

This article discusses displaced fractures in the clavicular shaft with a commentary on page 29.

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Displaced fractures of the clavicular shaft: Fact and fallacy

Introduction A 28-year-old surgical resident presents to your fracture clinic having fallen off his mountain bike going down a steep hill. He sustained an isolated, closed neuro-vascularly intact mid-shaft fracture of his left clavicle seen in **Fig 1**. Medically, he is otherwise completely well. On examination, there is an obvious clinical deformity with a droopy, protracted shoulder. The left shoulder is, by clinical measurement (sterno-clavicular joint to acromio-clavicular joint), two centimeters short. He stresses that rapid return to function (and his surgical duties) is very important to him, and points out that, like many modern physicians, his interests outside medicine are many and he is very active in mountain-biking, skiing and rock-climbing. He has gleaned some information from standard textbooks and discussions with colleagues and has a number of questions:



1

Is it true the incidence of nonunion after a displaced mid-shaft clavicle fracture is 1% or less?

The incidence of nonunion of the clavicle following mid-shaft fracture has traditionally been described as 1% or less, based on two landmark studies from the 1960s [1-4]. This figure has been used as a reason to avoid primary operative intervention. However, times have changed. A number of recent studies that have concentrated on 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 nonoperative care of these fractures [7]. There may be many reasons for this exponential increase in nonunion: better follow-up, inclusion of more severe fractures, elimination of children from the series (with their intrinsically good prognosis) patient reluctance to remain immobilized, etc. [5, 8]. I would tell this patient: the chance of his fracture not healing by one year is 15% to 20%.

Fig 1 X-ray of displaced clavicular shaft fracture in 28-year-old surgical resident.

2

Is malunion of the clavicle of radiographic interest only?

This is certainly what has been promoted in the past. However, through the pioneering efforts of surgeons like Carl Basamania, Jesse Jupiter and Lynn Crosby it is now apparent that clavicular malunion is a distinct clinical entity with characteristic orthopedic (weakness, easy fatigability, scapular winging), neurologic (thoracic outlet syndrome) and cosmetic (droopy, asymmetric shoulder, difficulty with backpacks, shoulder straps, etc.) symptoms [9-12]. Our series identified shortening (mean 2.9 cm) as a risk factor for the development of this condition, and showed that corrective osteotomy was a reliable treatment method for restoration of upper extremity function [13]. I would tell this patient that he had a 15% to 20% risk of developing a malunion symptomatic enough that he would request corrective osteotomy.

3

He has heard it said that "The only clavicle fractures that don't heal are the ones that are operated on".

This statement was based on studies from the 1960s that included surgery for only the worst fractures (selection bias) and used soft-tissue management and fracture fixation techniques that would be considered suboptimal by modern standards. There are multiple, modern studies from North America, Europe and Asia which clearly show that plate fixation is an extremely effective technique for treatment of clavicular shaft fractures with a low complication and nonunion rate [14, 15]. In fact, the meta-analysis quoted earlier described a nonunion rate with plate fixation of 2.2%, which represents an 86% risk reduction for nonunion compared to the same fracture treated nonoperatively (nonunion rate 15.1%) [7].

4

Will my shoulder be as strong as it was before my injury if it heals like this?

Prior studies of outcome following clavicle injuries did not describe any strength deficits following nonoperative care of displaced mid-shaft fractures, and tended to concentrate on radiographic and surgeon-based results. Hill et al were one of the first to use a patient-oriented outcome measure, and found 31% of patients were unhappy after nonoperative care [6]. This may be due to the fact that there are significant residual strength deficits following the conservative treatment of these fractures. Using an objective strength testing protocol for both maximal effort and endurance (which had not been done previously), we found strength deficits ranging from 10% to 35% in patients an average of 54 months after nonoperative care of a displaced fracture of the clavicular shaft [16]. This can have a significant effect on an active young person recreationally or occupationally.

5

Will a figure of eight bandage reduce my fracture and improve my outcome?

The first recorded description of the closed reduction of a clavicle fracture was in the "Edwin Smith" surgical papyrus from the 30th century BC, and there have been over 200 methods described since: there are so many because none of them work. There is little evidence that any closed method can reliably obtain and maintain reduction of a displaced mid-shaft clavicle fracture. A randomized trial by Andersen et al comparing a simple sling to a figure of eight bandage showed no functional or radiographic difference at final follow-up, and patients preferred the sling [17]. Essentially, if nonoperative care is selected, I would treat this patient in a sling and tell him that his fracture alignment will not change much from the initial x-ray.

6

If I choose nonoperative care, and develop a nonunion, is fixing it later as good as primary fracture fixation?

It has always been thought that the delayed reconstruction of a clavicular nonunion or symptomatic malunion will produce results as good as immediate fracture repair, ie delayed reconstruction is as good as primary fixation. However, this may not be the case. In addition to the delay and period of disability, patients undergoing delayed reconstruction face a higher complication rate, a potential requirement for iliac crest bone grafting, and their final result may be inferior to that which would have been achieved with primary fracture fixation. We compared the patient-oriented outcome and objective muscle strength in a matched group of patients with delayed reconstruction to those who had primary fixation and found significant deficits, especially in endurance strength [18]. I would tell this patient that delayed reconstruction, if necessary, is effective but inferior to primary fixation.

