Displaced Clavicle Fractures: 
Surgery Provides Better Results

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1. Introduction: Clavicle fractures are common injuries accounting for 2.6% of all fractures\(^1\) and occur most commonly in young active individuals\(^2\). Middle third (or mid-shaft) fractures account for approximately 80% of all clavicle fractures\(^1,2\), and have traditionally been treated non-operatively, even when significantly displaced. However, more recent studies have shown non-union rates of up to 21% in displaced midshaft clavicle fractures and unsatisfactory patient oriented outcomes in up to 31%. In addition, clavicular malunion has recently been described by multiple authors as a distinct clinical entity with characteristic clinical and radiographic features. Possible explanations for the increased residual disability seen following the non-operative care of these fractures may be changing injury patterns, increased patient expectations, more complete follow-up (including patient-oriented outcome measures) and eliminating children (with their inherently good prognosis and remodeling potential) from the data analysis. It is clear that there is a role in selected individuals for primary operative fixation of displaced fractures of the shaft of the clavicle.

2. Outcomes of non-operative treatment:
Studies of non-operative treatment of completely displaced, mid-shaft fractures of the clavicle reveal nonunion rates between 15% and 20% \(^5,6\). These studies were recently summarized in a meta-analysis that found a nonunion rate of 15.1% following non-operative care\(^7\). Malunion of the clavicle is a distinct clinical entity with characteristic orthopaedic (weakness, easy fatigueability, scapular winging), neurologic (thoracic outlet syndrome) and cosmetic
(droopy, asymmetric shoulder, difficulty with backpacks, shoulder straps etc.) symptoms. It is associated with increasing degrees of clavicular shortening. Clinically symptomatic malunion has an incidence of 15-20%. There are multiple, modern studies that show plate fixation is an extremely effective technique for treatment of clavicular shaft fractures with a low complication and nonunion rate. A meta-analysis described a nonunion rate with plate fixation of 2.2%, which represents an 86% risk reduction for nonunion compared to the same fracture treated non-operatively (nonunion rate 15.1%) . Hill et. al. were the first to use a patient-oriented outcome measure, and found 31% of patients described unsatisfactory outcome after non-operative care of displaced clavicle fractures. This may be explained by significant residual strength deficits following the conservative treatment of these fractures (strength deficits ranging from 10% to 35% were found in patients a mean of 54 months after non-operative care of a displaced fracture of the clavicular shaft).

3. Randomized Clinical Trials of surgery versus non-operative treatment:
Eight studies have been performed (n=690 patients, 337 treated operatively, 353 treated non-operatively): all were RCTs that enrolled completely displaced midshaft clavicle fractures. The studies were multiple countries; Finland (2011), United States (2009, 2000), Austria (2009), Canada (2007), Germany (2007), United Kingdom (2013), and Chile (2105). There were no statistically significant differences in baseline demographics between the operative and non-operative groups, and individuals enrolled in all eight studies were homogenous, consisting of young (mean age 28.0-39.8 years) predominantly male patients. Three studies, examined specific sub groups (Judd et.al. - active duty military personal, Witzel- athletes, and Melean- work related injuries). Operative techniques included plate fixation in 5 studies, and IM pin fixation in 3 studies. Non-operative treatment consisted of a sling in all studies.

Virtanen et. al. 2011: Virtanen et. al randomized sixty patients to sling (thirty-two patients), or plate (twenty-eight patients) treatment. At one year twenty-six operative and twenty-five non-operative patients were followed and Constant Shoulder Scores (non-operative group 86.1, operative group 86.5, p=0.90), DASH scores (7.1 in the non-operative group, and 4.3 in the operative group, p=0.81), and the VAS (on a scale from 1-100 at rest, 7 for the nonoperative group, 3 in the operative group, p=0.88) were recorded. There were six non-unions in the non-operative group versus none in the operative group (6/25, 23%, versus 0/26, 0%, p=0.01). These six patients with nonunion had greater initial displacement of their fractures (p=0.002) and worse DASH scores (mean sixteen points lower, p=0.05).
Smekal et al. 2009: Smekal et al. randomized sixty-eight patients to sling or elastic titanium intramedullary pin fixation. Sixty patients (thirty in each group) were assessed at two years post-injury. Time to union was shorter in the operative group (12.1 weeks) compared to the non-operative group (17.6 weeks) (p=.04). The DASH scores remained significantly lower (p<0.05) in the operative group for the first 18 months after injury. The CS score was significantly higher (p<0.05) at both the 6-month and 2 year follow up in favour of the operative group. Delayed union (no evidence of healing at 24 weeks post-injury) developed in six patients in the non-operative group (6/30, 20%) versus none of the operative group (0/30, 0%) (p=0.02).

