Epidemiology of Surgically Treated Clavicle Fractures in Our Setting

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ABSTRACT

Introduction: Clavicle fractures account for 2.6–10% of all skeletal fractures and occur predominantly in young adults. In recent years, indications for surgery have expanded, driven by advances in implant technology. **Objective:** To conduct an updated epidemiological analysis of surgically treated clavicle fractures at a referral center in a large metropolitan area. **Materials and Methods:** This retrospective, descriptive, observational study included 451 adults who underwent surgery between January 2010 and December 2024. Demographic variables, mechanism of injury, anatomical location, fracture type according to the modified Edinburgh classification, associated injuries, time to surgery, time to union, and complications were analyzed. **Results:** Eighty-four percent of the patients were men (mean age, 29.8 years). The most affected age group was 18–29 years (32%). Most fractures involved the midshaft (84%), and the 2B1 pattern was the most common. The most frequent mechanism of injury was a motorcycle or all-terrain vehicle accident (24%), followed by sports-related injuries (23%). Associated injuries occurred in 14% of patients. The mean time to surgery was 11.6 days, the mean time to union was 12.5 weeks, and the overall complication rate was 10%. **Conclusions:** Surgically treated clavicle fractures are more common in young men, with a predominance of midshaft fractures caused by high-energy mechanisms. Two new descriptive patterns were added to the Edinburgh classification. The rate of surgery-related complications was low.

Keywords: Clavicle fractures; epidemiology; surgical treatment; osteosynthesis; classification; traumatology.
Level of Evidence: IV

Epidemiología de las fracturas de clavícula tratadas con cirugía en nuestro medio

RESUMEN

Introducción: Las fracturas de clavícula representan el 2,6-10% de todas las fracturas del esqueleto, y predominan en adultos jóvenes. En los últimos años, la indicación de cirugía se ha incrementado impulsada por la evolución de los implantes. **Objetivo:** Realizar un análisis epidemiológico actual de las fracturas de clavícula tratadas quirúrgicamente en un centro de derivación de una gran metrópoli. **Materiales y Métodos:** Estudio observacional retrospectivo descriptivo que incluyó a 451 adultos operados entre enero de 2010 y diciembre de 2024. Se analizaron las siguientes variables: demográficas, mecanismo lesional, localización anatómica, tipo de fractura según la clasificación de Edimburgo modificada, lesiones asociadas, tiempo hasta la cirugía y la consolidación, y complicaciones. **Resultados:** El 84% de los pacientes eran hombres (media de la edad 29.8 años). El grupo etario más afectado fue el de 18 a 29 años (32%). La localización predominante fue el tercio medio (84%), y el patrón 2B1, el más frecuente. El mecanismo lesional más común fue el accidente en motocicleta o cuatriciclo (24%), seguido de traumatismos deportivos (23%). El 14% sufrió lesiones asociadas. El tiempo promedio hasta la cirugía fue de 11.6 días; el de consolidación, de 12,5 semanas y la tasa global de complicaciones fue del 10%. **Conclusiones:** Las fracturas de clavícula tratadas con cirugía son más frecuentes en hombres jóvenes, y predominan las fracturas mediodiafisarias por mecanismos de alta energía. Se incorporaron dos nuevos patrones descriptivos a la clasificación de Edimburgo. La tasa de complicaciones por la cirugía fue baja.

Palabras clave: Fracturas de clavícula; epidemiología; tratamiento quirúrgico; osteosíntesis; clasificación; traumatología.
Nivel de Evidencia: IV

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INTRODUCTION

Clavicle fractures are among the most common fractures of the skeleton, accounting for 2.6% to 10% of all fractures, and occur predominantly in young adults.[1-4] Most clavicle fractures can be treated conservatively.[5] Surgery is reserved for fractures with multiple fragments, marked displacement, or significant deformity.[6,7] Currently, there is a trend toward surgical fixation owing to advances in implant design, which allow early recovery, with low complication rates and excellent functional outcomes, in contrast to the long-term outcomes reported with conservative treatment.[7-9]

The objective of this study was to perform a current epidemiological analysis of surgically treated clavicle fractures at a single hospital, a referral center serving a large metropolitan area, determining their frequency by age group, mechanism of injury, fracture type, associated injuries, and postoperative complications.

