant literature on the clinical and radiographic outcomes of a complex primary total hip arthroplasty after osteosynthesis conversion. Most of these reports refer to conversion from an intramedullary nail or femoral plate and screws (due to a previous fracture or osteotomy) to THA with a distal fixation stem. That said, the objective of this report is to make a technical note on performing a complex primary THA without removal or with partial removal of a previous screw plate using primary implants.

Keywords: hip; total hip replacement; osteosynthesis removal

Level of Evidence: IV

Reemplazo total de cadera en pacientes con osteosíntesis previa

RESUMEN

Existe literatura abundante sobre los resultados clínicos y radiográficos de un reemplazo total de cadera (RTC) primario complejo tras una conversión de osteosíntesis. La mayoría de esos reportes se refieren a la conversión de un clavo endomedular o una placa con tornillos femoral (debido a una fractura u osteotomía previa) en un RTC con un tallo de fijación distal. El objetivo de esta nota técnica es describir la realización de RTC primarios complejos sin el retiro de una placa con tornillos preexistente, o con su retiro parcial, utilizando implantes primarios.

Palabras clave: Cadera; Reemplazo total de cadera; Retiro de osteosíntesis

Nivel de Evidencia: IV

INTRODUCTION

Primary total hip replacement (THR) in patients with hip osteoarthritis has shown excellent long-term outcomes in reducing pain and improving function and quality of life.[1] However, there are patients who, due to a history of trauma, developmental dysplasia of the hip or femoral deformity, present complex reconstructive scenarios due to the existence of plates with femoral screws that obliterate the intramedullary canal, or deform the metaphyseal-diaphyseal region of the femur.[2] In this population, THR has failure rates of 14% to 30% at 10 years and 60% after 15 years, when conversion to primary THR is often necessary.[3-7]

Performing a primary THR in patients with a previous osteosynthesis in the proximal femur presents a complex situation for the surgeon. The use of a versatile approach is of utmost importance, which allows locating and taking into account the anatomical structures that may have lost their topographical references with previous surgeries. The total or partial removal of the material from a previously performed osteosynthesis generates areas of weakness and changes in the modulus of elasticity of the femur, which increase the risk of intraoperative femoral fractures.[8-10] Likewise, it is common to find deformities of the proximal femur that make it difficult to correctly position the prosthetic components. These scenarios usually warrant the use of revision femoral stems, including distal fixation stems, megaprostheses, or combined metaphyseal-diaphyseal fixation stems. In

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patients with a large amount of osteosynthesis material, its removal can make the remaining bone quality incompatible with a THR in the same surgical stage, which is why some surgeons choose to perform the procedure in two stages.

The objective of this technical note is to describe a surgical alternative to avoid the total or partial removal of previous implants and the need to use revision stems in cases of complex primary THR in a femur previously treated with a plate and screw.

Case 1 (Video 0:16-0:49)

The case of a 78-year-old male patient is shown, with a history of osteotomy of the right proximal femur in 1974, who consulted for limiting right groin pain. Radiographically, Tönnis 3[11] osteoarthritis with translational metaphyseal deformity[2] and presence of osteosynthesis is evidenced. After careful pre-surgical planning and taking into account the pre-existing osteosynthesis, the patient was proposed a resurfacing arthroplasty without the need to remove the previous implant.

Technical consideration

The patient is placed in the supine position on a traction table and, under fluoroscopic guidance following the technique described by Bolanos et al.,[12] a guide pin is inserted percutaneously in the axis of the femoral neck and through the joint surface about 2 or 3 mm. Subsequently, the patient is repositioned in lateral decubitus and, through a posterolateral approach, the hip is dislocated, exposing the guide pin. With a cannulated drill bit on the pin, the drilling is performed, creating an orifice for the fixation stem of the femoral component. This is then followed by the conventional technical steps for resurfacing.[13]

Postoperative outcome

Twelve years after the procedure, the patient is pain-free, walks unaided with a slight limp, and has a Merle D'Aubigne & Postel (MDA) score of 16 points.[14]

Case 2 (Video 0:50-1:57)

A 51-year-old female patient with a history of a varus osteotomy of the right femur at the age of 46, with a dynamic condylar screw. She consulted for coxalgia that prevented her from performing her daily activities. Radiographically, Tönnis 3 osteoarthritis and previous osteosynthesis are evident. A short-stem THR is proposed, partially preserving the plate with screws.

