ISSN NO. 2320-5407

Journal homepage: http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

Changing trends in the management of adult clavicular fractures. A prospective study

Dr Suhail Ahmad Bhat[1*], Dr Khursheed Ahmad Bhat[2], Dr Sanjeev Gupta[3], Dr Mohd Suhail Lone[4], Dr Abedullah Bhat[5], Dr Nadeem Ali[6]

1. Assistant surgeon, MS orthopedics, J&K Health Services
2. Assistant surgeon, MS orthopedics, J&K Health Services
3. Assistant Professor, Orthopedics, GMC Jammu, J&K
4. Senior Resident Microbiology, SKIMS Srinagar, J&K
5. Senior Resident Orthopedics SHKM Medical College, Haryana
6. Senior Resident Orthopedics SHKM Medical College, Haryana

Manuscript Info

Manuscript History:

Received: 12 April 2014
Final Accepted: 25 May 2014
Published Online: June 2014

Key words:

Corresponding Author*

Dr Suhail Ahmad Bhat

Abstract

Clavicular fractures account for approximately 2.6 % of all fractures. Fractures occur most commonly in the middle third of the bone .Various treatment methods are:-**Non Operative:** A multitude of slings, straps and braces have been proposed for clavicular immobilization and treatment of fractures. **Operative:** External fixators, Intramedullary devices, Plates and screws. The aim of the present study was to analyze the results of fixation of clavicular fractures with plate and screws with regard to assessing the union radiologically, complications associated with the procedure and restoration of range of motion and function of the shoulder and to evaluate the results clinically regarding pain, activities of daily living, range of motion, power, radiologically regarding union, non-union, refracture, screw and plate loosening, implant breakage. A total of 25 cases of midshaft clavicular fractures which were Allman (type I) closed & fresh were included. They were treated by open reduction & internal fixation with S-shaped clavicular LCP in 17 patients and 3.5mm reconstruction locking plate in 8 patients. The age of patients in this study ranged from 18-50 years. Males formed 68% of the patients. Most common cause of the fracture in this was road traffic accidents (52%). Right side was involved commonly (56%). Duration from injury to surgery was an average of 3.56 days and hospital stay was an average of 4.44 days. The time taken for complete radiological union ranged from 6 to 10 weeks. The time taken to return to previous level of activity ranged from 8 to 20 weeks. Overall excellent results were achieved in 23 patients & good in 2 patients.

INTRODUCTION

Clavicular fractures account for approximately 2.6 % of all fractures and approximately 35% of all fractures in the shoulder region and are common in young, active individuals. In contrast to most fractures, the annual incidence in males is highest in age group less than 20 years, decreasing with each subsequent age cohort. [23]

Fractures occur most commonly in the middle third of the bone (76% to 82%) and less often in the distal (12 to 21%) and medial (3 to 6%) thirds. Proximal clavicle fractures tend to occur in elderly men; middle-third fractures tend to occur in children (typically undisplaced), adolescents (displaced), and young male adults (comminuted); distal-third fractures are frequent in middle-aged patients. [25]

Allman described the mechanism of injury as either a fall onto an outstretched hand or a fall onto the point of the shoulder. [1] More recent data, however, indicates direct trauma as the predominant cause of clavicle fractures. [25]

Various treatment methods are:

a) **Non Operative:** A multitude of slings, straps and braces have been proposed for clavicular immobilization and treatment of fractures. [2,4,10,11,18]

b) **Operative :**

1. External fixators
2. Intramedullary devices
3. Plates and screws

From the earliest recorded mention of clavicle fractures, the treatment has been considered supportive, the results considered excellent. [21, 24, 26] However, recently, investigators have discovered that union after midshaft clavicle fracture is not as universal as once thought. Moreover, certain types of clavicular fractures have declared themselves to be problematic. [13] Recently, a large consecutive series of more than 500 diaphyseal fractures identified several independent factors predictive for the increased likelihood of nonunion. These included advancing age, female gender, absence of residual cortical contact between fracture ends, and comminution. [28, 31, 33]

Intramedullary fixation can be accomplished with smooth or threaded K-wires, Steinman pins, Knowles pins, or cannulated screws. Advantages include: less surgical dissection and soft tissue stripping is needed, and the hardware is less prominent. Disadvantages include possible pin migration and poor rotational control during elevation of the extremity above shoulder level. [5, 9, 14, 22]

Biomechanically, plate fixation is superior to intramedullary fixation because it better resists the bending and torsional forces that occur during elevation of the upper extremity above shoulder level. Disadvantages include the necessity for increased exposure and soft-tissue stripping; potential damage to the supraclavicular nerves, which cross through the surgical field; slightly higher infection rates; and the risk of refracture after plate removal. [3, 12, 27]

