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Research Article

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Fractures of the Diaphysis of the Humerus. Our Therapeutic Vision

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ABSTRACT

Introduction: Fractures of the humeral shaft are relatively common, accounting for approximately 1% to 5% of all fractures. The annual incidence ranges between 13 and 20 per 100,000 people and is higher with age. Several treatment options are possible: conservative treatment, open reduction and internal fixation with a plate, or closed reduction and intramedullary nailing. An external fixator is also an option. The purpose of this work is to show the results obtained in fractures of the humeral shaft, through minimally invasive fixation, with a fine intramedullary nail (Steimann) and a monopolar external fixator.

Method: Prospective descriptive study with patients with humerus fracture in the period from January 2018 to August 2023, treated by osteosynthesis with a fine intramedullary nail (Steimann) and a monopolar external fixator, who underwent a six-month post-surgical follow-up.

Results: 103 humeral shaft fractures were treated, classified according to AO/OTA as: 47 - A (21 - 12A1, 15 - 12A2 and 11 - 12A3); 31 – B (19 – 12B2 and 12 – 12B3) and the remaining 25 were type C fractures (14 – 12C2 and 11 – 12C3). In some cases, basically in groups 12B and 12C, it was required to increase interfragmentary compression after 6 - 8 weeks due to little bone callus visible on radiographs, consolidation was achieved in 98% of the patients between 12 and 16 weeks, without presence of neurological injury (radial nerve) and functional recovery of the scapulohumeral joint was complete in all cases.

Conclusion: Minimum invasive osteosynthesis of humerus shaft fractures with closed fine intramedullary nail and monopolar external fixator produces good results related to bone consolidation and scapulo-humeral functional recovery, in a relatively short time.

Keywords: Humerus Shaft Fracture, Fine Intramedullary Nail, Minimally Invasive Osteosynthesis, Monopolar External Fixator

Introdution

Fractures of the humeral shaft are defined as the solution of continuity of bone tissue along the diaphyseal region of the humerus.

The first records of this injury date back to around 1600 BC in ancient Egypt, with references in Greco-Roman texts such as Corpus Hippocraticum [1].

The most recent literature of the twentieth century shows that it is a difficult fracture to treat and in 1924 Campbell stated that delayed consolidation and nonunion occurred more frequently in fractures of the humeral shaft than in any other fracture. which was later corroborated in 1935 by Ghormley and Mroz of the Mayo Clinic, who found a nonunion rate of 65%.1 Caldwell, in 1933, recommended the use for the immobilization and treatment of these fractures, which became known as hanging plaster; an outpatient device, so that the weight of the limb distal to the fracture would provide traction and thus force to align the fragments [2].

Fractures of the humeral shaft account for up to 5% of all fractures and approximately 15-20% of humeral fractures, with proximal humeral fractures being the most common. These humeral fractures occur most often in early or middle adulthood

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and/or in the older population. Injuries can occur as a result of a direct or indirect force applied to the humeral shaft, such as indirect force transmitted from the wrist after a fall on an outstretched hand. As such, fractures of the humeral shaft in young or middle-aged adults usually follow penetrating or high-energy trauma, while those in the older population, commonly osteopenic or osteoporotic, usually follow low-energy trauma, such as falls from a standing height [3].

Therefore, there is a bimodal distribution in relation to the age of this lesion, which peaks in the third and seventh decades, respectively, with high-energy mechanisms for younger populations and low-energy mechanisms for older adults [4,5]. The age-specific incidence was 13.4 and 14.5 per 100,000 inhabitants for these two groups. gradually increasing to almost 90 per 100,000 inhabitants in the ninth decade of life [5].

The location of the fracture trace is located, in descending order of frequency, in the middle third (transverse fractures in particular), in the upper third (spiroid traces in general) and in the lower third. This higher frequency of mid-third fractures is explained in particular by a larger lever arm at this level in the case of indirect trauma [6,7].