Technical consideration

Using a posterolateral approach, the femoral dislocation is performed; next, the cervical and femoral head osteotomy is performed to expose the dynamic screw of the pre-existing osteosynthesis. It is removed in an antegrade manner, allowing the femoral canal to be identified. Following the preoperative planning, the 2 most proximal screws of the plate are removed to allow for the placement of the programmed stem. After canal preparation with progressive rasps, the final femoral component is implanted. The implantation of the acetabular component does not present differences from the conventional technique.

Postoperative outcome

Five years after the procedure, the patient walks unaided and without pain, with an MDA score of 18 points.

Case 3 (Video 1:58-3:56)

This is a 48-year-old female patient who consulted for left coxalgia, with a history of diaphyseal fracture of the left femur that occurred 20 years earlier and was treated with reduction and osteosynthesis using a nail-plate with screws. She had Tönnis 3 osteoarthritis. A THR with a short stem prosthesis with partial preservation of the previously placed plate is proposed as treatment.

Technical consideration

As in the cases described, the existing osteosynthesis in this patient obstructed the femoral canal and prevented the placement of a conventional femoral stem. In order to avoid the complete removal of the implant, partial removal was chosen. In this case, as it was a non-modular nail plate (without the possibility of removing

the cephalic fixation by decoupling), it was necessary to use a high-speed saw with a small-diameter diamond blade to cut metal precisely and with less damage to the adjacent tissue. After extracting the osteosynthesis, the cervical-diaphyseal region was prepared for the insertion of the short stem, following the conventional technique.

Postoperative outcome

Two years after the procedure, the patient has no pain and walks unaided without functional limitations.

Case 4 (Video 3:57-4:12)

This is the case of an 82-year-old woman with a history of left subtrochanteric fracture treated with a dynamic condylar screw 15 years earlier, with advanced coxarthrosis of the left hip and a secondary varus deformity, with its respective shortening. Due to her functional limitation, a THR with partial withdrawal of the osteosynthesis was indicated.

Technical consideration

Taking into account the patient's age, osteopenia of the proximal femur, and varus deformity, a cemented femoral stem was chosen. As in the patient in case 2, partial removal of the pre-existing osteosynthesis was carried out, performing the extraction of the dynamic screw in an antegrade manner. The use of cemented stems in patients with angular deformities allows their correction with a greater degree of freedom and technical ease, which helps to avoid the occurrence of an intraoperative calcar fracture.

Postoperative outcome

One year after the procedure, the patient walks unaided, with a slight limp, and without pain, with an MDA score of 16 points.

Final considerations

The presence of osteosynthesis material in the proximal femur when performing a THR represents a technical challenge for the surgeon. If a femoral implant is removed in its entirety, the last screw of said implant must be bridged with at least 2 cortical diameters of the width of the native femur.[10] Taking this into account, not all previous implants need to be completely removed. Some can be partially or fully maintained and function as internal tutors, avoiding the need for revision implants.

Preoperative planning is a crucial step in these scenarios, allowing the correct selection of the implant. Surface arthroplasty could be an indication in these cases, especially in those with translational metaphyseal deformities. However, some translational metaphyseal deformities may require corrective osteotomies for proper component orientation when metaphyseal fixation femoral implants are used. Short uncemented stems can accommodate angular varus deformities due to their curved geometry. However, in cases of severe osteopenia, the selection of a cemented stem makes it possible to minimize the risk of intraoperative fracture of the femur. It is essential to know that, in all the cases described, the surgeon always had a plan B with conventional stems (cemented or not) and distal fixation stems, since, on certain occasions, the initial plan cannot be carried out.

CONCLUSION

It is possible to perform total hip replacements in patients who have already undergone osteosynthesis without the need to completely remove the pre-existing osteosynthesis material or resort to revision implants. Proper identification of deformities and careful preoperative planning allow the use of primary implants, whether they are surface implants, short uncemented stems, or conventional cemented stems.