MATERIALS AND METHODS

The study was approved by the institution's Ethics Committee. A retrospective, descriptive observational study was conducted including all patients who underwent surgery for an isolated clavicle fracture at a single surgical center between January 2010 and December 2024. The series comprised 451 patients (379 men and 72 women). Before surgery, all patients underwent comparative radiographic evaluation with the contralateral unaffected side (anteroposterior and 45° cephalic tilt anteroposterior views), as well as computed tomography with 3D reconstruction. Exclusion criteria were age <18 years, open fractures, pathological fractures, fractures associated with other injuries of the shoulder girdle, previous surgery on the ipsilateral clavicle, and conservative treatment.

Fracture type was determined according to the Edinburgh classification.[1] For midshaft fractures (type 2) in this classification, a descriptive modification was introduced for epidemiological purposes, adding two new fracture patterns: fractures with a vertical fragment oriented at 90 ± 30° relative to the clavicular axis were classified as type 2C, whereas fractures with a midshaft fragment combined with a lateral or medial avulsion fracture involving the sternoclavicular or acromioclavicular joint, respectively, were classified as type 2D (Figures 1 and 2). This modification was not intended to validate a new classification but rather to describe morphological patterns observed in routine clinical practice.

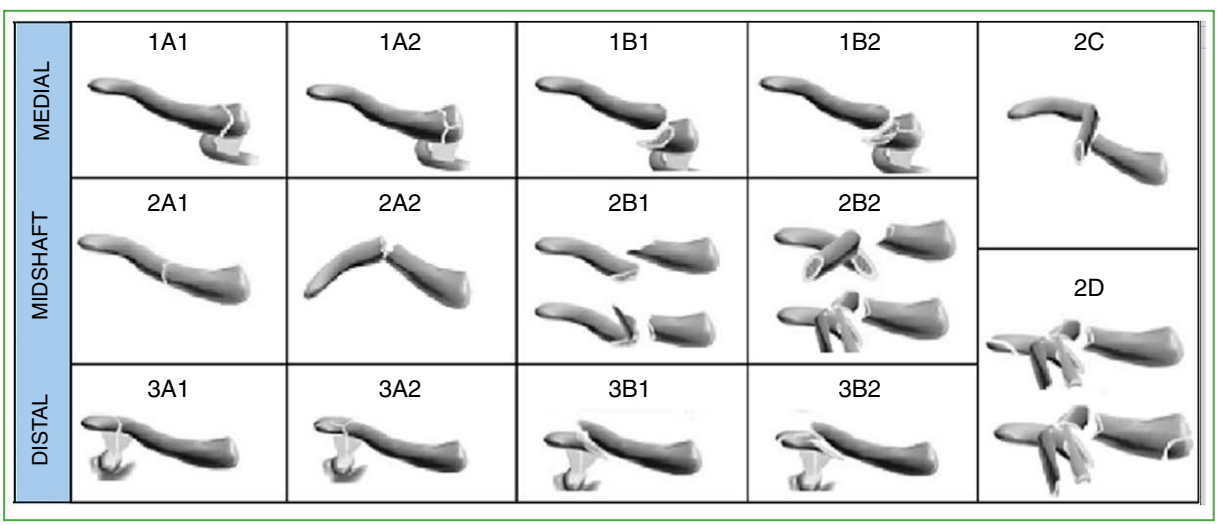

Figure 1. Clavicle fracture types according to the modified Edinburgh classification: 1A1. Medial, nondisplaced, extra-articular. 1B1. Medial, displaced, extra-articular. 1A2. Medial, nondisplaced, intra-articular. 1B2. Medial, displaced, intra-articular. 2A1. Midshaft, nondisplaced. 2A2. Midshaft, angulated. 2B1. Midshaft, displaced, simple or with a wedge fragment. 2B2. Midshaft, displaced, segmental or comminuted. 2C. Midshaft, displaced, with a third fragment oriented at 90° ± 30°. 2D. Midshaft fracture associated with a medial or distal intra-articular fracture. 3A1. Distal, nondisplaced, extra-articular. 3B1. Distal, displaced, extra-articular. 3A2. Distal, nondisplaced, intra-articular. 3B2. Distal, displaced, intra-articular.