7

Will surgery get me back to work or sports any quicker?

There is increasing evidence that primary operative care returns patients to functional status earlier, on average, than nonoperative care. A recent randomized clinical trial conducted by the Canadian Orthopedic Trauma Society of 111 patients comparing primary plate fixation to nonoperative care (a sling) showed not only an overall improvement (at one year) in shoulder function, but also a much more rapid return of function and decrease in pain in the operative group [19].

Summary The choice to proceed with operative intervention for a displaced mid-shaft fracture of the clavicle will be a decision made between surgeon and patient. There is a much higher likelihood that both parties will be satisfied with their decision if it is based on fact from modern prospective and/or randomized studies with objective and patient-related outcome measures rather than fallacy. After a discussion, our patient elected to undergo surgical intervention (Figs 2 and 3) and was back at work in two weeks. His final result is excellent.

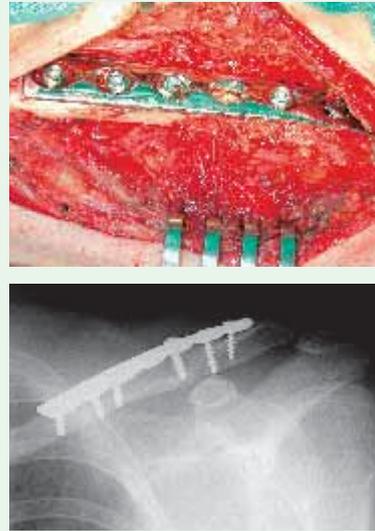


Fig 2 An intra-operative x-ray following open reduction and internal fixation with a small fragment LC-DCP. Note that the soft-tissue attachment to the comminuted fragment(s) has been left intact, and these pieces positioned under the plate without excessive stripping. If possible, a lag screw can be placed through the plate into this fragment.



Fig 3 Final x-ray revealing solid union.

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Commentary by Jesse B Jupiter

Michael McKee has clearly and convincingly outlined the rationale for reevaluating many heretofore well accepted concepts regarding fractures of the clavicle. So many of us were taught that these are “benign injuries; almost all heal; deformity is not a functional problem; and/or operative intervention is meddlesome and fraught with complications.” McKee and colleagues in several excellent studies have challenged these concepts utilizing both physician and patient rated outcome tools [1-3]. To further support his perspectives of “fallacies,” in a prospective study published in 2004, Nowak et al followed 208 patients who sustained clavicular fractures from 1988-1991 in Uppsala, Sweden for 9-10 years post injury [4]. While 112 (54%) recovered “completely,” 96 patients (46%) still experienced sequelae including pain at rest or with exertion, as well as cosmetic complaints.

Having been somewhat of a mentor to Michael McKee, I would be hard pressed to offer any alternative viewpoints, yet—lest the pendulum swing too precipitously towards the operative suite, it behooves us to try to define most clearly some aspects of his “facts.” First off, one must ask the question of just how much “displacement” is required to be considered sufficient to warrant operative treatment, especially if these concepts become widely accepted? Certainly, few would object to considering surgical management for the illustrated case of the 28-year-old surgical resident whose fracture includes a displaced segmental fragment. Here, too, the study of Nowak et al identified this pattern as one that was a predictor of adverse outcome along with those fractures without any bony contact or fractures in the older aged patient.

Is a standard anteroposterior x-ray sufficient to quantify “displacement”? Should we not require at least a 45° angled anteroposterior view and perhaps, when unsure, a 3D CT reconstruction?

What about “shortening” as an indication for operative intervention? While both Michael McKee and I have seen and treated with an osteotomy symptomatic patients with malunions characterized by shortening, what are the limits of shortening that are acceptable? Here, prior literature may be inadequate to define this parameter. Nordquist et al in 1997 followed 85 patients and did not find shortening to be a symptomatic problem [5] and likewise with the study of Nowak et al. Yet, in 1986, Eskola described an association of pain and diminished shoulder function in those fractures which healed with greater than 12 mm of shortening [6], while in 1997, Hill et al found that greater than 20 mm of shortening led to symptoms [7].

McKee and other members of the Canadian Orthopedic Trauma Society identified few complications and a high rate of

union in the operative cohort in their prospective randomized study. Can we expect the same from those who may have far less experience in this anatomic region? Should we begin to urge operative care of “displaced fractures”? Furthermore, plates applied on the superior surface of the clavicle may prove problematic or unsightly requiring a second procedure for later plate removal. As suggested by Kloen et al, anteroinferior plate placement may avoid some of these problems [8].

The subcutaneous nature of the clavicle should lend itself to less invasive surgical techniques. Witness the results of the experience of Rehm and colleagues in Köln, Germany, who reported on 136 fractures in 132 patients treated with a flexible titanium nail with 78 placed entirely percutaneously, and the remaining requiring a limited exposure for fracture reduction [9]. All but one healed, with follow-up revealing outstanding functional results.

In summary, I agree with the observations and recommendations by Michael McKee, but caution that we strive to establish defined criteria for those fractures requiring intervention and continue to document our outcomes in a careful manner.

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