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Scores IV

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ABSTRACT
The Editorial Committee wants to provide its readers with an update on the 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 have 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.
Keywords: Scales; scores; tables; update.
Level of Evidence: V

Puntajes IV

RESUMEN
El Comité Editorial quiere brindar a los lectores de la RAAOT 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, definimos su uso e incluimos 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 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 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 hip and knee scores.

HIP

HARRIS SCALE (MODIFIED)

The Harris scale was introduced in 1969 to assess traumatic hip pathology based on four variables: pain, function, deformity, and range of motion. They receive different scores. Values below 70 points are poor results, values from 70 to 79 are regular, values from 80 to 89 are good, and those from 90 to 100 are excellent.

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Table. HARRIS SCALE (Modified)

1. Pain	None	40
	Mild or occasional	35
	Moderate	20
	Severe	0
2. Function - Distance walked	10 blocks or more	15
	6 blocks	12
	1-3 blocks	7
	Less than 1 block	2
	Unable to walk	0
3. Function - Support	None	5
	Cane occasionally	4
	Cane or crutch always	3
	Two canes or crutches	2
	Walker	1
	Unable to walk	0
4. Mobility and muscle power. Ability to move in a vehicle	Without difficulty	5
	With difficulty	3
	Unable	0
5. Foot care. Washing, drying	Without difficulty	5
	With difficulty	3
	Unable	0
6. Claudication	None	5
	Mild	3
	Severe	0
7. Climbing stairs	Normally	5
	Using a handrail	4
	Step by step	2
	Unable	0

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MODIFIED MERLE D'AUBIGNÉ AND POSTEL

The scale developed by R. Merle d'Aubigné and M. Postel was first described in 1954 in the paper "Functional Results of Hip Arthroplasty with Acrylic Prosthesis", published in the prestigious *Journal of Bone and Joint Surgery*. In response to the need to assess the pre- and postoperative functional outcomes of patients undergoing hip surgery, the authors devised this scale that took into consideration pain, walking ability, and joint range of motion. These categories are rated with scores from 0 to 6, as described in the following table. By adding the score obtained in each of these categories, a global value between 0 and 18 is obtained, in which 0 is the worst possible score and 18 is the ideal in terms of functionality.

The results obtained on this scale are very useful when comparing pre- and postoperative values, since they allow the results to be objectified. Due to its simplicity and practicality, this scale is one of the most accepted and is widely used by hip surgeons around the world as a method of measuring the functional outcomes of their patients.

Score	Pain	Range of motion	Walking ability
0	Severe and permanent pain	Ankylosis in abnormal position	Impossible
1	Severe pain, disturbs sleep	Ankylosis in normal or slightly abnormal position	Only with crutches
2	Severe pain when walking, prevents doing any activity	Flexion <40° (Abduction 0°) or mild joint deformity	Only with 2 canes
3	Severe but tolerable pain, limited activity	Flexion <40°- 60°	Limited, with one cane (less than 1 hour). Very difficult without a cane.
4	Pain only after walking, disappears with rest	Flexion >60°-80° (manages to tie shoelaces)	Prolonged with a cane; limited without a cane (limp)
5	Little and intermittent pain, does not limit daily activity	Flexion > 80°- 90°. Limited abduction (25°)	Without a cane, but with a limp
6	No pain at all	Normal. Flexion >90°, Abduction <25°	Normal

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KNEE

KSS (Knee Society Score)

Developed in 1989 by the American Knee Society (AKS), it is the most widely used scale for joint replacements. Modified by Insall, it consists of two parts. The first part includes pain, flexion and extension contracture, range of motion, alignment and stability. The second part assesses walking, stair climbing, and the use of canes. This scale includes two evaluations, one pre-surgical and the other post-surgical. Scores below 60 are considered poor; between 60 and 69, fair; between 70 and 79, good; and between 80 and 100, excellent.