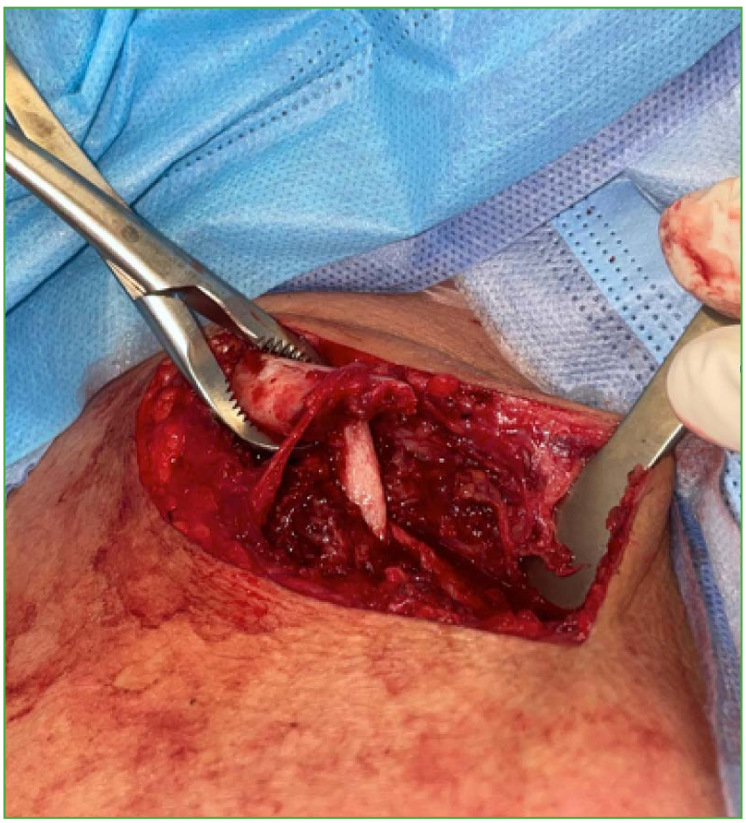

Figure 2. Intraoperative image of a type 2C clavicle fracture with a vertical fragment in a 23-year-old man.

Anatomical location was defined as medial, midshaft, or distal, using the lateral border of the first rib and the conoid tubercle as landmarks. Fractures located medial to the lateral border of the first rib were considered medial fractures; those located between this anatomical landmark and the conoid tubercle were classified as midshaft fractures; and those lateral to the conoid tubercle were classified as lateral or distal-third clavicle fractures (Figure 3).[1]

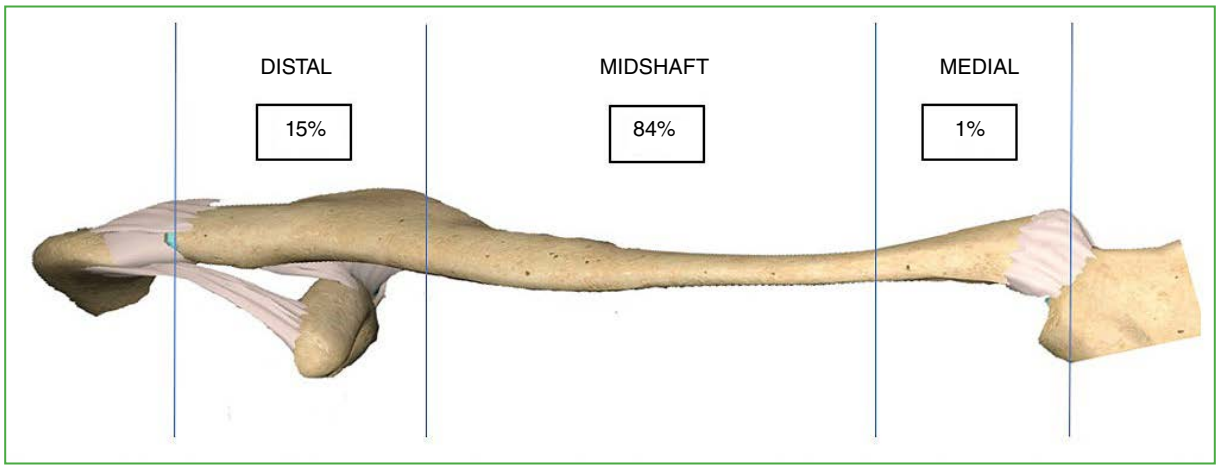

Figure 3. Anatomical distribution of clavicle fractures: midshaft fractures, 84% (n = 380); distal fractures, 15% (n = 67); and medial fractures, 1% (n = 4).

