



Middle third clavicular fractures: to fix or not to fix?

– effect on outcome for patients

Clavicular fractures are common injuries with the incidence quoted between 29 and 198 per 10 000 population per year.¹ They are classified into three types:

1. Type 1: Middle third
2. Type 2: Lateral third (distal to coracoclavicular ligament)
3. Type 3: Medial third

The majority of fractures (> 70%) are type 1. Traditionally these fractures have been treated conservatively with initial immobilisation in a broad arm sling, collar and cuff, or figure of eight strapping. The results of conservative treatment were generally felt to be satisfactory. Nordqvist et al² in Malmö reviewed 225 mid clavicular fractures at an average of 17 years from injury. The great majority (185/82%) were symptom free. Thirty-nine (17%) had moderate pain and one patient was classified as poor. Fifty-three of the patients had a malunion and seven had nonunions. Forty of the patients with malunited fractures and three with nonunion were rated as good. Fagg¹ reviewed the available literature and found an incidence of nonunion of 7% in displaced mid shaft fractures at that time.

RECENT RESEARCH

Thormodsgard et al³ looked at patient satisfaction after non-operative management of clavicular fractures using the Disabilities of the Arm, Shoulder and Hand (DASH) classification. They looked particularly at clavicular shortening and found that patients with shortening of over 2 cm had the highest DASH scores indicating

disability and dissatisfaction with their outcome after the injury. They looked at all types of clavicular fracture but found that DASH scores were higher in type 1 fractures. They concluded, “patients with midshaft clavicle fractures with shortening of greater than 2 cm may be good candidates for operative repair.”

Murray et al⁴ assessed the significant risk factors for nonunion in 941 conservatively treated mid shaft clavicular fractures in adults. One hundred and twenty-five (13.3%) had clinical and radiological evidence of nonunion. The most important factors predictive of nonunion were smoking, comminution and fracture displacement. The most important single factor was smoking (odds ratio, 3.76). They felt that smoking cessation should be an integral part of treatment.

More recently there has been a resurgence of interest in operative fixation of displaced mid-shaft fractures of the clavicle. McKee et al⁵ conducted a meta-analysis of operative *versus* non-operative treatment in these patients. Six randomised clinical studies (412 patients) were included. They found that the incidence of both nonunion (14.5% vs 1.4%) and symptomatic malunion (8.5% vs 0%), was lower in the operated patients. They found an earlier return to function in the operated group. However, they concluded, “there is little evidence at present to show that long term functional outcome of operative intervention is significantly superior to non-operative care.”

Obremskey⁶ commented on this meta-analysis believing that it had led some surgeons into overuse of internal fixation for these injuries. He emphasised that 75% of patients with

displaced mid clavicular fractures treated non-operatively achieve a satisfactory outcome. He believed that further work was required to identify those patients within this group that would benefit from surgical fixation. Perhaps Thormodsgard’s criterion of over 2 cm shortening is a useful starting point?

There have been three further attempts to get to grips with the subject since McKee meta-analysis.⁵ Liu et al⁷ conducted a further meta-analysis reviewing 633 patients but not separating out displaced mid-shaft fractures. They concluded that “operative treatment is better than non-operative treatment, but decisions should be made in accordance with specific conditions for clinical application.” Their results and conclusions were the subject of significant methodological comment and criticism by Ye et al⁸ and Zhu and Nie.⁹ They felt that the results of the Liu et al⁷ study should be treated with caution and that further randomised controlled trials were required.

Robinson et al¹⁰ reported the results of a prospective multicentre single-blinded randomised controlled trial comparing non-operative treatment with plate fixation of displaced mid-shaft fracture union rates, functional outcomes and costs. They recruited 200 patients and followed them up at three, six and 12 months. They were followed-up using DASH and Constant scores. Union was assessed using three-dimensional CT. There were 16 nonunions in the conservative group and one in the operated group. DASH and Constant scores were significantly better in the operated group but when patients with nonunion were excluded from the analysis

there were no significant differences in the DASH and Constant scores at any time point. The cost of treatment was significantly greater in the operated group. As the better results in the operated group resulted only from the prevention of nonunion and because of expense and implant-related complications, they believed that the results of their study did not support routine primary open reduction and plate fixation in the treatment of displaced mid shaft clavicular fractures.

McKee¹¹ made a number of pertinent comments on the Robinson paper:

1. The rate of delayed and nonunion is high after non-operative treatment. Twenty-four (26%) of 92 patients in the non-operative group were still not healed at six months from injury and 17 (18%) subsequently underwent surgery for either nonunion or symptomatic malunion.
2. Primary fixation with a plate is a safe and reproducible technique.
3. The major complication rate following plate fixation is low and the most common indication for re-operation is implant removal. Ten patients in the study had plates/screws removed and this is comparable with the studies reviewed in McKee's earlier paper.
4. The improved functional outcomes in the operated patients are most evident in the early post injury period. While other studies have shown an earlier return to work in the operated patients, this was not evident in the Robinson study.
5. Finally and probably most importantly, McKee stressed that most patients with a displaced mid shaft clavicular fracture will do well with conservative treatment. The "number needed to treat" (NNT) to avoid a specific negative outcome such as nonunion is high. Robinson et al¹⁰ had calculated that 6.2 patients would need to undergo surgery in order to prevent one nonunion. The earlier McKee et al⁵ meta-analysis had put the figure a little lower at 4.6. He emphasised, as had Obremsky,⁶ that better prognostic indicators were required to recognise which patients were at high risk of nonunion or symptomatic malunion so that surgical resources could be focused on these patients, reducing unnecessary procedures and reducing the NNT. Murray⁴ suggested that the NNT number was 7.5 but if only fractures with a predicted probability of > 40% nonunion, i.e. their high risk group were considered, then the NNT reduced to 1.7.