PART 1	
Pain	None
	Occasional
	When climbing stairs
	When walking and climbing stairs
	Moderate - occasional
	Moderate - continual
	Severe
Flexion contracture	None
	5 to 10
	10 to 15
	16 to 20
	More than 20
Extension lag	None
	Less than 10
	10 to 20
	More than 20
Range of motion	
Alignment (Varus - Valgus)	
Anteroposterior stability	Less than 5mm
	5 to 10mm
	More than 10mm
Mediolateral stability	Less than 5
	From 6 to 9
	From 10 to 14
	More than 15
PART 2	
Walking	Unlimited
	More than 10 blocks
	5 to 10 blocks
	Less than 5 blocks
	Housebound
	Unable
Climbing stairs	Normal up and down
	Normal up, down with handrail
	Up and down with handrail
	Up with handrail, down unable
	Unable to go up and down
Walking aids	None used
	Cane
	Two canes
	Walker

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Case Resolution

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Case presentation on page 616.

DIAGNOSIS: Vastus medialis obliquus agenesis.

The gold standard study is nuclear magnetic resonance, which reported a complete absence of the vastus medialis obliquus muscle (VMO) and a presumptive diagnosis of complete agenesis of this muscle in axial, sagittal, and coronal slices in the T1 and T2 sequences (Figures 4 to 8). Coronal slices at different comparative heights of both thighs in the region of the distal middle third. (Figures 5 to 8).

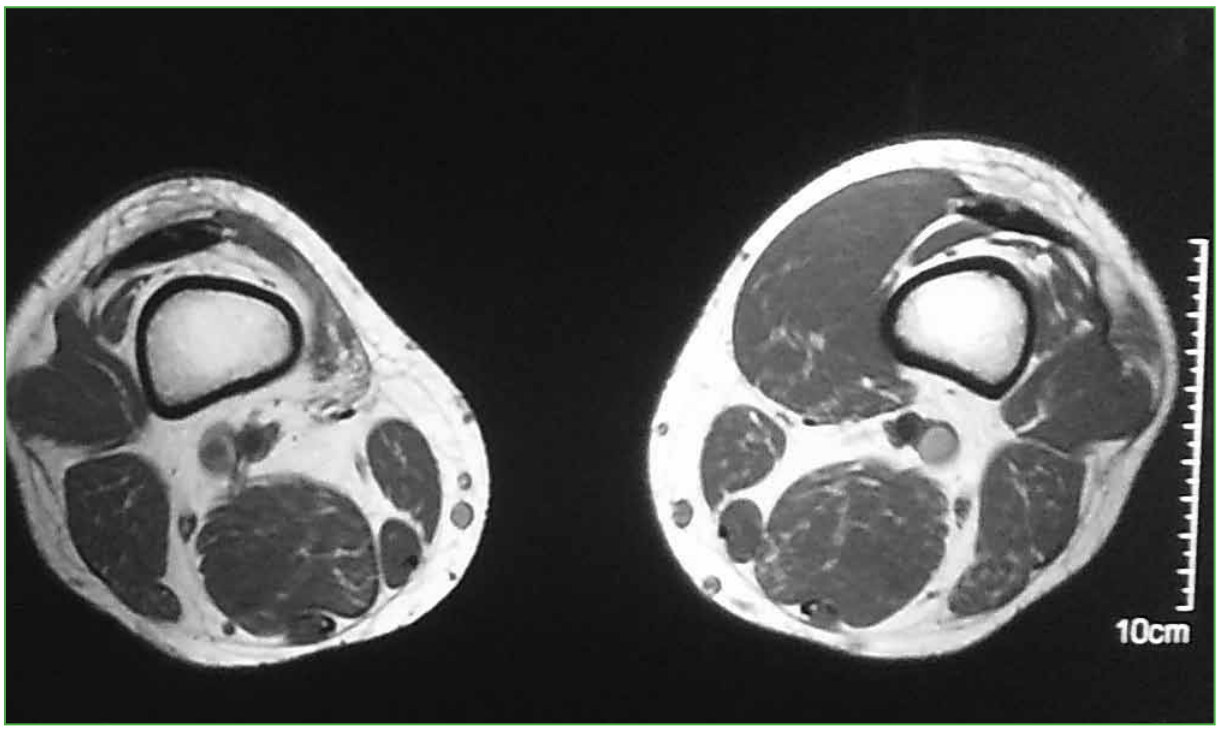

Figure 4. Axial slice.