Surgical Technique and Postoperative Protocol

The surgical technique consisted of a modified Coupe infraclavicular approach[10] for medial and midshaft fractures and a supraclavicular approach for most distal fractures, with fixation using precontoured locking anatomical plates. In selected cases of comminuted fractures or significant instability, interfragmentary screws, high-strength sutures, or suture anchors were additionally used for ligament stabilization.

In the immediate postoperative period, patients were immobilized in a Velpeau-type sling for 4-6 weeks, depending on fracture complexity (degree of comminution and ligament involvement). Rehabilitation began during the first postoperative week and was structured into two main phases over the first three weeks: an initial protection and control phase focused on pain management, protection of the capsulolabral complex, and restoration of scapular control through isometric activation and co-contraction exercises, followed by a mobilization phase involving assisted scapulohumeral motion in the supine position, prioritizing glenohumeral stability over range of motion and remaining within pain limits. Beginning in the fourth week, isometric and progressive strengthening exercises were introduced, with resisted exercises allowed from the sixth week onward. Return to sports was permitted from 12 weeks onward, provided that complete bone union had been achieved.

Union was defined as disappearance of the cortical discontinuity at the fracture site due to callus formation. A time to union of <16 weeks was considered "normal," 16-24 weeks was considered "delayed union," and lack of union beyond 24 weeks was considered "nonunion."[1]

Demographic and temporal variables, mechanism of injury, fracture type, time to surgery and union, associated injuries, and complications were analyzed.

Statistical Analysis

Continuous variables (age, time to surgery in days, and time to union in weeks) are expressed as mean ± standard deviation and median with interquartile range (IQR). Categorical variables are expressed as absolute frequencies and percentages.

RESULTS

Of the 451 patients in the series, 379 (84%) were men and 72 (16%) were women. The mean age was 29.8 ± 13.3 years (median, 29; IQR, 8.5). Patients were grouped by age (18-29, 30-39, 40-49, 50-59, 60-69, and 70-79 years). Figure 4 shows the incidence of fractures by age group.

Most fractures involved the middle third of the clavicle (380 patients, 84%), followed by distal (67 patients, 15%) and medial fractures (4 patients, 1%). According to the modified Edinburgh classification, the most common fracture patterns were simple type 2B1 (120 patients, 27%), type 2B2 (110, 24%), and type 2B1 with a wedge fragment (76, 17%) (Table).