The optimal treatment strategy for humeral shaft fractures is still under debate. Although the vast majority of nonsurgically treated humeral shaft fractures heal without complications, successful treatment requires activity restrictions and immobilization with a splint for up to 12 weeks until fracture healing [8-11].

Surgical treatment of humeral shaft fractures may be indicated in patterns with >30 volar angulation, >20 anterior angulation, or >2-3 cm shortening, with several other absolute indications and contraindications. An advantage of surgical fixation is that it can improve the binding rate and allow an earlier return to the patient's usual duties. Surgical fixation of humeral shaft fractures is also an important consideration in polytraumatized patients [12,13].

Despite the lack of significant long-term functional benefit to date, surgery may result in a more predictable recovery course and faster functional gain compared to nonsurgical treatment [14-16].

The potential for early mobilization and faster return to function could be a tremendous benefit for certain patient populations, such as elderly patients who require assistive walking devices, as well as younger patients, which could allow for an earlier return to work. Therefore, it is essential to understand how surgical fixation can affect a patient's course of recovery and unique goals by advising them in the office on management strategies [17,18].

The treatment of fractures of the humeral shaft is a scientific problem that has not been definitively and universally resolved, where the initial objective is to eliminate the clinical manifestations that affect patients who suffer from it and to allow early mobility, which has an impact on their level of activity and thus on the performance of daily activities of life. The methods to achieve this initial goal, although they may also be non-surgical, seem to indicate that the surgical solution offers some advantages. Our objective was to evaluate the effect of urgent surgical treatment six months after its performance on the outcome of patients diagnosed with fractures of the humeral shaft.

Methodological Design

Prospective descriptive study carried out with a cohort of patients over 18 years of age, who were diagnosed with a displaced humeral shaft fracture and treated urgently at the "Calixto García" Hospital by osteosynthesis with a fine intramedullary nail (Steimann) and a monopolar external fixator (figure 1); operated on between January 2018 and August 2023 and evaluated six months later. The sample consisted of 103 patients, 64 men and 39 women.

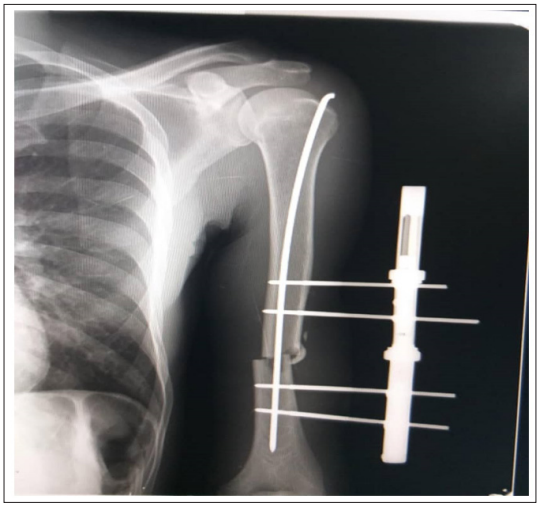

Figure 1: Osteosynthesis with a Fine Intramedullary Nail (Steimann) and a Monopolar External Fixator

Results

A total of 130 potentially eligible patient, the sample was limited to 103 patients after the application of inclusion and exclusion criteria. Of them, 39 were women (37.8%) and 64 men (62.2%) with a mean age of 40,6 ± 2,1 years. The médium was 39,3 years with a range between 20 to 64.

There were 39 fractures in the left side and 64 in the right; 59 caused by direct trauma and 44 by indirect trauma, mostly falling on the hand with the elbow in extension.

We think that the type of fracture according to the AO/OTA classification can influence both the consolidation time and the possible complications that could arise. It should be noted that there was no predominance of any of the types of fractures studied. The fractures were classified, according to AO/OTA as: 47 type A (21 - 12A1, 15 - 12A2 and 11 - 12A3); 31 type B (19 - 12B2 y 12 - 12B3) and 25 type C (14 - 12C2 and 11 - 12C3). All of this is visible in table 1.