A further meta-analysis has recently been published in the Journal of Shoulder and Elbow

Surgery by Xu et al.¹² Its conclusions were that, "in the management of midshaft clavicular fractures surgery is superior to non operative treatment. Surgery with plates results in lower incidences of non-union, fewer total complications and fewer symptomatic malunions compared with non operative treatment." However, the reservations and comments made by McKee¹¹ in response to the Robinson trial are not addressed in the Xu et al¹² meta-analysis. Identification of patients at high risk of nonunion still appears to be the key issue.

The other side of the coin is presented by Leroux et al¹³ who reviewed 1350 operated midshaft clavicular fractures in Ontario. The fixations were carried out between 2002 and 2010. They found that one in four patients (24.6%) underwent at least one re-operation on the clavicle. The most common procedure was implant removal (18.8%) but repeat surgery was also required for nonunion (2.6%), deep infection (2.6%) and malunion (1.1%). Nonunions were more common in females and those with significant comorbidities. Sixteen patients (1.2%) developed pneumothoraces. Brachial plexus and subclavian vessel injuries were found in fewer than five patients overall.

CONCLUSIONS

Analysis of the data from Robinson et al,¹⁰ McKee et al^{5,11} and Murray et al⁴ in particular suggests that increasing degrees of fracture displacement in patients with high functional demands warrants a more aggressive approach to surgical fixation. However, it is sometimes difficult to get agreement between experienced surgeons on the degree of overlap/shortening, particularly in the 1 cm to 2 cm range. Smoking is clearly an issue.

Do the recent studies and discussions surrounding the treatment of displaced mid-shaft clavicular fractures have any implications for orthopaedic surgeons assessing claimants in medico-legal practice? They explain the reason why more patients with internal fixation devices (particularly plates) are seen after clavicular fractures than was the case ten to 15 years ago. They confirm the earlier restoration of function in those patients who have undergone plate fixation, with the possibility of earlier return to work. Leroux et al¹³ give a clear indication of the likelihood of complications and re-operation after fixation. The message is still clear that around three quarters of patients with a displaced midshaft clavicular fracture will get a perfectly acceptable result without surgery. There is

nothing to suggest that (barring any complications of surgery) internal fixation has any significant effect on the long-term outcome of these injuries. If symptomatic nonunion occurs it can still be addressed in a relatively friendly environment in the conservatively treated patient.

REFERENCES

6. Fagg PS. *MedicoLegal Reporting in Orthopaedic Trauma*. Fourth Ed. Elsevier: Churchill Livingstone, 2010.
7. Nordqvist A, Petersson CJ, Redlund-Johnell I. Mid-clavicle fractures in adults: end result study after conservative treatment. *J Orthop Trauma* 1998;12:572-576.
8. Thormodsgard TM, Stone K, Ciraulo DL, Camuso MR, Desjardins S. An assessment of patient satisfaction with nonoperative management of clavicular fractures using the disabilities of the arm, shoulder and hand outcome measure. *J Trauma* 2011;71:1126-1129.
9. Murray IR, Foster CJ, Eros A, Robinson CM. Risk factors for nonunion after nonoperative treatment of displaced midshaft fractures of the clavicle. *J Bone Joint Surg [Am]* 2013;95-A:1153-1158.
10. McKee RC, Whelan DB, Schemitsch EH, McKee MD. Operative versus nonoperative care of displaced midshaft clavicular fractures: a meta-analysis of randomized clinical trials. *J Bone Joint Surg [Am]* 2012;94-A:675-684.
11. Obremsky WT. Should I ever fix a clavicular fracture? Commentary on an article by Robbin C. McKee, et al.: "Operative versus nonoperative care of displaced midshaft clavicular fractures: a meta-analysis of randomized clinical trials". *J Bone Joint Surg [Am]* 2012;94-A:e52.
12. Liu GD, Tong SL, Ou S, et al. Operative versus non-operative treatment for clavicle fracture: a meta-analysis. *Int Orthop* 2013;37:1495-1500.
13. Ye C, Liao G, He S, Zhang Z. Comment on Liu et al.: Operative versus non-operative treatment for clavicle fracture: a meta-analysis. *Int Orthop* 2013;37:1619-1620.
14. Zhu Z, Nie L. Comment on Liu et al.: Operative versus non-operative treatment for clavicle fracture: a meta-analysis. *Int Orthop* 2013;37:1621.
15. Robinson CM, Goudie EB, Murray IR, et al. Open reduction and plate fixation versus nonoperative treatment for displaced midshaft clavicular fractures: a multicenter, randomized, controlled trial. *J Bone Joint Surg [Am]* 2013;95-A:1576-1584.
16. McKee MD. Displaced fractures of the clavicle: who should be fixed?: commentary on an article by C. M. Robinson, FRCSEd(Tr&Orth) et al.: "Open reduction and plate fixation versus nonoperative treatment for displaced midshaft clavicular fractures. a multicenter, randomized, controlled trial". *J Bone Joint Surg [Am]* 2013;95-A:e1291-1292.
17. Xu J, Xu L, Xu W, Gu Y, Xu J. Operative versus nonoperative treatment in the management of midshaft clavicular fractures: a meta-analysis of randomized controlled trials. *J Shoulder Elbow Surg* 2014;23:173-181.
18. Leroux T, Wasserstein D, Henry P, et al. Rate of and risk factors for reoperations after open reduction and internal fixation of midshaft clavicle fractures: a population-based study in Ontario, Canada. *J Bone Joint Surg [Am]* 2014;96-A:1119-1125.