Figures 5 to 8. Coronal slices at different comparative heights.

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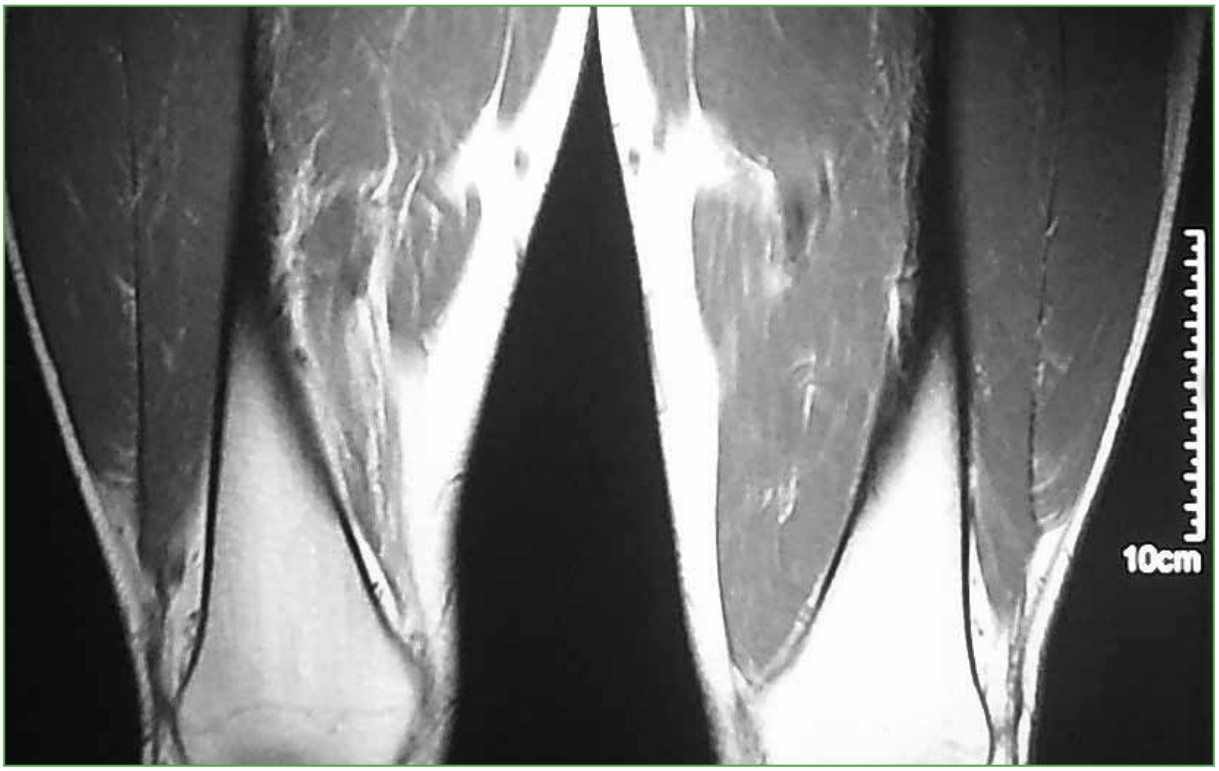