The mean period until consolidation of 10,9 ± 1,5 weeks with the median in 10 (range 9-14 weeks). That is shown in table 2.

Table 1: Biomedical Variables of the Sample

Variable		AGE	
Mean ± DS		40,6 ± 2,1	
Medium (range)		39,3 (20-64)	
Sex		**No**	**%**
	Female	39	37,8
	Male	64	62,2
	Total	103	100,0
Distribution according to lesion characteristics		**No**	**%**
Localization	Left	39	37,8
	Right	64	62,2
Production mechanism	Direct trauma	59	57,3
	Indirect trauma	44	42,7
AO/OTA Classification	A	47	45,6
	B	31	30,1
	C	25	24,3
Total		103	100,0

Source: Data Collection form.

Table 2: Time to Consolidation

	Time to unión/weeks
Mean ± SD	10,9 ± 1,5
Median (range)	10 (9-14)

Source: Data Collection form.

Regarding shoulder and elbow mobility at the end of treatment, we found that 87 patients were classified as having excellent mobility in the shoulder joint (84.5%) and 16 (15.5%) with mobility classified as good. While for elbow joint, this relationship was 92 (89.3%) with mobility considered as excellent and only 11 (10.7) as good; The above is shown in table 3.

Table 3: Assessment of Shoulder and Elbow Movement at the End of Treatment

		No	%
Shoulder movement	Excellent	87	84,5
	Good	16	15,5
Elbow movement	Excellent	92	89,3
	Good	11	10,7
Total		103	100,0

Source: Data Collection form

When applying the "Shoulder constant score", very good values were found, which allowed the results to be classified with 91 as excellent and only 12 as good (table 4).

Table 4: Shoulder Constant Score.

Abduction Force	Mean ± SD	23 ± 1,2	
	Median (range)	24 (19-24)	
Pain	Mean ± SD	12,3 ± 2,1	
	Median (range)	13 (10-14)	
Activity level	Mean ± SD	19,1± 1,1	
	Median (range)	19 (17-20)	
Flexion	Mean ± SD	10,3 ± 0,98	
	Median (range)	10,5 (9-12)	
Abduction	Mean ± SD	8,7 ± 1,2	
	Median (range)	8,5 (8-10)	
External rotation	Mean ± SD	8,5 ± 2,1	
	Median (range)	8,2 (7-10)	
Internal rotation	Mean ± SD	9,1 ± 0,3	
	Median (range)	8,9 (8-10)	
	No	**%**	
Result	Excellent	91	88,3
	Good	12	11,7
Total		103	100,0

Source: Data Collection form

Finally, the assessment six months after the surgical treatment applied allowed us to determine an excellent result in 96 patients (93.2%), with a small group of seven patients with good results. Table 5.

Table 5: Result at the End of the Follow-up.

		No	%
Upshot	Excellent	96	93,2
	Good	7	6,8
Total		103	100,0

Source: Data Collection form.

Discussion

Although there are several options for the treatment of humeral shaft fractures, including plating or intramedullary nailing, which of these provides the best outcomes for patients is an area of active research. As a result, several meta-analyses have attempted to compare the outcomes of plating and nailing in humeral shaft fractures.17-29

There are apparent inconsistencies in the findings of these meta-analyses. While most report no significant difference in the rate of postoperative union between plating and nailing, findings vary with respect to the risk of postoperative infection, shoulder function scores, and the rate of iatrogenic radial nerve palsy. These inconsistencies may make it difficult for surgeons to use the clinical findings from these studies to make decisions about patient care.

Therefore, the aim of this study was to evaluate the outcomes of intramedullary fine nail placement associated with monopolar external fixation in humeral shaft fractures for a very specific

subset of humeral shaft fractures in order to guide clinical decision making (figure 2).

