Primary Plating of Displaced Mid-shaft Clavicular Fractures

Wg Cdr V Kulshrestha*

Abstract

Background: Recent studies have shown that displaced mid-shaft clavicular fractures do not have assured favourable outcomes with non-operative management and nonunion rates could be as high as 20%. In addition many malunion with significant shortening. Non-union or malunion causes functional deficit and many of them may benefit from primary internal fixation.

Methods: We reviewed the results of twenty cases of displaced/ comminuted midclavicular fractures, which were treated with primary open reduction and internal fixation with a reconstruction plate placed over the superior surface of clavicle.

Result: All the fractures clinically united by eight weeks. As per Rowe criterion 12 had excellent, six good and two fair results. On an average patients had full functional recovery in four months.

Conclusion: Primary internal fixation of displaced comminuted mid-shaft clavicular fractures leads to predictable and early return to function thus preventing unacceptably high complication rates of nonoperative management of these fractures.

MJAFI 2008; 64 : 208-211

Key Words: Clavicle fracture; Displaced; Middle third; Open reduction; Plating

Introduction

Clavicle fractures account for approximately 4% of all fractures. Fractures occur most commonly in the middle third of the bone (76-82%) and less often in the distal (12-21%) and medial (3-6%) thirds [1,2]. There appears to be a fairly uniform consensus regarding conservative management for medial third fractures and operative for displaced distal third fractures, however that for mid third clavicular fractures is still emerging. Traditionally most of these fractures have been treated with benign neglect, slings, or figure-of-eight harnesses. Historically we were taught, "All clavicle fractures do well with non-operative treatment". Such treatment is usually successful and till recently most of the available literature showed that more than 95% of clavicle fractures achieve union with acceptable cosmetic and functional results [3]. "Operative treatment is not only meddlesome but can increase the nonunion rate significantly", much of this thinking came from the original work of Neer and Rowe et al [2,4] in the 1960s when operative techniques were variable and not standardized or refined [2,4]. Typically these early attempts at surgical intervention were complicated by utilization of smooth pin fixation with occasional catastrophic results from pin migration, infection, and nonunion.

It is now well documented that displaced mid-third

clavicular fractures in adults do poorly when treated non-operatively [5], have higher rate of nonunion and, even when they unite, often result in an unsightly cosmetic bump in the centre of clavicle, shoulder ptosis, shoulder discomfort, and patient dissatisfaction [6,7]. When it involves a young active soldier any compromise in shoulder function due to malunion/nonunion of clavicular fracture severely hampers his employability. Many published articles document the success of open reduction and internal fixation for nonunion of displaced clavicle fractures with low complication rates. Most of these authors used plate fixation with rare articles documenting pin fixation for treatment of nonunion [8]. Therefore, it would seem apparent that if these patients could be identified before they go on to nonunion, similar techniques could be used to treat their fractures acutely. This study involves evaluation of primary internal fixation of such injuries.

Material and Methods

Twenty patients who were operated for displaced middle third clavicle fracture at our institute from April 2003 to April 2005, were reviewed retrospectively. All were male, 21 to 46 years old (average 31 years). Fifteen patients had sustained fracture in an automobile accident and five due to fall from height. Eight patients had multiple injuries with an injury-severity score [9], ranging from 17 to 34 points (average, 30 points). Associated injuries in these patients included head injury (six patients), fracture of multiple ribs (eight patients),

*Classified Specialist (Orthopaedics), 5 AFH, C/o 99 APO.

haemopneumothorax (four patients), undisplaced scapular neck fracture in three patients, upper limb fracture (two patients), and fracture of the lower limb (one patient). Eleven fractures were on the right side and nine were on the left. All of them were grossly displaced and twelve were comminuted multifragmentary. There were three Gustilo-Anderson type-I open clavicular fractures. There were no neurovascular injuries.

After resuscitation of the patients in the emergency room, radiographic examination was performed which included the three-view trauma series of the shoulder devised by Neer and Rockwood. Radiographs of the chest were done routinely to detect any concomitant fractures of the ribs or a pneumothorax. Four patients who had a haemo-pneumothorax underwent insertion of a chest tube. Delay in surgery ranged from one to seven days (average, five days).

The patients were operated in supine beach chair position, with the arm draped free for easy manipulation. A curvilinear anterosuperior subcutaneous approach along the Langers lines was employed in all cases. The skin and soft tissue with strap muscles were elevated as a flap to expose the fracture including middle 3/5th of the clavicle. The fracture was reduced ensuring a perfect anatomical reduction in most cases. In three cases where there was extensive comminution at the fracture site and end-to-end opposition was not possible tricortical iliac crest graft was used to ensure good bony continuity and restoration of clavicular length (Fig. 1). In all cases the fracture was fixed with contoured 3.5 mm reconstruction plate; nine or ten holes to ensure at least six to eight-cortex fixation on both sides of the fracture (Fig. 2). In few cases interfragmentary screws were used. The wound was closed in two layers under suction drain. The duration of the operation ranged from 50 - 90 minutes. The average blood loss during fixation of the fracture was less than 100 milliliters.