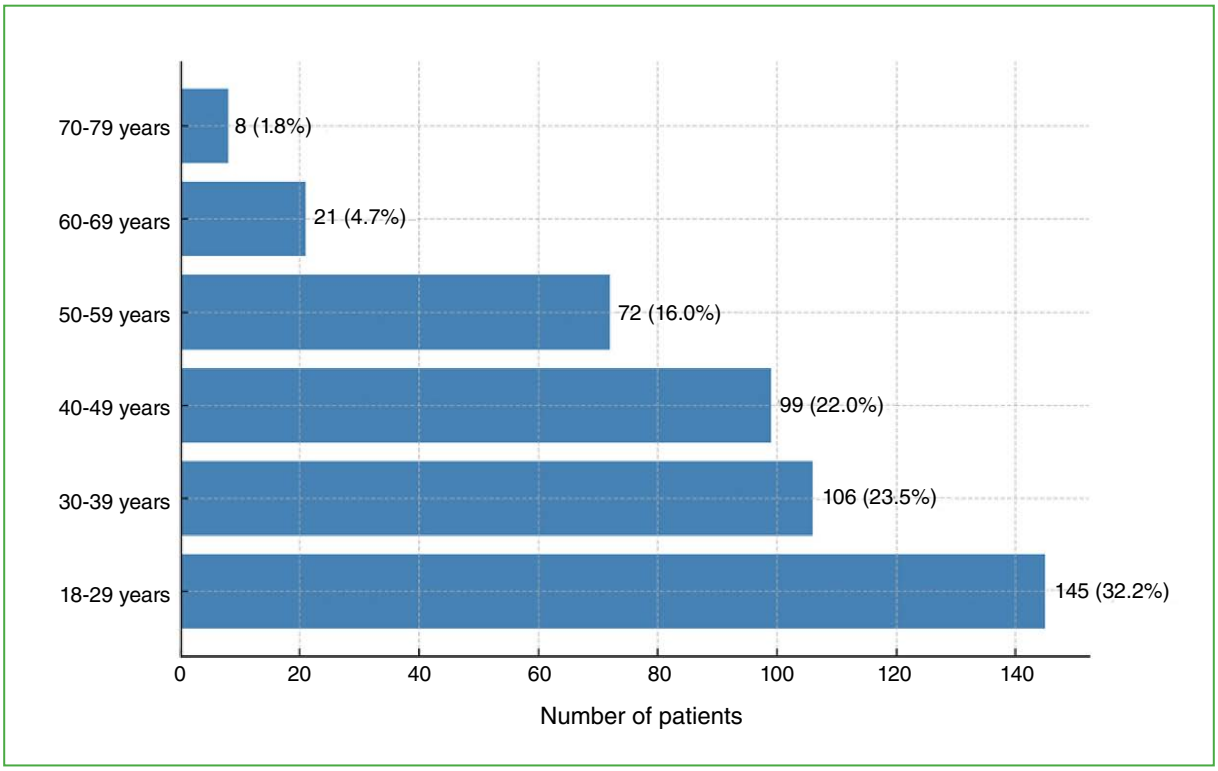

Figure 4. Distribution of clavicle fractures by patient age.

Table. Distribution of clavicle fractures according to the modified Edinburgh classification and anatomical site.

	Medial fractures				Mid-diaphyseal fractures							Distal fractures			
	1% (n = 4)				84% (n = 380)							15% (n = 67)			
Modified Edinburgh Classification	1A1	1A2	1B1	1B2	2A1	2A2	2B1 single	2B1 wedge	2B2	2C	2D	3A1	3A2	3B1	3B2
Number of patients	0	0	4	0	5	31	120	76	110	36	2	1	4	40	22
Percentage of patients	0	0	1	0	1	7	27	17	24	8	0	0	1	9	5

The most common mechanism of injury was motorcycle or ATV accidents, followed by sports-related injuries (most commonly soccer and rugby). Bicycle falls ranked third (18%), while falls from standing height and falls from horses each accounted for 10%. The least common mechanisms were falls from a height and motor vehicle accidents (Figure 5).

