Thermoplastic Brace Treatment for Humerus Fractures

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ABSTRACT

Purpose: To evaluate the satisfaction with the use of a thermoplastic brace and the functional outcomes in the conservative treatment of patients with humeral shaft fractures. **Materials and Methods:** Retrospective study of patients with closed humerus fractures, treated with a thermoplastic brace until union and with a minimum follow-up of 12 months. We recorded the type and location of the fracture, mechanism of injury, injured limb, time of immobilization with plaster and use of brace, complications, and time of consolidation. The evaluation was performed using the visual analog scale (VAS) for pain, the Likert scale for patient satisfaction, the Constant scale for joint balance, and the QuickDash score for functionality. **Results:** 17 patients were included (16 female, 1 male), with an average age of 67 years. The initial plaster immobilization lasted 13 days (range 0-32). The patients wore the brace for 8.6 weeks (range 3-16) until radiographic consolidation in the 10th week. The average follow-up was 24 months (range 12-60) and the pain score was 0.5 (range 1-3). 59% were very satisfied with the results and 41% were satisfied. 59% achieved a shoulder flexion >150°; 47%, an abduction >150°; 41%, an internal rotation with thumb between scapulae; and 47%, an external rotation of 70°. The average QuickDASH score was 9. **Conclusion:** The use of a thermoplastic brace in the conservative treatment of humerus fractures presented high patient satisfaction and acceptable functional outcomes for the affected limb.

Keywords: Humerus; fractures; thermoplastic brace; conservative treatment.
Level of Evidence: IV

Tratamiento con brace termoplástico para fracturas de húmero

RESUMEN

Objetivo: Evaluar la satisfacción con el uso del brace termoplástico y el resultado funcional del tratamiento conservador en pacientes con fracturas de la diáfisis del húmero. **Materiales y Métodos:** Estudio retrospectivo de pacientes con fracturas de húmero cerradas, tratados con brace termoplástico hasta su consolidación y un seguimiento mínimo de 12 meses. Se registraron los siguientes datos: tipo de fractura y localización, mecanismo de lesión, miembro lesionado, tiempo de inmovilización con yeso y uso del brace, complicaciones y tiempo de consolidación. Se evaluaron el dolor mediante la escala analógica visual, la satisfacción con la escala de Likert, el balance articular con la escala de Constant y la funcionalidad según el puntaje QuickDASH. **Resultados:** Se incluyó a 17 pacientes (16 mujeres, 1 hombre; edad promedio 67 años). La inmovilización inicial con yeso fue de 13 días (rango 0-32). Los pacientes usaron el brace por 8.6 semanas (rango 3-16) hasta la consolidación radiográfica en la décima semana. El seguimiento promedio fue de 24 meses (rango 12-60) y el puntaje de dolor, de 0,5 (rango 1-3). El 59% estuvo muy satisfecho con los resultados y el 41%, satisfecho. El 59% logró una flexión del hombro >150°, el 47%, una abducción >150°, el 41%, una rotación interna con pulgar entre escápulas y el 47%, una rotación externa de 70º. El puntaje QuickDASH promedio fue de 9. **Conclusiones:** Los pacientes se mostraron muy satisfechos con el uso del brace termoplástico para el tratamiento incruento de las fracturas de húmero y los resultados funcionales fueron aceptables.

Palabras clave: Húmero; fractura; brace termoplástico; tratamiento conservador.
Nivel de Evidencia: IV

INTRODUCTION

Conservative management of humeral shaft fractures is a commonly chosen alternative, with acceptable published outcomes and a non-union rate that ranges between 1% and 12%, according to different reports.[1]

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Currently, the humeral brace is considered the standard conservative treatment for non-surgical humeral fractures. This technique was popularized by Sarmiento, who described and developed a therapeutic alternative to achieve bone consolidation while maintaining joint mobility, thus reducing rehabilitation times and costs and surgical complications.[2]

The rationale for brace treatment is to provide alignment and stability to the fracture (limiting movement at the fracture site), compressing the muscles and soft tissues surrounding the injured bone, allowing the controlled movement of the joints that are proximal and distal to the fracture, thus stimulating bone consolidation. The forces exerted during muscle contraction translate into compression and coaptation forces that mechanically stabilize the fracture. That is, the compression does not depend on the strength of the material, but on the size and shape of the thermoplastic brace, which allows constant pressure to be exerted on the fracture during active muscle contraction. The contraction of the muscles that run parallel to the humeral axis (biceps, triceps, and brachialis) allows reestablishing proper alignment and rotation, which would explain why functional deformities are rare if there is active movement.[3,5,10]

The formal contraindications of the brace include: fractures associated with soft tissue defects, vascular or neurological compromise, excessive angulation or humeral shortening, and low patient compliance with this type of treatment.[4]

The objective of this study was to evaluate the satisfaction with the use of the thermoplastic brace and the functional outcomes of the conservative treatment of patients with humeral shaft fractures.

