

# Displaced Mid-Shaft Clavicular Fractures: Is Conservative Treatment Still Preferred?

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**ABSTRACT:** **Background:** A clavicular fracture accounts for 2.6%–5% of adult fractures. Fractures in the middle-third (OTA 15-B) represent 69%–82% of all clavicular fractures. There is no consensus among orthopedic surgeons regarding treatment for these fractures: many support conservative treatment even for displaced middle-third clavicular fractures, while others choose operative treatment.

**Objectives:** To assess the attitudes of orthopedic surgeons regarding treatment of displaced mid-shaft clavicular fractures.

**Methods:** We conducted a survey in which we interviewed orthopedic surgeons from various countries during the 2012 EFORT meeting in Berlin. The questionnaire included an X-ray of a displaced middle-third clavicular fracture, as well as questions regarding the surgeon's proposed treatment plan.

**Results:** A total of 177 orthopedic surgeons completed the questionnaire; 49% preferred operative treatment for a displaced middle-third clavicular fracture. Among the orthopedic trauma specialists, 58% suggested operative treatment, as did 82% of shoulder specialists. Most surgeons preferred a locking plate for fixation.

**Conclusions:** The treatment approach for a displaced middle-third clavicular fracture seems to be evenly split between conservative and operative approaches. The tendency toward operative treatment was even more remarkable among orthopedic trauma specialists and shoulder specialists who completed the questionnaire. Most surgeons prefer a locking plate as a fixation system for this type of fracture.

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**KEY WORDS:** displaced mid-shaft clavicular fracture, operative vs. conservative treatment, plating, intramedullary nail

A mid-shaft clavicular fracture (OTA 15-B) accounts for 2.6%–5% of adult fractures [1]. This is the thinnest area of the clavicle and is not protected by muscle tissue, which makes this area prone to fractures. All mid-shaft fractures occur lateral to the sternocleidomastoid muscle and medial to the coracoclavicular ligaments. The medial fragment is pulled superiorly and posteriorly by the sternocleidomastoid muscle. The lateral fragment is pulled forward and rotates

inferiorly due to the weight of the upper extremity and the pull of the pectoralis muscle.

Traditionally, the absolute indications for surgical treatment include open fractures and fractures associated with skin compromise or with neurologic and vascular injury. Conservative treatment for these fractures was the common practice since older studies claimed the non-union rate to be less than 1% [2,3]. A certain amount of deformity with return of satisfactory function of the shoulder was expected. However, several recent studies reported worse results with conservative treatment: a non-union rate of 15–20%, shoulder muscle strength loss of 18–33%, poor early functioning of the injured shoulder, and as many as 42% of patients with residual sequelae 6 months after injury [4–9]. Since this injury occurs most often in young active patients who want to avoid the above complications, primary operative treatment has become common. Several fixation treatments are used, such as intramedullary nail, plate and screws, and a locking plate and screws [7,10–14].

Numerous randomized studies comparing conservative to operative treatment have been conducted [4–9]. Xu et al. [9] and McKee et al. [15] performed a meta-analysis to determine the preferred treatment. They found a higher non-union rate and symptomatic mal-union rate after conservative treatment.

It seems that the traditional guidelines for operative treatment of the displaced mid-shaft clavicular fracture are less strict than in the past. Guidelines in many medical fields change with time, and the emergence of new technologies mandates expert opinion. In this paper we review the literature and determine the current trends and common practices for treating a displaced mid-shaft clavicular fracture.

## METHODS

We developed a multiple-choice questionnaire on displaced mid-shaft clavicular fractures; X-rays were included [Figure 1 and Appendix]. The questionnaires were distributed to orthopedic surgeons during the 13 EFORT meeting in Berlin, Germany, in May 2012.

The first question addressed the preferred treatment option for a displaced mid-shaft clavicular fracture (OTA 15-B1) that was shown on an X-ray. Possible response was conservative

**Figure 1.** X-ray of a 50 year old healthy active patient admitted to the emergency room with a closed injury. Physical examination revealed no neurovascular injury and no skin tenting



or operative. The second question addressed the preferred operative technique for fixation of the illustrated fracture. The choices were non-locking plate and screw, a locking plate and screw, or an intramedullary nail. The third question related to the experience of the surgeons with operative treatment of displaced mid-shaft clavicular fractures. They were asked to report how many displaced mid-shaft clavicular fractures they had operated on the year before.