Judd et al. 2009: In this study, fifty-seven military personnel were randomized to Haigie pin fixation (twenty-nine) or a standard sling (twenty-eight). The SANE and L’Insalata scores were significantly higher at week 3 for the operative group (p<0.044 and p<0.015). There were no significant differences between these two groups at any other time. One patient in each group developed a nonunion (1/29, 3% operative versus 1/28, 4% non-operative). This study is notable for the high complication rate in the operative group (48%) compared to the non-operative group (7%). The high complication rate for the operative group was due primarily to minor complications from pin prominence postero-laterally (causing pin infections and early removal).

COTS 2007: This study randomized 132 patients to a standard sling (sixty-five) or small fragment plate fixation (sixty-seven). Forty-nine non-operative and sixty-two operative patients completed the 1 year follow-up. The CS and DASH scores were significantly better at all time points for the operative group of this study (p<0.01). There were two nonunions in the operative group (3%) and seven non-unions in the nonoperative group (14%) (p=0.042).

Witzel 2007: Witzel’s study randomized thirty-three patients to nonoperative care (sling) and thirty-five to operative fixation with a elastic intramedullary pin and concentrated on distinguishing differences in early return to function. Early (one month) pain scores were significantly better for the operative group (p=0.05), as was strength (p=0.01). On the 60th day 80% of the operative group resumed athletics while only 55% of non-operative patients did.

Smith et al. 2000: In a randomized clinical trial, Smith and colleagues randomized one hundred patients to a sling or small fragment plate fixation: only thirty-five non-operative and thirty operative patients completed follow-up (mean 18.5 months). Of the thirty operative patients there were no nonunions or symptomatic malunions (0%), and twenty-five patients were satisfied with their outcome (five dissatisfied). Of the thirty-five non-operatively treated patients there were
twelve nonunions (34%) and four symptomatic malunions (11%): twenty-six patients were satisfied with their outcome (nine dissatisfied).

**Robinson et. al. 2013:** In the largest RCT to date, Robinson et. al. randomized 200 patients to plate fixation versus non-operative care. The nonunion rate was significantly higher in the non-operative group (sixteen versus one, \( p=0.0001 \)), there were more symptomatic malunions in the non-operative group, DASH and Constant scores were better in the operative group, and patients were more satisfied with their shoulder appearance after surgery. However, the authors pointed out that if patients with nonunion were excluded, there was little difference in overall outcome, and stressed the need for developing better prognostic factors.

**Melean et. al 2015:** This group randomized 78 patients with work-related clavicle fractures to plate fixation versus sling and used CT scanning to evaluate bone formation and union. They concluded: “Surgical treatment with ORIF of displaced middle-third clavicular fractures achieved good and excellent functional results, shorter time to complete return to work, earlier bone union, and fewer cases of nonunions in a working population under injury compensation.”

### 4. Current operative indications

In general patients selected for primary operative fixation should be young (age 16 to 60 years), healthy and active. Select indications include:

**Fracture-specific**
1. Displacement or shortening > 2 centimeters
2. Increasing comminution (> 3 fragments) or segmental fractures
3. Open or Impending open fractures with soft-tissue compromise
4. Scapular malposition and winging on initial examination

**Associated Injuries**
1. Vascular injury requiring repair
2. Progressive neurologic deficit
3. Ipsilateral upper extremity injuries / fractures
4. Multiple ipsilateral upper rib fractures
5. "Floating shoulder”

**Patient Factors**
1. Polytrauma with requirement for early upper extremity weight-bearing / arm use
2. Patient motivation for rapid return of function (elite sports, self-employed professional, etc.)
References