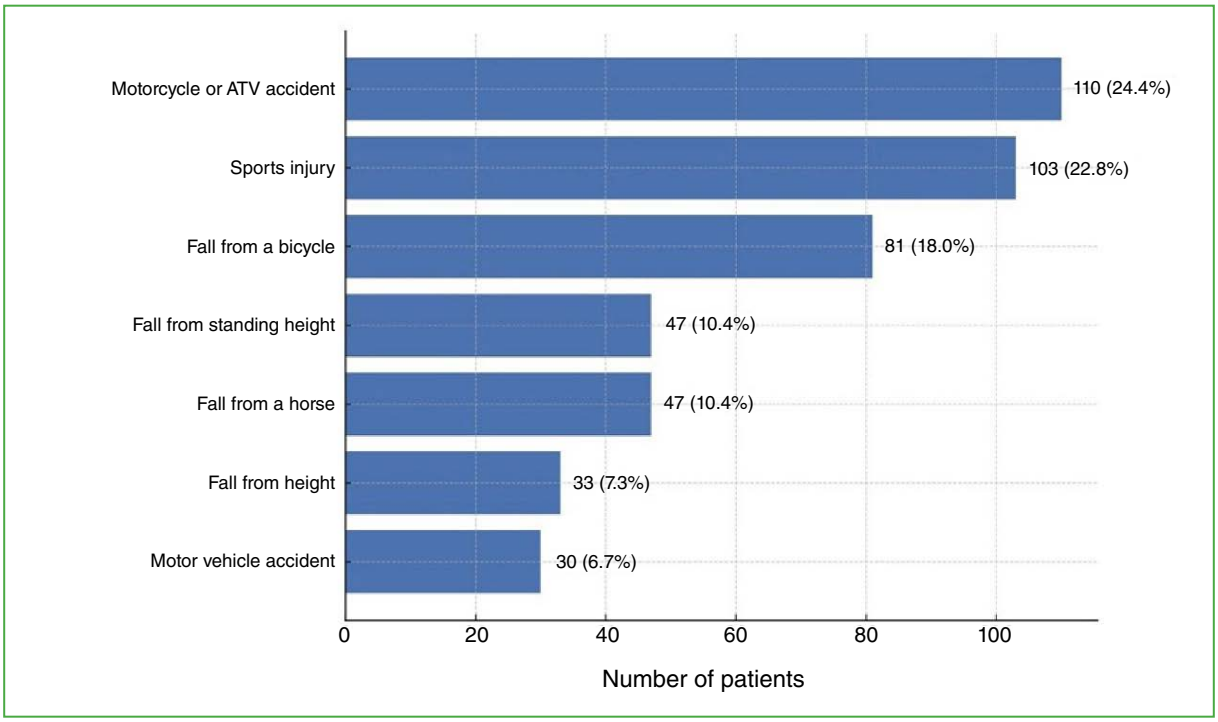

Figure 5. Main mechanisms of injury causing clavicle fractures.

The seasonal distribution showed the highest incidence in August (68 patients, 15%), followed by December (10%), and March and July (40 patients each, 9%). Fractures occurred most frequently on weekends: Saturday (97 patients, 22%) and Sunday (90 patients, 20%). They were less frequent on weekdays (Tuesday, 52 patients, 12%; Thursday, 41 patients, 9%) (Figures 6 and 7).

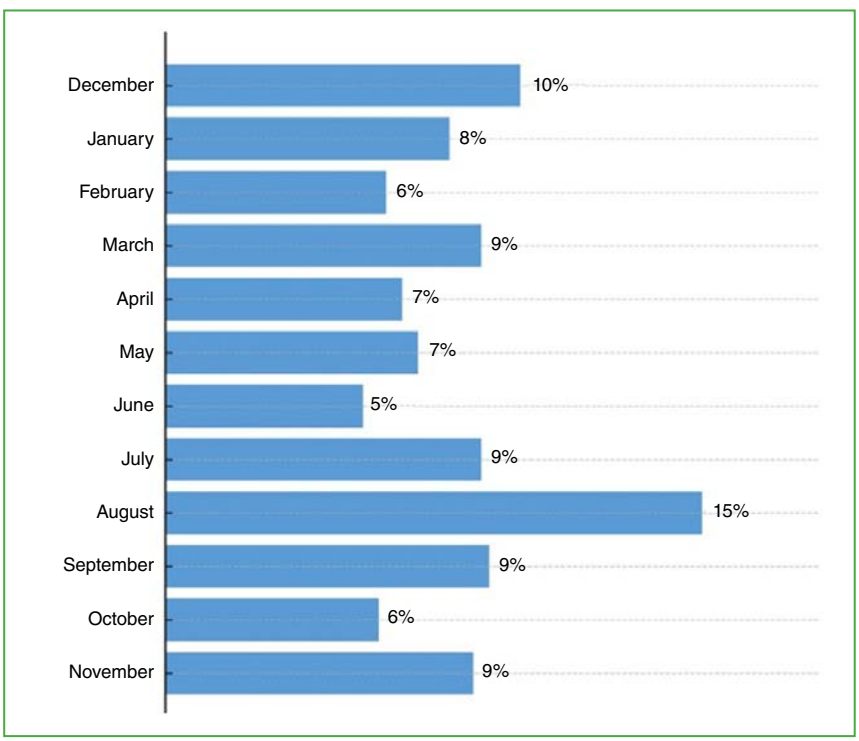

Figure 6. Seasonal distribution of clavicle fractures.

