Global Journal of Surgery, 2013, Vol. 1, No. 2, 8-10
Available online at http://pubs.sciepub.com/js/1/2/1

DOI:10.12691/js-1-2-1

Treatment of Acute Clavicle Fractures with an Anatomical Congruent Clavicle Plate

Daniel Gheorghiu[1,*], Christos Sinopidis[2], Daniel J. Brown[1]

[1]Trauma and Orthopaedics, Royal Liverpool and Broadgreen University Hospital, Liverpool, UK
[2]Trauma and Orthopaedics, St Luke's Hospital, Thessaloniki, Greece
*Corresponding author: d.gheorghiu@nhs.net

Received April 03, 2013; Revised May 01, 2013; Accepted May 08, 2013

Abstract Morbidity following un-united and mal-united adult clavicle fractures is being increasingly recognised and the indications for operative treatment of displaced fractures of the clavicle are increasing. Plate fixation options include low contact dynamic compression plates, which are strong, but difficult to contour and cause soft tissue irritation. Reconstruction plates are easier to contour, but lack sufficient mechanical strength. Pre-contoured locking plates are now available, matching the shape of the adult clavicle. The purpose of this study is to assess the clinical and radiological outcome of a pre-contoured congruent clavicle plate in the treatment of acute, displaced, mid-shaft clavicle fractures. This study presents the results of 29 patients treated with an anatomical congruent clavicle plate for acute displaced, mid-shaft fractures of the clavicle at a tertiary referral centre. All patients were treated with a congruent clavicle plate. The fracture united in all cases with minimal complications and high patient satisfaction on the Disability of the Arm and Shoulder (DASH) score, American Shoulder and Elbow Surgeons score (ASES) and Pain Visual analogue score (VAS). The results compare favourably with other published studies, and we believe that a congruent clavicle plate represents an advance in the operative management of these fractures.

Keywords: *clavicle fracture, plate fixation, union*

1. Introduction

Fractures of the clavicle are common, accounting for 5 to 10% of all fractures and up to 44% of all injuries to the shoulder girdle [1,2]. About 80% of these fractures occur in the middle third of the clavicle [1,3,4]. Traditionally these fractures have been treated conservatively with Neer in 1960 suggesting that only 0.1% of fractures, treated non-operatively, will fail to unite [1]. More recently, however, it has been suggested mid shaft fractures with 20 mm initial shortening have a 15% non-union rate [5]. Symptomatic mal-union of clavicle fractures can also occur in 31% to 50% of cases [5,6]. Reasons for dissatisfaction include weakness, pain, displacement, or a bump [6]. Other indications for clavicle fixation include open fractures, skin compromise, neurovascular damage, floating shoulder and symptomatic non unions [7,8,9].

Controversy exists on the types of fixation to be used of middle third clavicle fractures [1,10]. The treatment options include intramedullary fixation [11,12] and internal fixation with plates [9,13,14,15]. Fixation with wires carries the risk of wire migration which may cause damage to vital structures [16,17]. There is also controversy about which type of plate to use: Low Contact Dynamic Compression Plates (LC-DCP) are strong but bulky, difficult to contour to the anatomy of the clavicle and often cause soft tissue irritation. 3.5mm reconstruction plates, on the other hand, are easier to contour, but offer less mechanical strength [18]. Anatomic pre-contoured implants have the potential advantages of not requiring further bending, having a lower profile causing fewer soft tissue problems whilst retaining the mechanical strength of the stronger plates.

The purpose of this study is to assess the clinical and radiological outcome of the precontoured Acumed Congruent Clavicle Plate (Acumed LLC, Hillsboro, OR, USA) in the treatment of acute, displaced, mid-shaft clavicle fractures. The Acumed congruent plate is pre-contoured, low profile and made from titanium alloy. It comes in right and left sides and different shaped curves (additionally, the right plates can be turned round and used on a left clavicle which increases the selection still further).

2. Material and Methods

A prospective, consecutive case series of patients with acute, displaced, mid-shaft fractures of the clavicle treated with an anatomical congruent clavicle plate. All patients gave informed verbal consent to be included into the study and the study was authorized by the local Audit and Research department and the ethical committee. All fractures were Type 1 fractures according to the Allmann classification system [19]. Thirty five patients with the above fracture were identified and recruited over a twelve month time period. Six patients were lost to follow up and of the remaining twenty- nine, there were 24 male and 5 female patients. Pre-operative assessment included an AP and 45° degree cephalic tilt radiograph (Figure 1). This

combination of radiographs is useful in assessment of the amount of displacement and shortening. Post operatively, patients were allowed to perform passive and active assisted exercises for the first 6 weeks.

Heavy lifting, sports and raising the arm above head height were discouraged until signs of union were seen. Patients were assessed clinically and radiological (AP and 45° degree cephalic tilt radiograph) looking for union, plate loosening and implant failure (Figure 2).

