


SURGICAL INTERVENTIONS IN CLAVICLE SHAFT FRACTURE: A DETAILED LOOK THROUGH THE SPECIALIZED LITERATURE

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ABSTRACT

Clavicle fractures are relatively common injuries, accounting for 44% of shoulder girdle fractures and 2.6% of all fractures. They occur more frequently in active young men, especially those involved in high-impact activities. For this reason, this study aims to present the main surgical interventions used in clavicle shaft fractures. This is a literature review, which was carried out between June and July 2024, which used the SciELO database, in which the term "clavicle fracture" was searched, followed by subsequent

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analysis of articles published in the last 5 years, 6 articles were selected. It was observed that the Blocking Plate was the main technique used in surgical interventions for clavicle shaft fractures. Despite this, there is still a great deal of debate about the optimal approach to treating these fractures. In general, the patients who underwent the surgical approach presented good results in bone consolidation and few complications after the procedure.

Keywords: Bone fractures. Orthopedic procedures. General surgery.

INTRODUCTION

A fracture occurs due to intense, single, or repetitive overload, causing the bone to rupture. This trauma also damages adjacent soft tissues, which leads to a loss of structural continuity, deformity, pain, and impairment of support function. In addition, the fracture ruptures the blood vessels of the bone and periosteum, releasing biochemical factors that induce bone healing and healing (Gueorguiev-Rüegg & Stoddart, 2020).

Clavicular fractures are relatively common injuries, accounting for 44% of shoulder girdle fractures and 2.6% of all fractures (Postacchini et al, 2002). They occur more frequently in active young men, especially those involved in high-impact activities, whose most common causes include falls on the shoulder, indirect trauma, or direct impacts, such as in traffic accidents or sports injuries. They vary in severity depending on the intensity and direction of the force applied (Bucholz et al, 2013).

The majority (80 to 85%) occur in the midshaft, a more vulnerable region due to its narrow cross-section and central positioning, which makes it more susceptible to the transmission of compressive forces applied to the shoulder. Usually, the indications for surgery for this type of fracture are debatable, as some doctors prefer conservative treatment, while others opt for surgical intervention (Bucholz et al., 2013).

Surgical fixation can be performed by means of devices, such as screws, non-locked plates, locked plates, and tension band wires, which are fixed externally to the bone, under the soft tissue covering, and offer complementary stability on the bone surface. Each method has specific advantages depending on the type of fracture and the need for mechanical support (Schütz & Rüedi, 2013)

Screws are powerful resources for osteosynthesis, especially when they are used in conjunction with plates to provide additional stabilization. The same screw can have different functions depending on its shape and application technique. Two of the fundamental principles of conventional screws are: compressing from the fracture plane to promote the union of bone fragments (compression screw) and fixing the plate to the bone to maintain structural stabilization (plate screw) (Schütz & Rüedi, 2013).

Modern locked head screws offer angular stability to the implant due to their threaded head that attaches to the corresponding thread on the plate, forming a screw-plate system with angular stability. This mechanism prevents compression of the plate against the bone by transferring the load directly between the screws and the plate, similar to how an external fixator works, but positioned under the soft tissues, a concept called the "internal fixator principle". In "hybrid fixation," which combines conventional and locked screws, it is crucial

that all conventional screws are inserted before the locked ones in each fragment, to ensure the stability of the assembly (Frigg, 2016).

Compression screws can be inserted independently or through a hole in the plate. In any application, the compression between the bone fragments - or between the plate and the bone - generates preload and friction, factors that prevent the displacement of the fragments under external forces. During insertion, the surgeon drills into the bone with a drill with a diameter slightly larger than the smallest diameter of the chosen screw. To increase safety, especially in cortical bones and in dense cancellous bones of young patients, it is recommended to open the thread before inserting the screw. In more malleable bones, the screw can be inserted without the need for a thread. Self-tapping screws are a practical alternative, as they cut the thread during insertion, but require experience for proper application (Schütz & Rüedi, 2013).

Table 1, prepared by Schütz & Rüedi, presents the types and functions of screws according to clinical use.