**STATISTICAL ANALYSIS**

A univariate analysis was performed using the chi-square test to detect significant differences in choices among surgeons from different subspecialties and with varying levels of experience. Data were presented as numbers and percentages. Differences between selected subspecialties were compared using the chi-square test. A *P* value of < 0.05 was considered statistically significant.

**RESULTS**

Our findings are summarized in Table 1. Of the 177 orthopedic surgeons who completed the questionnaire, 68.4% were specialists and the rest were residents. An annual case load of more than 100 trauma cases was reported by 42%, and 62% had more than 50 cases yearly. More than 80 surgeons worked in hospitals. Regarding experience, 58% of the surgeons reported more than 10 years of experience and 32% more than 20 years. Seventy-nine surgeons (45%) were orthopedic trauma specialists, and 10 (5.6%) were shoulder and elbow specialists. The remaining were subspecialists in other fields in orthopedic surgery.

**• QUESTION 1**

177 surgeons responded: 50.6% chose conservative treatment and 49.4% recommended operative treatment. Among the trauma specialists, the answer to the same question differed significantly: 58% suggested operative treatment (*P* = 0.033). The same tendency appeared among shoulder specialists, with 82% preferring operative treatment (*P* = 0.046).

**• QUESTION 2**

177 surgeons responded: 37% chose a non-locking plate, 49% chose a locking plate, and 14% chose an intramedullary nail. Orthopedic trauma specialists and shoulder specialists answered this question with approximately the same distribution.

**• QUESTION 3**

From the total population of surgeons who participated in the survey, 36% had not operated on clavicle fractures in the last year, 38% had operated on up to 5 cases, and 15% operated on 6–10 cases. Only 11% had operated on more than 10 cases in the last year. These included 15% of the trauma specialists, only 6.5% of the non-trauma or shoulder specialists, and 20% of the shoulder specialists.

**DISCUSSION**

This study assessed common approaches to treating a displaced mid-shaft clavicular fracture (OTA 15-B1) in an international group of orthopedic surgeons. We wanted to determine whether the current preferred treatment differed from traditional guidelines, and whether it was influenced by subspecialty, experience or both.

**CONSERVATIVE VS. OPERATIVE TREATMENT**

Most mid-shaft clavicular fractures can be treated conservatively. These include children and adolescents with a greater chance of healing because of delayed closure of the medial epiphysis, simple or multi-fragmentary fractures with minimal displacement, and patients with high risk for low compliance [16,17]. Traditionally, the absolute indications for surgical treatment include open fractures and fractures associated with skin compromise or with neurologic and vascular injury. Several authors recommend surgical intervention if displacement is more than 100% of shaft width or if shortening exceeds 15 mm. The first

**Table 1.** Distribution of survey results

Question	Total	Non-trauma or shoulder surgeons	Trauma surgeons	Shoulder and elbow surgeons
<b>Treatment for displaced mid-shaft clavicular fracture</b>	n=172	n=88	n=81	n=9
Conservative	50.6%	59.1%	42%	18%
Operative	49.4%	40.9%	58%	82%
<b>Fixator type</b>				
Non-locking plate	37%	42.1%	33%	30%
Locking plate	49%	46.1%	49%	60%
Intramedullary nail	14%	11.8%	17%	10%
<b>Cases treated operatively per year</b>				
0	36%	55.6%	18.5%	10%
1–5	38%	37%	40.7%	30%
6–10	15%	1.2%	25.9%	40%
> 10	11%	4.9%	14.8%	20%

question of our study related to the argument of conservative vs. operative treatment for a displaced mid-shaft clavicular fracture. It seems that operative treatment is more common today than in the past. During the 1960s, mid-clavicular fractures were considered the domain of non-operative treatment, based on two studies conducted by Neer [2] and Rowe [3]. Regardless of fracture type and displacement, complete recovery of shoulder function was anticipated [2,3,18].