Figure 5

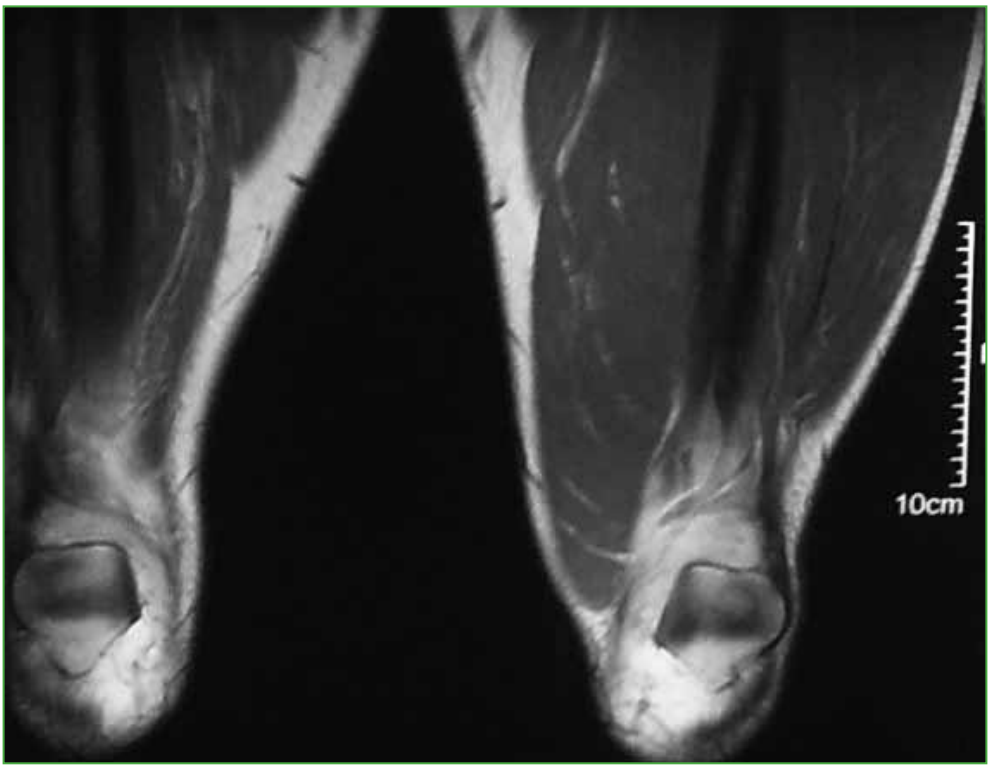

Figure 6

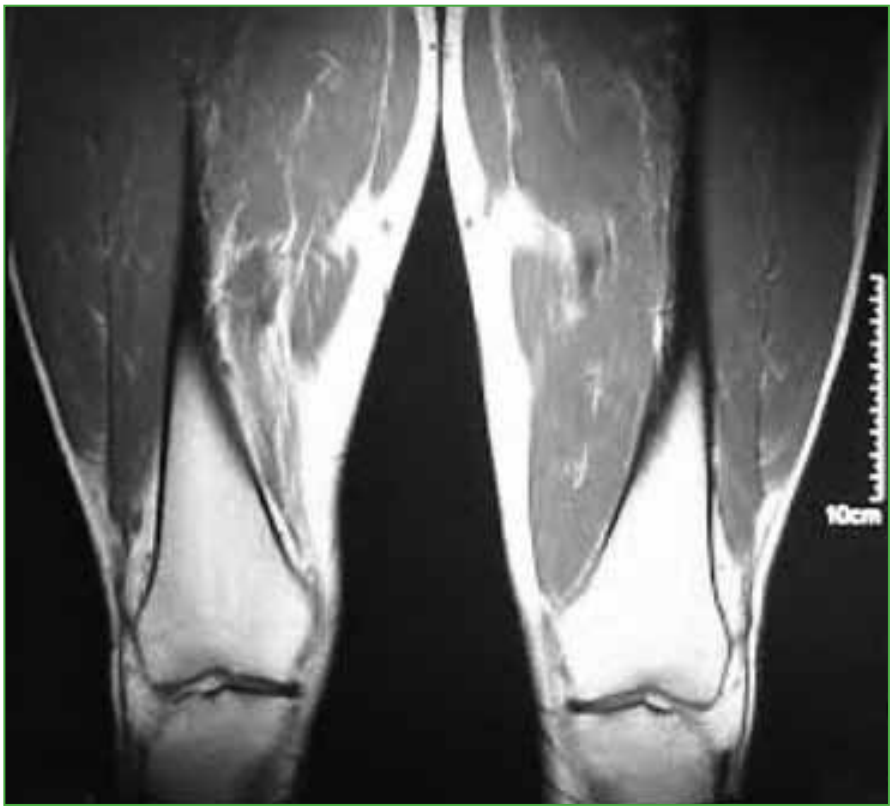

Figure 7

Figure 8

The usual representation of the right vastus medialis muscle is entirely missing, suggesting severe hypotrophy/muscle agenesis. Preserved right vastus intermedius, vastus lateralis, and rectus anterior in thickness and resonance signal. No alterations in muscle trophism were identified, nor was there a sign of resolution of the muscles of the right medial and posterior group, or at the level of the left thigh. No lesions or alterations of the femoral vascular package are observed. The asymmetry in the muscle mass of the inner thigh is striking; the vastus medialis muscle is not identified and there are no signs of edema, collections, or alterations of fatty planes.