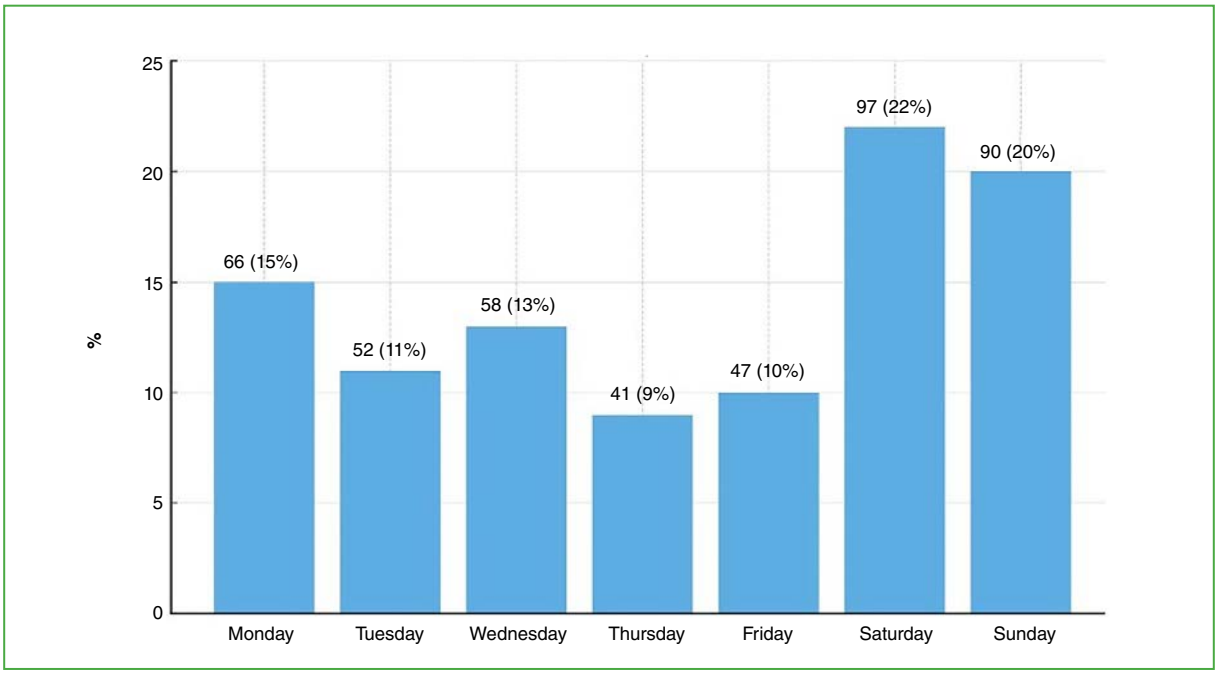

Figure 7. Distribution of clavicle fractures by day of the week.

Fifty-seven percent of patients had a left clavicle fracture and 43% had a right clavicle fracture. Of the 451 patients, 86% had no associated injuries, whereas 14% (n = 61) had at least one additional injury. Rib fractures were the most common associated injury (n = 20), followed by traumatic brain injuries (n = 13). In addition, 12 patients had upper-extremity fractures and six had lower-extremity fractures. Eleven patients sustained a pneumothorax or hemothorax, five of whom required emergency treatment. Two patients had lumbar vertebral fractures and two had orbitozygomatic fractures. Fifty-five percent of patients with concomitant injuries had a combination of at least two different types of injury.

The mean time to surgery was 11.6 ± 3.6 days (median, 13.5; IQR, 6.5), and the mean time to union was 12.5 ± 2.1 weeks (median, 12; IQR, 0.75). Ten percent of patients (n = 45) experienced complications. Fourteen patients required hardware removal because of pain or implant fatigue. Thirteen developed nonunion, six of whom had an infection. Six patients developed a surgical site infection; three required surgical debridement and targeted antibiotic therapy, whereas the remaining three were treated with empirical antibiotic therapy alone, with complete resolution. Five patients sustained a refracture following a new traumatic event and required repeat fixation. Four developed adhesive capsulitis of the shoulder, two developed neuritis at the surgical scar, and one developed anesthetic-induced chemical injury to the brachial plexus, which resolved spontaneously, with complete recovery at one year.

DISCUSSION

The incidence of clavicle fractures in our series showed a marked predominance in men (84%), higher than that reported in previous studies.[1,3,4] Clavicle fractures are considered common injuries in young patients, with a peak incidence before 30 years of age.[1,11,12]

Robinson and Nordqvist described a decreasing incidence of fractures from adolescence to 35 years of age, followed by a relatively stable incidence up to 75 years and an increase thereafter.[1,3] In contrast, Herteleer et al. reported a peak incidence of clavicle fractures between 41 and 50 years of age.[13] In our sample, the highest incidence occurred in the 18-29-year age group (32%), with a progressive decline with increasing age, consistent with the series by Nowak et al.[4] Regarding seasonal distribution, most studies report a higher incidence of fractures during the summer.[2,4,13] Although the incidence in our sample was also high during the summer, August was the month with the highest number of clavicle fractures (15%). As in other studies,[2,4,13] fractures occurred more frequently on weekends (Saturday and Sunday).