There are several reasons for discrepancies between those studies and newer studies that support operative over conservative treatment. One is the patients' expectations of treatment results. Osseous consolidation and range of motion, which were the main considerations for treatment success in the past, are not the only factors today. Patient-based scoring systems (Constant Score and DASH Score) also consider factors such as pain, cosmetic result and daily function. Neer and Rowe concluded in their well-known studies that conservative treatment is good enough, since both included in their series a large number of adolescents [2,3]. The clavicle has a great potential for remodeling at those ages due to late closure of its diaphysis. Conservative treatment is sufficient for young patients but should not be the treatment of choice in older patients. Only in 1998 was a new classification described that took into account the degree of displacement and comminution. With the newer classification, devised by Robinson [1], a suitable treatment can be assigned according to fracture type. Mal-union is one of the factors that cause reduced shoulder function. It was noted recently that displaced mid-shaft clavicular fractures have a high rate of mal-union, non-union, and sequelae. Robinson noted four risk factors for the above complications: age, female gender, displacement of more than one clavicular shaft width, and comminution [1]. Displaced mid-shaft clavicular fractures might be complicated with mal-union and non-union in 19–33% of cases. When the fracture is comminuted, the rate of mal-union and non-union increases to between 33% and 47% [1,16,19]. Several recent studies stressed the importance of clavicular length restoration. They showed that clavicular shortening of more than 15 mm following healing caused a higher incidence of pain [19,20]. Thirty-three percent of patients were dissatisfied after treatment for displaced mid-shaft clavicular fractures that resulted in shortening. Strength reduction was also noted in shoulder flexion, abduction and rotation [10,21]. Several static changes following mal-union and shortening might cause decreased strength, including a greater sternoclavicular angle, change in resting position of the scapula, opening of gleno-humeral angle which leads to greater shearing forces on the anterior glenoid and labrum, and eventual shortening of the lever arm of muscles of the shoulder girdle [21]. Robinson reported a higher dissatisfaction rate in patients treated conservatively for displaced mid-shaft clavicular fractures [7]. These findings have led to the tendency to operate even on

adolescents when the fracture is completely displaced or when the length of the clavicle cannot be restored [19].

Of the surgeons who took part in this study, 49.4% felt that operative treatment is the preferred option for this injury. Interestingly, among trauma specialists and shoulder specialists (the surgeons who treat these injuries most often), the proportion of surgeons who prefer operative treatment was much higher.

#### OPERATIVE TREATMENT OPTIONS

The goal of operative treatment is anatomic reduction and internal fixation. The two main fixation options after reduction are internal fixation with a plate (non-locking or locking) and internal fixation with an intramedullary nail. With both options, the patient is positioned slightly upright. It is easier if the patient is positioned on a radiolucent operative table. The arm and shoulder are draped freely to allow for the necessary manipulation to achieve reduction.

#### PLATE OSTEOSYNTHESIS

Plate osteosynthesis is still the standard method for the surgical treatment of clavicular shaft fractures. The skin is incised over the clavicle along the Langer lines. Some perform the incision 1–2 cm below the clavicle to decrease the chance of skin complications. The plate is positioned on the anterosuperior surface of the clavicle. It is common to use three screws on each side of the fracture to achieve good fixation [17]. Since the clavicle rotates during arm elevation, the plate is subjected to high forces during arm movements. In order to prevent hardware failure, it is essential to use a strong plate relative to the bone strength. The 3.5 mm plates are preferable for these fractures. The LC-DCP plates are considered more suitable than the DCP plates. These plates have reduced bone contact area and are less harmful to the periosteum. Fixation with locking plates compared to reconstruction plates leads to superior biomechanical stability for mid-shaft clavicular fractures [22] [Figure 2]. Locking plate fixation of displaced clavicle fractures in athletes is a safe procedure, with high satisfaction rating that allows early return to sports [23].

#### INTRAMEDULLARY NAIL

The intramedullary nail provides a good alternative solution for the displaced mid-shaft clavicular fracture. A clavicular intramedullary nail can be inserted by open retrograde intramedullary nailing or using a minimally invasive technique with a titanium elastic nail.