Postoperatively, shoulder immobiliser was used to immobilize the shoulder. Elbow and wrist movements were started in immediate post op period. The initial phase of the rehabilitation program involved passive mobilization of the shoulder, which was started in the third week. The second stage was usually started after the fifth postoperative week, with the aim of restoration of the entire range of motion of the shoulder. Muscle-strengthening exercises were started after motion had been restored. The patients were followed up from eighteen to forty months (average, twenty-five months). The function of the shoulder was assessed with use of the scoring system of Rowe [10]. The muscle power was assessed manually and compared with that of the contralateral, normal shoulder.

Results

The average time for clinico-radiological evidence of fracture healing was eight weeks (range six to nine weeks) (Figs. 3-5). According to the scoring system of Rowe [10], twelve patients had an excellent functional result, six had a good result, and two had fair result. The average score for the 15 patients was 84 points. Thirteen patients had no pain on movement of the shoulder, five had slight pain during activities, and two had moderate pain during activities. Eleven

Fig. 1 : Operative photograph showing tricortical iliac crest graft being used to restore clavicular length.

Fig. 2 : Operative photograph showing fracture of the clavicle fixed with contoured reconstruction plate placed on the superior surface of the clavicle, one leg screw has been used to fix the butterfly fragment.

patients had 150 to 170 degrees of abduction and flexion of the shoulder and nine had 120 to 150 degrees. Eighteen patients could internally rotate the shoulder so that the thumb could touch the scapula, and two had mild limitation of internal rotation such that the thumb could reach only the sacrum. Twelve patients had 80 degrees of external rotation and eight patients had 60 degrees. Twelve patients regained normal strength of the shoulder as compared to the normal side in less than six months and the rest by one year. Thirteen shoulders had normal function, six had mild limitation and one had moderate limitation. Subjectively, twelve patients regarded the result of the operation as excellent; six as good; and two as fair. The interval until the return of maximum function of the shoulder ranged from one to six months (average four months). Seven patients returned to sports and strenuous manual labor after a period of four to eight months (average five months), and the rest returned to light manual labor after three to six months (average six months).

There were no superficial or deep wound infections. The patient who had a fair shoulder score complained of discomfort on extension and abduction of the shoulder. Five patients reported mild discomfort about the clavicular plate, but the symptoms were too mild to warrant removal of the implant.

Fig. 3 : Plain radiograph of fracture middle third of clavicle with displacement and gross overriding (>2cm). Postoperative radiograph showing fracture reduced, clavicular length restored and fixed with reconstruction plate, eight cortex fixation on both sides.

Fig. 4 : Plain radiograph of comminuted grossly displaced fracture midshaft clavicle. Six weeks postoperative photograph showing healing of fracture fixed with contoured reconstruction plate and a lag screw.

Fig. 5 : Plain radiograph of comminuted fracture midshaft clavicle. Postoperative photograph showing clavicle length restored with intercalated tricortical iliac crest graft and fixed with contoured reconstruction plate.

Only in one case where the lateral end of the plate was palpable the plate was removed six months after surgery on achieving complete union and return to full function of the shoulder.

Discussion

Middle-third fractures are the most common clavicle fractures, accounting for approximately 80% of all fractures. Most (97%) of the fractures in this group are mild to moderately displaced and can be treated non-operatively. However, 3% of middle-third clavicle fractures are completely displaced and shortened. This small group of fractures accounts for 90% of nonunion in middle-third fractures and therefore may warrant early open reduction and internal fixation [11]. The incidence of nonunion of the clavicle following midshaft fracture has traditionally been described as 1% or less, based on two landmark studies from the 1960s [9,10]. This figure has been used to avoid primary internal fixation. However, a number of recent studies on completely displaced, midshaft fractures of the clavicle reveal nonunion rates between 15 - 20% [5,12,13], due to 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 [5,14].

It is also of concern that clavicular malunions are now a distinct clinical entity with characteristic orthopaedic (weakness, easy fatigability, winging of

scapula), neurologic (thoracic outlet syndrome) and cosmetic (droopy, asymmetric shoulder, difficulty with backpacks, shoulder straps, etc.) symptoms [15]. It has been shown that middle-third clavicle fractures with more than two cm of displacement or 15 mm of shortening are at increased risk for nonunion [7,15]. Thompson reviewed more than 100 middle-third clavicular nonunions reported in the literature and found that 90% of the original fractures had displacement greater than 100%, overriding more than one cm, or had severe comminution [11,16]. Although fractures with this much displacement are uncommon, accounting for 3% of all middle-third clavicle fractures, they warrant open reduction and internal fixation.

Studies from North America and Europe, show that plate fixation is an extremely effective technique for treatment of clavicular shaft fractures with a low complication and nonunion rate [17,18]. They quoted a nonunion rate of 2.2% in operative management of these fractures as compared to more than 15% rate in those managed with conservative methods. In our study the union rate was 100% and 96% of the patients regained good to excellent functions of the shoulder at six to nine months post surgery. When the plate is placed superiorly on the bone, it functions as a tension band and theoretically is effective because it is sufficiently rigid to withstand both the bending and the torsional forces at the middle third of the clavicle. It can also be bent to

the contour of the clavicle (Fig. 2). Additional fixation with interfragmentary screws can be achieved with a plate for oblique fractures.