DISCUSSION

VMO muscle atrophy is one of the most frequent causes of patellofemoral pain in young athletes. The congenital absence of the vastus medialis obliquus muscle is a rare alteration, although it is the most common of all congenital muscle anomalies of the quadriceps. There are not many publications that refer to complete or incomplete agenesis of the VMO muscle.

Vastus medialis obliquus hypotrophy is common in patients with patellofemoral syndrome (PFS). In addition, the VMO is the weakest and most vulnerable muscle of the extensor apparatus, to the detriment of the vastus lateralis (VL), which shows greater activity on electromyography. These patients often show reduced electromyographic activity of the vastus medialis obliquus in the symptomatic knee, compared with the contralateral healthy knee. It has also been observed that the VMO/VL ratio is lower in PFS patients than in healthy individuals. The lower activity of the vastus medialis and the higher activity of the vastus lateralis could lead to an imbalance between the two muscles.

Some authors postulate that the VMO, compared to the VL, needs time to develop the necessary strength for optimal patellar displacement. It has been shown that the activation time of the VMO is usually altered in patients with PFS. In their systematic review, Chester et al. suggested that there is a slight tendency to delay the activation of the VMO compared to the VL in patients with patellofemoral syndrome during different activities, such as getting up from a chair, going up or down stairs, etc. This arose from all the works published until 2007 on the specific analysis of the electromyographic activity of both vastus. Boling and Cowan demonstrated a significant delay in VMO activation before rehabilitation in patients with patellofemoral syndrome. After achieving pain remission with treatment, early activation of the VMO to normal levels was observed and optimal patellar displacement returned.

Most authors believe that the primary role of the VMO is to increase the stability of the patella within the patellofemoral joint and to prevent lateral subluxation of the patella by bringing it medially during knee extension and flexion.

The VMO plays a fundamental role in the stability of the patellofemoral joint, both in the control of displacement and patellar tilt, by performing an eccentric control of the force required to move it laterally. According to the conclusions of Pal et al., any VMO exercise plan, whether closed chain or open chain, should emphasize the eccentric phase of the exercise.

Other authors found that, in healthy individuals, the degree of electromyographic activity in both the vastus medialis and the vastus lateralis is similar and more pronounced during the last 30° of knee extension.

Most healthy individuals have higher electromyographic activity of the vastus lateralis compared to the vastus medialis, but some individuals have higher activity of the vastus medialis than the vastus lateralis. Finally, there is a third group of healthy individuals who show approximately the same electromyographic activity in both vastus. Few studies compare the activity of the VMO and the VL between patients with PFS and control groups. Pattyn E. made the comparative measurement between VMO and VL in patients with PFS and a control group. No significant differences were found between both groups of patients.

One of the critical factors for developing anterior knee pain is the delayed activation of the VMO compared to the VL during functional activity. Neptune et al. suggested an activation difference of 5 milliseconds.

Selective atrophy of the VMO is bound to occur in patients with PFS; the rehabilitation of these individuals requires a specialized exercise plan.

Letter to the Editor

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Dear Editor,

We have carefully read the work "Plantar fasciitis: analysis of therapeutic options" by Dr. Iglesias and collaborators recently published in the AAOT Journal.[1] We congratulate the authors for the interesting study on a condition with such a high incidence.