For the open retrograde reduction and fixation, the patient is positioned slightly upright. The fragments are visualized through a small incision. The fragments are prepared by drilling into the medullary canal. The posterolateral cortex is perforated through the medullary canal. Subsequently, the pin is retrogradely introduced over the fracture site into the lateral fragment and posterolaterally through the clavicle, soft tissue

**Figure 2.** A 30 year old healthy male injured his right clavicle in a motorcycle accident and was admitted to our department. He was operated 2 days later by open reduction and internal fixation with a locking plate



and skin. The pin is then retracted from the lateral end so that the medial end of the pin is completely within the lateral fragment. The fracture is then reduced and the pin is screwed into the medial fragment. Finally, a nut is screwed onto the pin posterolaterally to achieve compression of the fragment. The pin is cut close to the nut to avoid lateral hardware prominence [17].

For the minimally invasive approach, the patient is placed supine on a radiolucent table. The arm and shoulder are positioned to allow free movement. The surgeon is on the contralateral side, which allows introduction of the nail from a small medial incision. The optimal penetration point is 1–2 cm lateral of the sternoclavicular joint in the middle of the proximal clavicle. The ventral cortex is penetrated and the TEN (titanium elastic nail) is introduced into the medullary canal. The TEN is driven laterally toward the fracture. With the use of an image intensifier, closed reduction of the fracture is achieved. If closed reduction cannot be achieved, a 2 cm incision at the fracture site allows direct manipulation of the fragments. After reduction, the elastic nail is driven into the lateral fragment with rotational movements. The nail is shortened above the insertion site [17].

Intramedullary nailing of a mid-shaft clavicular fracture has some advantages over plating. It circumvents the problem of changing of tension band side with different rotational positions of the clavicle. Additional advantages are a smaller incision and intramedullary fixation, which prevents some of the scaring problems that are more common with plate fixation. In addition, there is no plate prominence over the clavicle. Also, there is no need for postoperative movement restriction with an intramedullary nail. Jubal et al. [24] reported on athletes who returned to their activities as soon as 2–3 weeks after surgery.

**Figure 3.** A 20 year old healthy female injured her right clavicle in a motorcycle accident and was admitted to our department. She was operated 5 days later by open reduction and internal fixation with an intramedullary nail



In summary, intramedullary nailing leads to good cosmetic and functional results [Figure 3].

Intramedullary nail insertion for a mid-shaft clavicular fracture does have some disadvantages. The most frequent complication is skin irritation at the insertion point caused by the subcutaneous position of the nail [25]. Occasionally, the nail needs to be shortened at the insertion site or even removed prematurely. The most serious complication with intramedullary nailing is migration, in which case the nail must be removed [24,25].

In our survey, only 14% of surgeons chose to use an intramedullary nail to repair a mid-shaft clavicular fracture. In contrast to the survey results, we usually use an intramedullary nail with a minimally invasive approach to repair a displaced mid-shaft clavicular fracture. We find this technique easy to perform, and both the functional and cosmetic results are good.

The third question revealed that most patients who sustain a mid-shaft clavicular fracture are treated by either an orthopedic trauma surgeon or a shoulder specialist. Most general orthopedic surgeons do not repair these injuries at all and some treat as few as five cases per year. We believe that treating an uncommon injury such as mid-shaft clavicular fracture should remain in the hands of the subspecialists, meaning orthopedic trauma and shoulder surgeons. We also believe that the argument of conservative vs. operative treatment for this injury should stay in the purview of trauma and shoulder surgeons. They treat the majority of these injuries, use a variety of surgical approaches and fixators, and have the experience and knowledge to judge whether the treatment should be conservative or operative; and if operative, to determine the preferred surgical approach.

**CONCLUSIONS**

According to our survey results there is still no consensus regarding conservative vs. operative treatment for a displaced

mid-shaft clavicular fracture. Orthopedic trauma specialists and shoulder specialists have a greater propensity toward operative treatment. Most surgeons who operate on these fractures prefer to use a locking plate as a fixation system.

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#### APPENDIX: Questionnaire (The questions are related to Figure 1)

A 50 year old healthy active patient was admitted to the ER with a closed injury. Physical examination revealed no neurovascular injury and no skin tenting.

- 1. What would your preferred treatment be?**
  - Conservative
  - Operative
- 2. The decision in your department was to operate on this patient. Which operative treatment would you recommend?**
  - Plate and screw (non-locking plate)
  - Locking plate and screws
  - Intramedullary nail
- 3. How many mid-shaft clavicle fractures did you treat surgically last year?**
  - 0
  - 1-5
  - 6-10
  - > 10