MATERIALS AND METHODS

We conducted a retrospective study between June 2013 and June 2018. The inclusion criteria were: patients of both sexes with a closed humerus fracture, treated with a thermoplastic brace made by the same team of therapists, with effective compliance with the equipment until consolidation and a minimum follow-up of 12 months. The exclusion criteria were: patients with associated injuries, failure to use the brace until consolidation, and lack of adequate follow-up.

The patients were initially immobilized with a cast and later referred to the Occupational Therapy Service, where the low-temperature thermoplastic brace was made.

The brace consists of two custom-made pieces of 2.4 mm thick thermoplastic material, adjusted with two pieces of 3 cm wide velcro (Figure 1).

Figure 1. Thermoplastic brace used in the treatment of humerus fractures, with its medial and lateral pieces shaped and separated.

Procedure for making the brace

1. The brace was molded on each patient, anatomically. The internal piece was molded on the internal aspect of the humerus, 2 cm below the armpit, and was fastened with velcro; the external piece was molded on the lateral aspect of the arm, extending immediately below the acromion, leaving the elbow joint unrestrained.

2. To be able to adjust the velcro sufficiently for the equipment to perform adequate coaptation, buckles were placed on the sides of the external piece (1 cm from the front edge of the brace) (Figure 2).

Figure 2. Thermoplastic brace used in the treatment of humerus fractures, with its medial and lateral pieces shaped and separated.

3. On the proximal end of the orthosis, at the level of the posterior side of the shoulder, a piece of velcro was placed around the contour of the body, passing under the armpit of the contralateral limb, and finally adhered to the orthosis at the level of the anterior side of the shoulder.

4. The edges of the orthosis were covered with fleece or EVA rubber. Tubular mesh (three layers, 1.5 mm thick) was placed between the skin and the orthosis to prevent irritability and skin lesions.

5. The use of a sling and active free joint exercises were indicated.

During the first month of use of the brace, the patients were monitored weekly, evaluating the comfort with the use, the presence of pain, the condition of the skin and the hygiene of the limb. If the equipment was in adequate condition, with no evidence of associated skin lesions, and the patient felt comfortable and complied with the treatment, they were not cited again until consolidation. After placing the brace, a radiograph was requested and controlled, in all cases, by the medical team. The radiograph was repeated one month, two months, and three months after the fracture. The patient was instructed to keep the limb inside the sling and to remove it to perform the elbow flexion-extension, wrist, and finger mobility exercise routine (3 times a day, 20 repetitions). Care guidelines were also provided for the control and treatment of edema.

The indication to space out the use of the sling and the brace was in the hands of the treating medical team, based on the clinical and radiographic evidence of consolidation.

Data on sex, age at the time of fracture, injury mechanism, injured upper limb, cast immobilization time (days), brace wear time (weeks), time until consolidation (weeks), and complications during the use of the brace were collected from the medical records.

Long-term follow-up was performed after consolidation. Patients were contacted by telephone and scheduled for an evaluation. The subjective assessment was carried out using the visual analog scale for pain, satisfaction with the use of the brace was determined with a 4-item Likert scale (1 = dissatisfied, 2 = not very satisfied, 3 = satisfied, 4 = very satisfied); shoulder range of motion was assessed with the joint balance section of the Constant Scale, and functionality, with the QuickDASH score. Data reported by the patient in relation to the equipment were recorded as observations.

The Stata program was used for statistical evaluation.

RESULTS

Seventeen of 31 patients treated with a brace for humerus fractures met the inclusion criteria. 53% of the fractures settled at the junction of the middle and proximal third (9/17); 35%, in the middle third (6/17) and 6%, at the junction of the middle and distal third (1/17). According to the AO classification, six fractures were type A1; one, type A2; one, type A3; five, type B1; one, type B2; and three, type C1. The average age at the time of the injury was 67 years (range 30-90). The sample consisted of 16 women (94%) and one man. Ten patients had involvement of the right humerus and seven of the left. All fractures were closed. In all patients, the mechanism of injury was low-energy trauma due to falling from their own height.

The cast immobilization before placing the brace lasted, on average, 13 days (range 0-32).

The thermoplastic brace was worn for an average 8.6 weeks (range 3-16). All patients wore the brace until the time of radiographic fracture healing, which occurred, on average, at 10 weeks (range 6–16). The average follow-up time was 24 months (range 12-60).

The average pain score on the visual analog scale was 0.5 (range 1-3).

Regarding the satisfaction of the patients with the use of the brace, according to the Likert scale, 59% (10/17) said they were very satisfied and 41% (7/17) were satisfied (7/17). None reported dissatisfaction in this series.

Complications during the use of the brace were: edema in the hand and skin discomfort, all temporary. No patient suffered a tissue injury.

Observations made by the patients included: a suggestion to incorporate thicker tubular mesh, the importance and need for control and hygiene, and the evaluation of buckles and fasteners, because they generated discomfort at the edges of the orthosis.