After more than 20 years of contributing to the development of shock waves in our country, we are gratified to see that the method is given recognition in a publication of these characteristics. As the authors point out, this therapeutic option is considered in the consensus treatment algorithm on plantar fasciopathy of the American College of Foot and Ankle Surgeons.[2] In said document, it is stated that extracorporeal shock wave therapy is safe and effective in the treatment of plantar fasciitis.[2] The same institution had already included shock waves as a treatment option 12 years before in another consensus.[3]

Given our experience in shock wave therapy, we would simply like to clarify some concepts about this technique expressed in the manuscript.

In the aforementioned publication, shock waves are mentioned as a treatment option, but the type of technology proposed is not detailed. The generic name of "shock waves" actually includes two types of mechanical waves: focal shockwaves, or shock waves per se, and radial pressure waves, which, from a strictly physical point of view, are not shock waves. These two technologies differ in their generation devices, physical characteristics, and mechanisms of action, but share several indications.[4] Their risk level is also different, which is why the International Society for Medical Shockwave Therapy and other institutions recommend the application of focal waves in the medical field.[4] In the case of plantar fasciopathy, both techniques can be effective.[5]

The article describes their mechanism of action mentioning that the shock waves create a "micro-tear (...), exacerbating an inflammatory reaction". Actually, 'micro-tear' is a valid mechanical concept for the effect of shock waves on kidney stones, but not on living tissue. In lithotripsy, focal waves are applied to an inert mineral accumulation to fragment it so that it can be eliminated through the urinary tract.

Mechanical stimulation often brings to mind the outdated concept of *physical therapies*.[6] In musculoskeletal tissues, the effect of waves is, instead, biological. Mechanical waves act through a phenomenon called *mechanotransduction*, by which cells can recognize a mechanical stimulus and respond biologically.[5,6] This stimulus is detected by transmembrane receptors and communicated to the cell nucleus through protein channels, triggering a biological response.

The fascinating process triggered by shock waves includes changes in the permeability of cell membranes, the stimulation of mitochondria with the release of ATP, the dilution of substance P, the reduction of unmyelinated nerve fibers, the modulation of inflammatory processes , vasculogenesis (the process of blood vessel formation by *de novo* production of endothelial cells), angiogenesis (formation of new blood vessels from preexisting vessels), increased concentrations of nitric oxide and growth factors, and, finally, the mobilization, migration, and differentiation of pluripotent cells.[5-8] All this is demonstrated by abundant literature on basic sciences whose enumeration exceeds the scope of this letter. The result is the stimulation of cellular functions, the induction of biological regeneration, and the restoration of cellular homeostasis.

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If used properly and with reliable equipment, shock waves do not injure musculoskeletal tissues. Cyteval et al.[9] evaluated shoulders treated with focal waves with magnetic resonance imaging, immediately before applying the shock waves, 6 hours later, and 2 weeks later. They found no complications or significant impact on the anatomical structures in any of the cases.

The authors mentioned that the application "can be single or serial", but, in reality, the vast majority of the protocols include 3 to 5 sessions,[10] as the same authors clarify later in the text.

Regarding the application itself, it is described that shock waves can be applied "with local anesthesia", although this is a controversial issue.[11] Numerous studies have reported worse outcomes when using anesthesia specifically in plantar fasciopathy.[12-14] One of the reasons is that the presence of fluids in the area of application modifies the *acoustic impedance* of the area to be treated and alters the penetration of the waves.

Even general or regional anesthesia could modify the effect of the waves. Evidence points to an important role for the peripheral nervous system in mediating the cellular effects of shock waves applied to the musculoskeletal system.[11,15-17]

The perception of the waves stimulates nociceptors (C fibers), which, in addition to fulfilling their sensory function, release a variety of neuropeptides that induce protein extravasation, fibroblast stimulation, and cell activation.[11,15] Anesthesia would neutralize this effect.

In short, we have a tool that, unfortunately, has been underestimated because we are surgeons and it is a conservative, non-invasive procedure. This leads to ignorance, confusion, and, many times, to yield its use to other specialties and professions. However, we must bear in mind that, in essence, the specialist in orthopedics and traumatology is, or should be, an expert in the diagnosis of musculoskeletal pathology and its surgical and conservative treatment options. When properly used, focal and radial waves are a great non-invasive alternative in the treatment of this type of chronic and degenerative condition.

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