Prior studies of outcome following clavicular fractures did not describe any strength deficits following nonoperative care of displaced mid shaft clavicular fractures and concentrated on radiographic and surgeon-based results. Hill et al [5] were one of the first to use a patient oriented outcome measure and found 31% patients were unhappy after non-operative treatment. This may be attributed to significant residual strength deficits following conservative management of these fractures. Another study which used an objective strength testing protocol for both maximal effort and endurance found strength deficits ranging from 10 - 35% in patients after an average of 54 months following nonoperative treatment of displaced fractures of the clavicular shaft [19]. This can have a significant impairment in shoulder functions of an active young person recreationally and occupationally. A study conducted by Canadian orthopaedic trauma society on 111 patients showed not only an overall improvement in shoulder functions (at one year) in operated cases, but also a much rapid return of function and decrease in pain in the operative group [20,21].

The most predictable method to maintain anatomic reduction of displaced mid shaft clavicular fractures, including length and rotation is in my opinion a plate and screw fixation. Although there is a learning curve with this form of treatment, once one becomes proficient in fixing two part clavicle fractures, displaced comminuted clavicle fractures become far less intimidating. The choice to proceed with operative intervention for a displaced mid-shaft clavicular fracture will be a decision made between the surgeon and the patient.

Conflicts of Interest

None identified

References

1. Nordqvist A, Petersson C. The incidence of fractures of the Clavicle. *Clin Orthop* 1994; 300: 127.
2. Rowe CR. An atlas of anatomy and treatment of midclavicular fractures. *Clin Orthop* 1968; 58: 29-42.
3. Laurence E Dahners. Antegrade clavicle nailing. *J Orthop Trauma* 2005; 19: 501.
4. Neer CS. Nonunion of the clavicle. *JAMA* 1960; 172 : 1006-11.
5. Hill JM, McGuire MH, Crosby L. Closed treatment of displaced middle-third fractures of the clavicle gives poor results. *J Bone Joint Surg (Br)* 1997; 79: 537-41.
6. Boehme D, Curtis RJ, DeHaan JT, et al. Nonunion of fractures of the mid-shaft clavicle. *J Bone Joint Surg (Am)* 1991; 73: 1219-26.
7. McKee MD, Wild LM, Schemitsch EH, et al. Midshaft malunions of the clavicle. *J Bone Joint Surg (Am)* 2003; 85: 790-7.
8. Hoe-Hansen CE, Norlin R. Intramedullary cancellous screw fixation for nonunion mid-shaft clavicular fractures. *Acta Orthop Scand* 2003; 74: 361-4.
9. Johnson EW Jr, Collins HR. Nonunion of the clavicle. *Arch Surg* 1963; 87: 963-6.
10. Rowe CR. Evaluation of the shoulder. In: Rowe CR, editor. *The Shoulder*. New York : Churchill Livingstone, 1988; 631-7.
11. Thompson JS. Operative treatment of certain clavicle fractures. An orthopaedic controversy. *Orthop Trans* 1988; 12: 141.
12. Robinson CM, Court-Brown CM, McQueen MM, et al. Estimating the risk of nonunion following non-operative treatment of a clavicle fracture. *J Bone Joint Surg (Am)* 2004; 86: 1359-65.
13. Zlowodzki M, Zelle BA, Cole PA, et al. Treatment of mid-shaft clavicle fractures: Systemic review of 2144 fractures. *J Orthop Trauma* 2005; 19: 504-8.
14. McKee MD, Stephen DJG, Kreder HJ, et al. Functional outcome following clavicle fractures in polytrauma patients. *J Trauma* 2000; 47: 616.
15. Basamania CJ. Claviculoplasty. *J Shoulder Elbow Surg* 1999; 8: 540.
16. Wick M, Muller EJ, Kollig E, et al. Midshaft fractures of the clavicle with a shortening of greater than 2 cm predispose to nonunion. *Arch Orthop Trauma Surg* 2001; 121: 207-11.
17. Poigenfurts J, Rappold G, Fischer W. Plating of fresh clavicular fractures: results of 122 operations. *Injury* 1992; 23: 237-41.
18. McKee MD, Seiler JG, Jupiter JB. The application of the limited contact dynamic compression plate in the upper extremity: an analysis of 114 consecutive cases. *Injury* 1995; 26: 661-6.
19. McKee MD, Pedersen EM, Jones C, et al. Deficits following nonoperative treatment of displaced, mid-shaft clavicle fractures. Accepted for publication. *J Bone Joint Surg (Am)*.
20. Hall JA, McKee MD. A multicentric randomized controlled trial of nonoperative versus operative treatment of displaced clavicle shaft fractures. *Proceedings of the 60th Annual Meeting of the Canadian Orthopaedic Association*; 2005; 04 : Montreal Canada: 37.
21. Mullaji AB, Jupiter JB. Low-Contact dynamic compression plating of the clavicle. *Injury* 1994; 25: 41-5.