47% (8/17) of the patients received an indication for rehabilitation (kinesiology or occupational therapy).

Regarding shoulder range of motion (joint balance section of the Constant scale), 59% (10/17) achieved a shoulder flexion motion >150° and 47% (8/17), a shoulder abduction >150°. Regarding the internal rotation of the shoulder, 41% (7/17) were able to bring the thumb between the scapulae and, in external rotation, 47% (8/17) reached, on average, 70º in the goniometric measurement.

The functionality (QuickDASH) was, on average, 9 (range 0-48; standard deviation 15.3; median 2.3).

Given that the higher the score, the greater the disability, based on the results (average QuickDASH 9), it should be noted that excellent/good functional outcomes were achieved (Tabla).

DISCUSSION

According to the literature, conservative treatment with the use of braces is recommended for humeral shaft fractures, since it offers a high rate of union, good functional outcomes and comfort for the patient.[4,6-8]

The brace is generally used in the treatment of closed fractures caused by low-energy mechanisms that require little or no reduction, which occurs spontaneously due to the effect of gravity and the consequent stabilization.[6]

The clinical experience of some authors has shown that brace-treated humeral fractures have a high rate of healing and excellent recovery of function, except for those with neurovascular and soft tissue complications (especially with concomitant radial nerve injury). The good outcomes obtained in this study reinforce the consideration of the brace as a useful tool in the conservative treatment of humerus fractures.[9]

Table. Summary of the series of patients with humerus fractures treated with a thermoplastic brace

Case	Sex	Age	Side	Brace wear time (weeks)	Time until consolidation (weeks)	Follow-up (months)	Pain (VAS)	QuickDASH	Satisfaction
1	F	88	RUL	3	6	29	0/10	0	Satisfied
2	F	52	LUL	6	8	28	0/10	2.3	Very satisfied
3	F	67	RUL	6	7	12	0/10	2.3	Very satisfied
4	F	75	LUL	8	8	44	0/10	6.8	Satisfied
5	F	30	LUL	8	12	13	3/10	6.8	Satisfied
6	F	69	RUL	9	13	32	0/10	2.3	Very satisfied
7	F	52	RUL	6	8	55	0/10	2.3	Very satisfied
8	M	65	RUL	16	16	12	0/10	2.3	Very satisfied
9	F	61	LUL	7	11	60.5	1/10	6.8	Very satisfied
10	F	64	RUL	12	12	12	0/10	4.5	Very satisfied
11	F	53	RUL	16	16	25	0/10	0	Very satisfied
12	F	83	LUL	10	10	21	0/10	0	Satisfied
13	F	90	RUL	7.5	7.5	12	0/10	1.8	Satisfied
14	F	86	RUL	8	8	12	2/10	4.8	Satisfied
15	F	71	LUL	6	8	12	3/10	4.8	Satisfied
16	F	81	LUL	8	11	12	0/10	0	Very satisfied
17	F	59	RUL	9.5	11	20	0/10	0	Very satisfied

M = male, F = female, RUL = right upper limb, LUL = left upper limb, VAS = visual analog scale.

Non-compliance with treatment is sometimes mentioned as a contraindication to brace treatment.[7,11] In the series of treated cases, compliance with the use of the brace was good and the rate of satisfaction with the equipment was high.

In the literature, there is consensus that certain exercises should be performed in protected ranges of free joints and that flexion and abduction movements of the shoulder should be avoided, as well as using the arm as support.[1,2,6,8]

It is worth mentioning that multiple studies evaluated functional outcomes after brace treatment and reported minimal loss of range of motion, which did not lead to limitations in activities of daily living. In our study, we obtained similar outcomes.[4,7,8]

Regarding the general and specific complications of humerus fractures, they are frequently associated with surgical treatment.[8] In the series of cases studied, there were no significant complications secondary to the treatment received. Often, dermatological problems arise from conservative treatment. In our study, no such problems were recorded and no skin lesions were found due to the use of the brace. Proper control of the orthosis and skin hygiene can minimize the risk of this complication. [6,8,11,12]

This study has certain limitations: it is a retrospective series with a small sample. Moreover, there is heterogeneity regarding the type of humerus fractures included in the study. However, we can mention as strengths the establishment of a common and detailed orthotic protocol by the same group of therapists, the follow-up by the same medical service until consolidation and the minimum follow-up considered appropriate for this condition. We believe that prospective studies can contribute to a more rigorous evaluation and provide a higher level of evidence.[3,5,10]

CONCLUSIONS

The results obtained in our study suggest that the use of a thermoplastic brace with correct coaptation and professional supervision allows achieving bone consolidation in humeral shaft fractures. Pain control along with patient satisfaction with the comfort of the brace validates this therapeutic option for this condition. Its adequate preparation is essential to improve tolerance on the part of the patient, since the use must be prolonged, and it must be considered in selected patients. In addition, it reduces operating room costs and the risks of infection from surgery.

Conflict of interest: The authors declare they do not have any conflict of interest.

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