Figure 1. AP radiograph of the clavicle demonstarting shortening

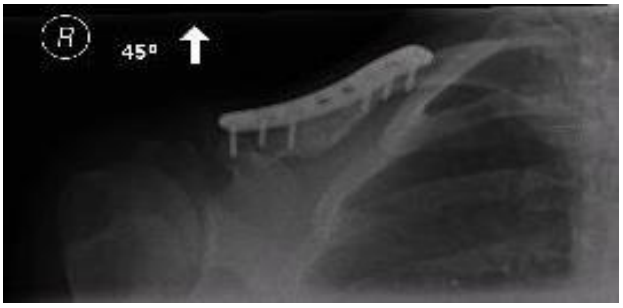

Figure 2. 45 degree cephalic tilt radiograph 9 weeks after open reduction and internal fixation

Healing was defined as pain free use of the arm/shoulder without evidence of delayed fracture union on the radiograph. Final outcome assessment was performed at an average of 11.7 months (range 3 to 35 months) post operatively. We used the Disabilities of the Arm Shoulder and hand questionnaire (DASH) scoring system on all 29 patients [20]. Twenty out of twenty-nine patients additionally completed the American Shoulder and Elbow Surgeons Shoulder score (ASES), including the Pain Visual Analogue and were available for examination of the shoulder by a member of the medical team at their final follow up.

2.1. Operative Technique

Under general anaesthesia the patients were placed in the supine beach-chair position on a shoulder table. An infraclavicular approach was utilised with careful periosteal stripping. The fracture was anatomically reduced and held with 2.7mm lag screws when appropriate configuration of the fracture permitted this and the plate applied to the superior surface of the clavicle as a neutralisation plate held with 3.5mm screws. Contouring of the plate was not required. An oscillating drill was used to reduce the risk of vascular injury.

3. Results

Twenty nine patients with acute, displaced, mid shaft fractures were treated with the Acumed congruent clavicle plate.

The mean age was 41.5 years (range from 16 to 59 years). 14 fractures occurred while playing sport, 8 were as a result of road traffic accidents (RTA), 6 due to falls and 1 due to an assault with a metal bar. All fractures were in the middle third and displaced greater than 2cm. One patient had an associated ipsilateral dislocated shoulder which required closed reduction under anaesthesia and one patient had additional ipsilateral multiple rib and a scapula fracture which were treated conservativly.

The mean time from injury to operation was 7.8 days (range from 1 to 32 days).

At mean follow up at 11.7 months (3-35 months) the mean DASH score was 13.4 (0.0-77.2) and the mean ASES score was 82.1 (28.3-100). The mean VAS score was 1.7 (0-8). Full range of motion was regained in all patients who were available for examination (20 out of 20 patients).

At a mean of 12.8 weeks (range 7 to 28 weeks) there was a 100% (29 of 29 patients) healing rate.

In one case of a 16 year old (BMI 19.1) the plate was felt to be prominent under the skin and was removed 13 months post-surgery. Mild hypersensitivity of the scar occurred in four patients but this did not limit function.

In several cases it was found that a better fit could be obtained by using a contralateral plate and reversing it (that is putting the medial end laterally). In no cases was it necessary to further contour the plate.

4. Discussion

Mid shaft clavicle fractures are common injuries. The reported results for the non-operative treatment of fractures of the clavicle have been variable. Neer reported a non-union rate of 0.1% for conservatively treated fractures [1], and non-union rate of 4.6% for fractures treated operatively. However the operatively treated fractures were of higher energy and it was accepted that poor surgical technique and fixation devices may have contributed to the non-unions.

Conservative treatment of fractures with shortening is associated with high risk of non-union and unsatisfactory shoulder function [5,6].

Shortening of the clavicle results in altered anatomical relationships and abnormal biomechanical stress on the shoulder [21]. Shortening of 1cm was shown to decrease shoulder function in 50% of cases and with shortening greater than 2cm the deterioration was considerable.

Mal-union of the clavicle may also alter the position of the glenoid fossa which may affect glenohumeral mobility and scapular rotation, leading to unsatisfactory results especially in young and active patients [6].

Controversy exists regarding the techniques used for fixation of displaced middle third clavicle fractures and the type of fixation device used [1,10]. Operative treatment is not without its risks, and a complication rate as high as 27.3% has been quoted [18].

Irritation due to prominent metal work has been a problem with dynamic compression plating and plate removal being a common reason for re-operation [18].

In this series it was found that routine plate removal is not necessary as the implant is low profile and causes minimal irritation.

The Canadian Orthopaedic Trauma Society compared the outcome of conservative and operative management in displaced mid shaft clavicle fractures and showed significantly better function, a lower rate of non-union, and a lower incidence of symptomatic mal-union in the operative group. It was found that removal of the plate was the most common reason for re-intervention. However, towards the end of the study the researchers changed to using the Accumed congruent plate and preliminary results indicated a markedly reduced prevalence of soft tissue irritation, which could lead to a decrease in the need for plate removal [22]. It should be pointed out, however, that there were only 4 patients in the latter group.

