ACADEMIC

Midshaft clavicle fractures: A review of current literature

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Abstract
Clavicle fractures are the most common fracture in the human body, accounting for 5–10% of all fractures presenting to the Emergency Department. The treatment of clavicle fractures historically has been more on the conservative side, but there has been recent evidence that operative management could reduce the incidence of adverse outcomes post-fracture. This review focuses on analysing the previous and present scientific literature on post-operative and post-conservative clavicle complications. This review concludes that the evidence for surgical management of clavicle fractures with certain indications is controversial and further studies are required.

Introduction

The clavicle is a bilateral long, slender, S-shaped bone, articulating medially with the clavicular notch of the manubrium, and laterally with the acromion of the scapula. It serves as a rigid support to allow the scapula to move freely, leading to maximal range of motion of the humerus. It also protects the neurological and vascular structures of the upper limb, and transmits compression forces from the hand to the axial skeleton, reducing the risks of appendicular injury.[1]

Clavicle fractures usually occur from trauma to the shoulder, such as landing on one's shoulder, or a fall on an outstretched hand. Incidence peaks within the first decade of life, comprising of 80% of all clavicular fractures, with a stepwise decrease in incidence in each subsequent decade, but with an increased chance of malunion.[2] Clavicle fractures can be categorised into thirds: proximal, middle, and distal clavicle fractures, with distal clavicle fractures being further subdivided according to the Neer Classification: Types I–IV, with further subtypes.[3] There are other classification systems that exist for clavicle fractures, such as Robinson's and Craig's, but we will focus on the Neer classification system as it is the oldest and most widely used.

Middle third clavicle fractures are the most common, at 80%,[4] due to strong muscular and ligamentous attachments at the medial and distal ends of the clavicle. Lateral third clavicle fractures occur next most commonly, at 20–30%, and proximal third clavicle fractures are the rarest, at 1–2%, and are usually due to serious injury, such as vehicular injury.[5]

Review

There are widely-accepted absolute indications for surgical management of acute clavicular fractures, including open fractures, damage to neurological and vascular structures, and a so-called "floating shoulder."[6] Surgical techniques either fall into open (with plating) or closed reduction (with intramedullary nailing). Indications for conservative management include minimal displacement of the fractured clavicle with no neurovascular compromise.[6] Conservative management includes using a sling and a figure-of-eight bandage with adequate analgesia.[7] There are many relative and controversial indications for surgical versus non-surgical management for clavicle fractures, including mild displacement.[8] Patient preference and co-morbidity are strong factors in determining management for these patients. Other factors which are relative indications for clavicular fixation include a higher energy injury, as these have a higher risk of nonunion, high degree of displacement, and specific fracture patterns.[9] The only New Zealand-specific guideline the author of this paper could find anywhere was the Starship guideline for paediatric clavicle fractures, in which a displaced middle/lateral third clavicle fractures was not an immediate indication for operation, but would have to be discussed with the on-call orthopaedic registrar on a case-by-case basis.[10] It is important to note, however, that these are simply guidelines and are not peer-reviewed literature.

Historically, clavicle fractures, most notably middle third fractures, were managed non-operatively, with internationally renowned orthopaedic surgeons Carter Rowe and Charles Neer (father of the modern shoulder arthroplasty) publishing studies in the 1960s. Rowe and Neer published retrospective cohort studies with 566 and 2235 patients with clavicular fractures in each study, with a nonunion rate of 0.8% and 0.1% respectively.[3,11] Both Rowe and Neer, alongside other surgeons during the 1960s–1990s, stated that nonunions and malunions were of radiological interest only, without any long-term clinical sequelae for the patient, and sang praise for conservative-based management due to the comparative downsides of potential surgical complications.[12] Surgical complication rates were higher in decades past, and with penicillin only being mass-produced in 1945,[13] the antibiotic arsenal was more limited than it is now. With a large number of patients in each of the exposure and comparison groups, and due to these papers being the first to systematically review operative and non-operative management, these studies were widely accepted. These studies have been criticised in recent times, on two main points: the inclusion of paediatric patients in their studies, and the omission of symptomatic and functional sequelae of nonunion and malunion.