Table 1. The various functions of screws and clinical examples

Name	Mechanism	Clinical example
Plate screw without locking	Preload and friction are applied to generate force between the plate and the bone	Application of plate to the forearm
Compression screw	The sliding hole allows compression between the bone fragments	Fixation of a butterfly or cuneiform fragment, or fracture of the medial malleolus
Screw with locked head	Used exclusively with locking plates; Threads on the screw head allow for mechanical coupling to a reciprocating thread on the plate, providing angular stability	Fracture-metaphyseal complex Osteoporosis
Locking screw	Attaches an intramedullary pin to the bone so that length, alignment, and rotation are maintained	Femoral intramedullary pin or blocked tibial
Anchor bolt	An attachment point used for anchoring a loop with metal wire or sturdy suture	Anchorage by tension band in a proximal humerus fracture
<i>Push-pull</i> parafuso (i.e. "come in and know")	Temporary fixation point, used to reduce distraction and/or compression fracture	Use of an articulated compression device
Reduction screw	Conventional screw passed through a plate to pull the fracture fragments in the direction of the plate; Once alignment has been achieved, the bolt can be removed or changed	Minimally invasive osteosynthesis technique with plate to reduce multifragmented fracture to plate
Parasitic <i>poller</i>	Screw used as a support point for redirection of an intramedullary pin	Fracture in the proximal tibia during intramedullary pinning

In addition to the compression screw, as previously stated, compression plates ensure absolute stability and promote bone healing. However, to avoid direct contact between the plate and the bony cortex, which can reduce vascularization and increase the risk of necrosis, Tepic and Perren (1995) developed the principle of the "internal fixator." This method brought a new concept of fixation independent of continuous contact with the bone cortex.

On the other hand, non-surgical - or conservative - treatment is adequate for most clavicle fractures. However, surgical intervention may be indicated when the fracture cannot be adequately reduced or stabilized, or when early movement provides a significant functional advantage. The main objectives of surgery include anatomical reduction and stabilization of the fracture, to restore alignment and integrity of the limb, as well as to control pain and allow early movement, promoting rapid return of function. The benefits must be weighed against the risks associated with anesthesia, the surgical procedure, and the insertion of materials, which can increase the risk of complications such as infections and implant rejection (White, 2017).

In view of this, this study aims to review the literature to compare the benefits and repercussions of surgical approaches in the treatment of clavicular shaft fractures.

METHODOLOGY

This is a literature review carried out between June and July 2024, using the SciELO database, where searches containing the term "clavicle fracture" were consulted, restricting it to articles published in the last 5 years. The initial search brought 10 articles and after screening, which used as a criterion to choose studies related to clavicle shaft fracture, 6 articles were selected for this review.

The phases of this research were organized as follows: first, the appropriate descriptors were determined; Then, in a sequential manner, the search strategy was elaborated, the databases were chosen, the most relevant titles were selected, and the texts were read completely. Finally, these stages culminated in the elaboration of the text.

According to item III of Resolution No. 510/2016, due to the use of secondary data in the public domain, it was not necessary to submit the project to a Research Ethics Committee.

RESULTS

Table 2 presents the results of the research, organizing the studies according to the author, year, methodology and results of the research. This framework was chosen for its