The most common mechanism of injury was a motorcycle or ATV accident (24%), followed by sports-related trauma (23%). Bicycle falls ranked third (18%). This was the most common mechanism of injury in European studies, particularly in the Nordic countries.[1-3] Falls from horses ranked fourth (10%), a mechanism not reported in the other studies analyzed. This finding may be influenced by the large number of competitive and therapeutic equestrian activities in this region.

Clavicle fractures have traditionally been considered common injuries in polytrauma patients. Robinson reported that 96 of 1000 patients evaluated (9.6%) required hospitalization for treatment of associated injuries: 75 had injuries requiring orthopedic treatment, 29 had cranial or facial injuries, 27 had severe chest trauma, and 4 had severe abdominal trauma.[1] Following a review of 321 clavicle fractures at Uppsala University Hospital in Sweden, Kihlström et al. reported that 21% of patients had associated fractures, most commonly vertebral, scapular, skull, and forearm fractures.[14] In another Swedish study, associated injuries were identified in 36% of 185 patients; however, 40% consisted of superficial abrasions of the upper extremity or face and 20% were rib fractures, whereas only 5% involved an extremity fracture.[4] In our study, associated injuries (14%) were less frequent than in other series, and the most common were traumatic brain injuries and rib fractures.

In Robinson's study, medial or type 1 fractures were the least common (2.8%). Midshaft or type 2 fractures were the most common (69.2%), and most were displaced. Among these, type 2B1 fractures with a simple fragment predominated. Type 3 fractures accounted for 28% of the total, with nondisplaced fractures predominating.[1] In a Swedish study, 80% of surgically treated fractures were midshaft fractures, and 73% of these were displaced type 2B1 and 2B2 fractures. Fewer than 20% of all surgically treated fractures were displaced lateral fractures (3B1–3B2). Very few nondisplaced midshaft and lateral fractures (2A1, 2A2, 3A1, and 3A1) and no medial fractures required surgical fixation.[14]

Although our study included only surgically treated clavicle fractures, the distribution of fracture patterns was consistent with that reported in the literature. In our population, 84% of patients had midshaft fractures, with a predominance of the simple type 2B1 pattern. For descriptive and epidemiological purposes, the classic Edinburgh classification was modified by adding two additional fracture patterns. Previous studies have shown that midshaft clavicle fractures with a vertically oriented third fragment are associated with higher rates of symptomatic nonunion and cosmetic skin compromise; in the literature, these are considered more complex fracture patterns and a potential indication for surgery.[15] In our series, these fractures were classified as type 2C, whereas midshaft fractures associated with a medial or distal fracture were classified as type 2D because of their greater morphological complexity.

Left clavicle fractures were more frequent in our study (57%), as also reported in retrospective studies by other authors. Nordqvist and Petersson reported an incidence of left clavicle fractures of 52%, as did Kihlström et al.[14] Hill et al. reported a rate of 63.5%[16] and Postacchini et al., a rate of 61%.[2]

A predominance of the nondominant side has also been described for other upper-extremity fractures, such as distal radius fractures.[17,18]

The mean time from fracture to surgery was 11.6 days, and the mean time to fracture union was 12 weeks (range, 8-24). Retrospective studies have reported low complication rates after surgery for clavicle fractures, with nonunion and infection rates <10%.[7,18] Most complications associated with surgical treatment appear to be implant-related, with reported rates of hardware irritation or failure ranging from 9% to 64%.[7,18-20] The complication rate in our study was 10%.

The limitations of this study include its retrospective design and the fact that it was conducted at a single referral center, which may limit the generalizability of the results to other populations or healthcare settings. In addition, the absence of a control group precludes direct comparison with conservative treatment.

The strengths of this study include providing a contemporary epidemiological overview of surgically treated patients in our setting, particularly considering that most large-scale epidemiological studies of this condition come from European countries, mainly the Nordic region. Additional strengths include the sample size (451 patients), the homogeneity of the series, with all patients treated by the same surgical team using the same technique, and the follow-up period of more than 10 years, which allowed long-term assessment of a large number of patients.

CONCLUSIONS

In our setting, clavicle fractures are common and predominantly affect young men, often in the context of polytrauma or one or more associated injuries. They generally occur on nonworking days and during vacation periods. Current surgical treatment is safe and effective and has a low complication rate.

Prospective, multicenter studies with long-term functional follow-up are needed to validate the fracture patterns described, analyze functional outcomes according to fracture type, and assess surgical indications in specific patient subgroups.

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

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