One of the first studies criticising the widely-held belief of lack of significance of malunion and nonunion was by Hill et al in 1997, studying 52 non-surgically managed clavicle fractures, where in the group of eight patients with non-union fractures, seven (87%) had pain at rest, compared to the group of 44 unionised fractures, only six (14%) of patients with unionised clavicle fractures having pain at rest.[14] All other measures showed decreased function, including decreased shoulder range of motion.[14] One issue with the accuracy of this paper is that even though 242 patients had clavicular fractures, only 52 responded to the questionnaires from the researching team, leading to a small sample size of eight nonunions. The method of measurement is also not as robust as more recent studies, as questionnaires were the main method of reporting function, and actual quantitative scores such as the Disabilities of the Arm, Shoulder, and Hand (DASH) Questionnaire or Constant-Murley Shoulder Outcome Score (Constant Score)

were not used, with the former only having been introduced to the medical literature the year prior.[15] However, similar studies conducted later purported the same findings. In more recent years, some meta-analyses of surgical and nonsurgical methods of treatment such as Wang et al's 2019 meta-analysis of 13 randomised controlled trials (RCTs) showed surgical management to have a decreased risk ratio of 0.57 for complications, with a statistically significant increase of function in Constant scores by 4.7 points, but a decrease in DASH score of 6.34.[16] This study had a large sample size, was adequately powered, and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were adhered to. The drastic difference between functional scores could be because out of the 13 RCTs, only six of them had functional Constant score data, and five of them had functional DASH data, which could mean that all 13 RCTs were not evaluated equally in terms of functional outcome. However, the authors of this meta-analysis concluded that there was significant functional improvement with surgical management.

The inclusion of paediatric patients in Rowe and Neer's studies casts further doubt on the true rate of nonunion in the adult population, as the rates of malunion with the paediatric population are lower.[3,11] Children exist in an osteogenic environment, meaning that the healing processes are already ongoing at the time of fracture, decreasing the risk for nonunion.[17] Until recently, paediatric clavicle malunions were only found in case reports, due to their exceeding rarity.[18] A study by Pennock et al in 2018 showed a remarkably high malunion rate, as in a group of 545 adolescents with midshaft clavicle fractures, only 25 (4%) did not show any paediatric (<10 years old) malunions.[18] This study tripled the number of reported cases in the literature at the time, but there were limitations to its accuracy. Limitations to this study include that out of 25 patients with clavicle fractures, eight (32%) of the patients had had prior fractures to the clavicle, decreasing the union rate compared to an "unfractured" paediatric population, and confounding the actual risk of clavicular fracture.

In contrast to the paucity of reported paediatric clavicle malunion rates, adult malunion rates have been documented since the 1960s; some papers portrayed no change in function between surgery and conservative management. A meta-analysis by Axelrod et al[9] in 2020 analysed 22 RCTs regarding the risk of nonunions post midshaft clavicular fracture, finding that out of 585 non-operative patients, 65 patients (11%) developed malunion, compared to out of 1554 operative patients, with only 51 (3.3%) developing malunion. Supplementary measures of function one year post-operatively (utilising the DASH and Constant scores) showed an average of 3.8 and 4.5 point increases in functional scores in the operative group compared to the non-operative group; however, the 95% confidence interval (CI) was not statistically significant.[9] Axelrod et al[9] purport that even though malunion and nonunion rates are better in operative groups radiographically, this does not necessarily correlate with function, echoing sentiments of Rowe and Neer (however with a much higher non-operative nonunion/malunion rate).[3,11] The meta-analysis itself is robust, with a large sample size, and only included studies with a low risk of bias according to the Cochrane Collaboration's tool for assessing the risk of bias in RCTs.[19] A further, robust meta-analysis by Amer et al[20] in 2020 analysed 954 midshaft displaced clavicular fractures and showed similar results, with out of 457 non-operative patients, 64 patients (14%) developed nonunion, in contrast with out of 497 operatively managed patients, only seven (1.4%) developed nonunion. This study also could not find any statistically significant difference between functional scores for operative and non-operative management.

What does this all mean? We have multiple meta-analyses which show that operative management for adult midshaft clavicular fractures reduces the risk of nonunion and malunion, but there is a bifurcation of opinion regarding the increase of function and quality of life of patients in the long term. Some of these discrepancies may be explained by the fact that there is no gold standard for functional improvement after upper limb injury.[21] Even DASH and Constant, the most common scores, still have their flaws, such as bias in self-reporting and a lack of certain measures of function, such as shoulder stability.[22] There are also differences in patient demographics, whose differences in culture can explain differences in self-reported questionnaire-based function.[22] However, these explanations do not fully explain this difference in function post-fracture. There are clear indications for surgery, such as a floating shoulder or neurovascular compromise, but there are many relative and controversial indications for conservative and surgical management. An argument could be made for favouring nonsurgical management for relative indications for clavicle fractures, due to the complications that can come with surgery, as well as the cost to the District Health Board, but there is a clear decrease in nonunion/malunion with surgery, whose relevance is not fully clear and explained. As always, with simple questions come complicated answers; further research is required, such as a New Zealand-specific cohort study on conservative and surgical management of relatively-indicated midshaft clavicular fractures, analysing functional and radiological short- and long-term outcomes.

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