ability to provide a comparative view of the selected studies

Table 2. Studies listed according to author, year, methodology and results

Author, year	Methodology	Results
Amaral, F.E. <i>et al</i> , 2024	Prospective case series evaluating displaced fractures of the middle third of the clavicle to blocked IMO, with procedures performed by a single surgeon. The patients were evaluated at 12 months using the University of California at Los Angeles (UCLA) scale and by radiographs of the anteroposterior (AP) clavicles with cranial inclination and flow rate of 45°, in addition to reports of complications.	A total of 15 patients were evaluated. The median surgical time was 50 minutes (IQR 35). The UCLA scale at 12 months had a median of 35 (IQR 2). All patients had fracture healing. Minor complications occurred in three cases (20%): two (13.3%) with plaque prominence and one (6.7%) with local paresthesia. Major complications occurred in only one case (6.7%), with suture dehiscence, requiring surgical reapproach.
Rodrigues, L.M. <i>et al</i> , 2023	Analysis of case series. The sample included individuals undergoing surgical treatment for clavicle fractures.	In total, 88 subjects met the predetermined criteria. Of these, 75 (85.22%) were male; car accidents corresponded to the largest etiological group, reaching 48% of prevalence; there was a slight predominance on the right side, totaling 45 cases (51%); most fractures were classified as Allman type I; an infection rate was observed in 1.13% of cases; and the development of pseudoarthrosis was identified in 2.27% of the patients.
Mendes Junior, F.A. <i>et al</i> , 2021.	This was a longitudinal, observational study with 32 consecutive patients (31 men; mean age, 41 years) with comminuted fractures of the clavicle shaft who were surgically treated using the minimally invasive osteosynthesis technique with a 3.5 mm reconstruction plate in the upper position. Patients were clinically and radiologically evaluated for a minimum follow-up period of 12 months.	In 30 patients (93.72%), fracture healing occurred in a mean time of 17 weeks (range, 12 to 24 weeks). The median follow-up time was 21 months (range, 12 to 45 months). No implant breakage or pseudoarthrosis was recorded. There were no complaints of paresthesia around the surgical incisions. The surgically treated shoulder had lower passive elevation and longer clavicle length ($p < 0.05$) compared to the contralateral shoulder. The functional assessment revealed a mean Arm, Shoulder and Hand Disability (DASH) score of 1.75, which is considered satisfactory. Age > 60 years showed a negative correlation with the DASH score ($p < 0.05$).
Hehn, F.H.S. <i>et al</i> , 2020.	This was a retrospective cross-sectional study in which 36 patients who suffered fractures of the middle third of the clavicle and who were surgically treated between January 2012 and February 2017 were evaluated. They were evaluated for fracture types, age, smoking, osteosynthesis material, and scores on the Constant-Murley Shoulder Rating Scale and Modified University of California at Los Angeles (UCLA-M).	The mean scores of Constant-Murley and UCLA-M were 91.59 and 31.29, respectively. The mean age was 37.62 years, and was statistically related to the type of osteosynthesis ($p < 0.05$), but the osteosynthesis material was not significant with the improvement in the rates of functional scores.
Xu, H.; Nie, Y.; Han, L.; Li, L.; Sui, H. 2020.	Fifty patients with proximal clavicle fractures received surgical	Surgery time ($t=2.063$, $P=0.058$), intraoperative bleeding ($t=1.979$,

	treatment. They were divided into a clavicular T-plate group and a double mini-plate group. The duration of the operation, blood loss during the operation, fracture healing time, and incision infection were evaluated between the two groups.	P=0.062) and fracture healing time (t=1.082, P=0.066) were not statistically significant in both groups. Patients were followed for 12-18 months; one patient in the T-plate group had early nail removal, but no clinical symptoms. At the 2-month follow-up, the ASES score in the double mini-plate group was significantly better than in the T-plate group (P<0.001); but at the 6-month follow-up, 1 week before the removal of internal fixation and the final follow-up, the two groups showed no significant differences (P>0.05).
Kilinc, B.E.; Oc, Y.; Erturer, R.E. 2020.	Forty patients were retrospectively included. The patients underwent an anterior posterior radiograph of the right shoulder after the examination. The results were evaluated by the patient's return to daily activities, Constant score, Arm Disability, and Shoulder and Hand score, followed by radiological and clinical examination.	Fourteen (35%) patients were female and 26 (65%) were male. The mean age was 36.2 years. Twenty-six patients had fractures of the right clavicle and 14 patients were discharged. Twenty-three fractures were type 2B1 and 17 fractures were type 2B2. The mean follow-up time was 36.4 months. Radiological consolidation was 9.1 ± 1.3 weeks. All patients had excellent results. The mean Constant score was 97.2 ± 1.8 , the mean arm disability and shoulder and hand score were 3.8 ± 2.4 .

DISCUSSION

Rodrigues *et al* (2023) conducted an observational and cross-sectional study with 88 patients, of both genders and under the age of 60, who underwent surgical approach for clavicle fracture between May 2020 and February 2024 at a specialized orthopedics center. In all, 81.81% had clavicular shaft fractures. The materials used in osteosynthesis are listed in **Table 3**, ordered by prevalence. The study did not detail the materials used specifically for shaft fractures, which represents a limitation in the analysis. Despite this, the study allowed us to observe how the different plates constitute a common approach in surgical treatment.

Table 3. Materials used in clavicle osteosynthesis procedure in a study by Rodrigues *et al* (2023)

Material used	n	%
Blocked clavicle plate	46	52,27
Rebuild plate	15	17,04
Rebuild locked board	11	12,5
Kirschner wire with anchor	6	6,8
Kirschner's Fio	4	4,5
Kirschner wire with ligation	3	3,4
Locked T-plate	1	1,1
Single Plate (DCP)	1	1,1

Prepared by the authors

Another approach explained by the study was the use of Kirschner sutures. Created in 1909 by Martin Kirschner, it is a metal device widely used in orthopedic surgeries to stabilize fractures and facilitate healing. These devices offer an effective and safe solution to maintain the stability necessary for recovery (SBCOC, 2024). However, the use of Kirschner wires can be associated with several complications, which include: vascular and nerve injuries, tendon ruptures, osteomyelitis, loss of fracture reduction or dislocation, superficial infections, and wire migration (Tan *et al*, 2016). These complications can significantly affect the clinical outcome and recovery of the patient, highlighting the importance of close follow-up during the postoperative period.