Contouring of implants takes time, and experience is needed before plates can be accurately contoured to match the patient's anatomy. Repeated bending of implants can lead to structural failure. Huang et al compared the anatomy of the clavicle with the shape of the Accumed congruent plate via digital mapping. They found that the plate fitted the S-shaped contour of the superior surface of the majority of male clavicles but not for white female clavicles. However the mapping study did conclude that the plate was adequately shaped for fixation of fractures in the medial three-fifths of clavicles [23]. In this study it was found that the plates can be reversed and used for the contralateral side which provides an increased range of choice. This and the fact there are now different shaped curves on the set may increase the numbers of clavicles the plates now fit compared with Huang's findings.

This paper describes a series of 29 patients with acute, displaced, mid-shaft fractures. The study is limited in the fact there is no control group and therefore it provides no basis for firm conclusions, or statistical analysis.

However the study does demonstrate that the Accumed congruent plate appears to be an effective and reliable means of fixing mid shaft clavicle fractures and due to its low profile nature, routine plate removal is not required.

References

[1] Neer CS. "Nonunion of the clavicle". *JAMA* 1960; 172:1006-11.

[2] Post M. "Current concepts in the treatement of fractures of the clavicle". *Clin Orthop* 1989; 245:89-101.

[3] Robinson CM. "Fractures of the clavicle in the adult. Epidemiology and classification". *J Bone Joint Surg* [Br] 1998; 80-B (3): 476-84.

[4] Rowe CR. "An atlas of anatomy and the treatment of midclavicular fracture". *Clin Orthop* 1968; 58:29-42.

[5] Hill JM, McGuire MH, Crosby LA. "Closed treatment of displaced middle third clavicular fractures of the clavicle gives poor results". *J Bone Joint Surg* [Br] 1997; 79-B (4):537-9.

[6] McKee MD, Pedersen EM, Jones C, Stephen DJG, et al. J *Bone Joint Surg* [Am] 2006; 88-A (1): 35-40.

[7] Jupiter JB, Leffert RD. "Non-union of the clavicle". *J Bone Joint Surg* [Am] 1987; 69 A (5):753-60.

[8] Manske DJ, Szabo RM. "The operative treatment of mid shaft clavicular non-unions". *J Bone Joint Surg* [Am] 1985; 67-A (9):1367-71.

[9] Poigenfurst J, RappoldG, Fischer W. "Plating of fresh clavicular fractures: Results of 122 operations". *Injury* 1992; 23(4): 237-41.

[10] Herbsthofer B, Schuz W, Mockwitz J. "Indications for the surgical treatment of clavicular fractures". *Aktuelle Traumatol* 1994; 24:263-8.

[11] Jubel A, Andemahr J, Bergmann H, et al. "Elastic stable intramedullary nailing of midclavicular fractures in athletes". *Br J Sports Med* 2003; 37: 480-484.

[12] Ngarmukos C, Parkpain V, Patradul A. "Fixation of fractures of the midshaft of the clavicle with Kirschner wires. Results in 108 patients". *J Bone Joint Surg* [Br] 1998; 80: 106-8.

[13] Ali Khan MA, Lucas HK. "Plating of fractures of the middle third of the clavicle". *Injury* 1978; 9: 263-267.

[14] Mullaji AB, Jupiter JB. "Low contact dynamic compression plating of the clavicle". *Injury* 1994; 25:41-45.

[15] Schwarz N, Hocker K." Osteosynthesis of irreducible fractures of the clavicle with 2.7mm ASIF plates". *J Trauma*. 1992; 33:179-183.

[16] Lyons FA, Rockwood CA." Migration of pins used in operations on the shoulder". *J Bone Joint Surg* [Am] 1990; 72-A: 1262-7.

[17] Norell H, Llewellyn RC. "Migration of threaded Steinmann pin from an acrmioclavicular joint into the spinal canal:a case report". *J Bone Joint Surg* [Am] 1965; 47-A: 1024-6.

[18] Iannotti MR, Crosby LA, Stafford P, et al. "Effects of plate location and selection on the stability of midshaft clavicle osteotomies: a biomechanical study". *J shoulder Elbow Surgery*. 2002; 11:457-62.

[19] Allmann FL. "Fractures and Ligamentous Injuries of the Clavicle and Its Articulation". *J Bone Joint Surg* [Am] 1967;49:774-784.

[20] Hudak PL, Amadio PC, Bombardier C. "Development of an upper extremity outcome measure: DASH (Disabilities of the Arm Shoulder and hand)". The Upper Extremity Collaborative Group (UECG). *Am J Ind Med* 1996; 29:602-8.

[21] Chan KY, Jupiter JB, Leffert RD, Marti R. "Clavicle malunion". *J Shoulder Elbow Surg* 1999; 8: 287-90.

[22] Canadian Orthopaedic Trauma Society. "Nonoperative treatment compared with plate fixation of displaced midshaft clavicular fractures. A multicenter randomised clinical trial". *J Bone Joint Surg* [Am]. 2007; 89:1-10.

[23] Huang JI, Toogood P, Chen MR,et al. "Clavicular Anatomy and the Applicability of Precontoured Plates". *J Bone Joint Surg*[Am].2007;89(10):2260.