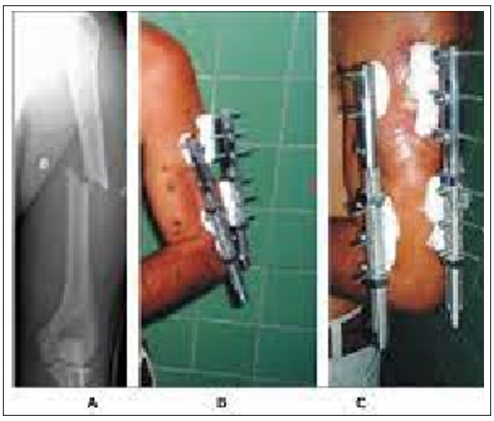

Figure 2: A) Humeral shaft fracture type --------; B y C) osteosynthesis with a fine intramedullary nail (Steimann) and two monopolar external fixator.

Surgeons should also recognize the benefits of intramedullary osteosynthesis as a less invasive procedure with potentially less blood loss, especially when operating on older patients. While the current literature provides conflicting information on which procedure is more time consuming, there is less blood loss associated with intramedullary osteosynthesis than with plate and screw fixation. Intramedullary osteosynthesis requires a smaller incision than is required for plating, with less associated blood los [18,19]. These data add to the growing body of literature comparing the two surgical methods in an attempt to optimize outcomes for humeral shaft fractures.

Over the past decade, meta-analyses have sought to better delineate the outcomes of intramedullary nailing versus plate and screw fixation for humeral shaft fractures, with wide disagreement in their findings. In 2010, Concha et al. and Liu et al. reported that both intramedullary nailing and plate and screw fixation did not demonstrate statistical differences in the prevalence of radial nerve injury, infection, and fracture healing [20,21].

The results of our study are consistent with those of Concha and Liu; However, Liu et al reported that patients with intramedullary nailing experienced a higher rate of delayed healing, which was not found in the present study [21]. In 2015, Zhao performed a systematic review of overlapping meta-analyses and concluded that plate and screw fixation is superior to intramedullary osteosynthesis largely due to the lower risk of shoulder impingement, although their findings demonstrated no difference in fracture union rates, radial nerve injury, and infection rates [22].

McCormack published a small prospective randomized control trial comparing intramedullary osteosynthesis with plate and screw fixation and found no significant differences in ASES, VAS, strength, range of motion, or return to activity scores, but noted that the intramedullary nail cohort experienced a higher rate of complications and need for secondary procedures [23].

Despite the trend toward decreased use of intramedullary osteosynthesis, Gottschalk reported that treatment with intramedullary nails resulted in lower rates of infection complications and radial nerve palsy, with no significant differences in union rates, compared with plate and screw fixation [9].

In this meta-analysis of acute closed humeral shaft fractures in adult patients without prior radial nerve palsy, the overall relative risk of nonunion was not significantly different when plating versus nailing (P = .55). This finding is consistent with previous meta-analyses and suggests that, with respect to fracture union rates, plating and nailing achieve similar outcomes [20-29]. However, the findings of the present study suggest that there is an increased relative risk of iatrogenic radial nerve palsy (RR 8.45, P = .01) and a longer time to union (1.11 weeks, P < .00001) with plating compared with nailing for this subset of humerus fractures. There were no differences in the risk of postoperative infection. Although this is an important metric for clinical decision making, there were insufficient studies reporting operative time or shoulder function scores to perform meta-analyses on these secondary outcomes.

Conclusions

This study improves the available literature comparing treatment options for humeral shaft fractures by addressing both the likelihood of developing postoperative adverse outcomes and the age dependence for experiencing specific adverse outcomes. Overall, our hypothesis was partially correct, and patient age did not greatly influence the results.

The method employed by us appears to be effective for the treatment of primary humeral shaft fractures in patients older than 18 years of age. By associating osteosynthesis with a fine intramedullary nail (Steimann) with the monopolar fixator, biomechanical stability of the fracture is achieved in several planes, which allowed obtaining consolidation in a relatively short time, good mobility of the shoulder and elbow joints, and results of the “Shoulder constant score” and at the end of the follow-up considered excellent and good.

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