In the study by Amaral *et al* (2023), the results of the treatment of 15 clavicle shaft fractures using the Minimally Invasive Osteosynthesis with Locked Plate technique were analyzed. All patients had bone healing within three months. Regarding complications, three patients had minor complications: one with anterior paresthesia of the clavicle and two with prominence of the plaque, without the need to remove the synthesis material. There were no cases of hypertrophic scarring or skin irritation. Only one patient had a major complication, with dehiscence of the surgical scar, requiring cleaning, debridement, and suturing in the surgical environment. The study demonstrated that minimally invasive treatment for displaced clavicle fractures achieved excellent clinical and radiographic results, with complete consolidation in all cases and a lower complication rate compared to studies that used open plate fixation.

According to Hehn *et al* (2020), the optimal approach for the treatment of fractures of the middle third of the clavicle is still a widely debated topic in the literature, reflecting the continuous search to optimize the prognosis of patients and allow a complete return to their

usual activities. Recent studies have favored surgical intervention, as it has been shown to reduce the incidence of pseudoarthrosis and inadequate union, in addition to improving shoulder function. The most common osteosynthesis involves fixation with a plate and screws positioned in the upper part of the clavicle, corroborating the research by Rodrigues *et al* and Amaral *et al* with the main complications related to the use of surgical material.

The main criticism of the surgical treatment of clavicle fractures lies in the prominence of the synthesis material, given that the clavicle is located in a subcutaneous position. This aspect was also observed in the study by Hehn *et al*, where 44.1% of the patients reported discomfort due to plaque protrusion, a finding that is consistent with the technique used and with data from other studies. Similarly, Wang *et al* (2015) found 40% of complications associated with the prominence of the plate or screws, while Nourian *et al* (2017) also noted that the superior approach results in a high rate of problems with the plates and often requires further surgery to remove the implant.

The study by Mendes Junior *et al* (2021) covered a sample of 32 patients who underwent surgery for multifragmented fracture of the clavicle shaft. **Table 4** below, created by the authors, summarizes Mendes Junior's findings, contributing to the understanding of the main postoperative repercussions in this study.

Table 4. Main postoperative repercussions of clavicle osteosynthesis in the study by Mendes Junior *et al* (2001)

Observed Appearance	n	%	Main flaw	n	Failure rate
Performed 12-hole implant	28	87,5	Needed to remove the 12-hole implant	5	15,6
Bone healing over a mean period of 17 weeks, with no cases of pseudoarthrosis or infection	30	93,7	Failure of osteosynthesis	2	6,25

Prepared by the authors

Of the patients who presented osteosynthesis failure, both were 61 years old and had implant loosening in the initial phase, without plaque rupture. One patient, who was an alcoholic, was released 1 week postoperatively, while the other, with type 2 diabetes, had the failure after 8 weeks. Both patients were reoperated with open reduction and internal fixation with plate and screws, without the need for bone grafting, and evolved with fracture consolidation. Other complications reported in the study are shown in **Table 5**:

Table 5. Post-surgical complications found in 32 patients who underwent surgery for multifragmented fracture of the clavicle shaft in a study by Mendes Junior *et al*

Complication	n	%
Discomfort on the plate	6	18,8
Pain during exertion	5	15,6
Hypersensitivity	2	6,2
Pain at rest	1	3,1

Prepared by the authors

FINAL CONSIDERATIONS

The literature on clavicle shaft fractures is extensive and up-to-date, considering that this is the main region affected by trauma to this specific bone. Epidemiological data revealed that these injuries mostly affected people who engage in high-impact activities, with car accidents being a frequent source of these fractures.

Despite the importance of surgery, there is still disagreement among experts about the ideal approach. Although conservative treatment is widely recommended, surgical treatment has demonstrated a high success rate and low complication rates, allowing a faster return of the patient to their usual activities.

Regarding surgical techniques, it was observed that blocking plates were the most used, while Kirschner wires were less frequently used. These findings highlight the need for further studies that can guide the choice of the optimal approach for each type of fracture and patient.

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