Many investigators have recommended the use of a 3.5-mm AO dynamic compression plate (DCP) or a low-contact dynamic compression plate with at least three screws (six cortices) in both the medial and lateral fragment and an interfragmentary lag screw whenever the fracture pattern allows it. Autogenous bone graft should be used in comminuted fractures with bone loss. [19, 29, 30]

Recent advances in plate technology have added to the treatment choices for midshaft clavicle fractures. [7, 15, 16] Specifically, having the plate and screws as a single construct may enhance the ability of the plate to resist the large inferiorly directed torque on the outer segment and therefore may limit the potential for plate pull-out. Alternatively, clavicular plates are now available in an s-shape, to better follow the axial course of the clavicle when they are placed in a superior position. Pelvic reconstruction plates (3.5) mm are also used in both locking and non locking forms. [18]

AIMS AND OBJECTIVES

The aim of the present study was to analyze the results of fixation of clavicular fractures with plate and screws with regard to

1. Assess the union radiologically
2. Complications associated with the procedure
3. Restoration of range of motion and function of the shoulder

The objective of the present study was to evaluate the results

1. Clinically regarding pain, activities of daily living, range of motion, power.
2. Radiologically regarding union, non-union, refracture, screw and plate loosening, implant breakage.

MATERIAL AND METHODS

This prospective study was conducted in the post graduate department of Orthopedics Government Medical College, Jammu during the period from 1st May 2011 to 31st July 2012.Both male and female patients were included in the study. The selection criterion was based on Allman classification of clavicular fractures. [1]

Inclusion criteria:
Displacement >2cm, shortening >2cm, no cortical contact between the two main fragments, segmental fractures, increasing comminution (>3 fragments), age between 18 to 50 years, fresh fractures.

Exclusion criteria:
Multiple injured patients, associated neurovascular injuries, open fractures, cancer or severely ill patients which increases the operation morbidity, pathological fractures, patients below 18 and above 50 years, fracture more than 14 days old, pregnancy

All the patients were initially assessed in the emergency section of GMC Jammu. They were given first aid in the form of analgesia, shoulder arm pouch immobilization, and other resuscitation measures. After selection of the patients for surgery, patients were prepared for elective surgery to be conducted in the elective operation theatre.

Pre-operative evaluation:
Pre-operative evaluation included patients name, age, sex, address, date of injury, associated chronic illness, date of surgery and date of discharge. Every patient was evaluated for swelling, bruising & ecchymosis at the fracture site and visible deformity of the shoulder girdle. Shortening of the clavicle was measured by a measuring tape.

A careful neurological and vascular examination of the involved limb was done. All the routine investigations like complete blood count & biochemistry were done. Radiographic evaluation by X-ray of the chest, shoulder PA view and axial view was done in every patient. Informed and written consent was taken from the patients

Implants
In this study two types of the plate system for fixation of the clavicular fractures were used.

1) S-shaped clavicle LCP (3.5mm)
2) Reconstruction LCP (3.5mm)

Screws
Cortical screws of 3.5mm thread diameter made up of stainless steel have been used with these plates. These screws were typically self tapping and fully threaded. 3.5mm locking cortical screws were also used with 3.5mm drill sleeve.

Operative Technique:-
The patient was positioned in supine position or Beach -chair with a bump or pad between the scapulae to aid exposure and facilitate the fracture reduction. Shoulder and involved limb were draped under all aseptic conditions. Face was turned away from the side to be operated. A superior approach and plating was the technique preferred. An oblique skin incision was made centered inferiorly over the fracture site. The subcutaneous tissue and platysma muscles were kept together as one layer and extensively mobilized, especially proximally and distally. The main fracture line and major fragments were clearly identified and cleaned of hematoma and debris and the fixation strategy was formulated (Fig 1). If there was a free fragment of sufficient size to be structurally important, it was fixed with a lag screw. The proximal and distal fragments were then reduced with the aid of reduction forceps, they were held temporarily with a K-wire or, ideally with a lag screw.

Sometimes image intensifier was used to achieve the anatomical reduction and to detect any residual step, not appreciable clinically. Both the proximal and the distal ends of the fracture were drilled with 2.7mm drill bit, after the selected plate had been secured on the superior surface of the bone. The desired plate of the appropriate length was applied and fixed with 3.5mm self tapping cortical screws (Fig2). In osteoporotic and comminuted fractures 3.5mm locking screws were used to decrease the possibility of implant failure .Segmental fractures were fixed step by step. At first fixation of a small fragment to one of the main fragments was done and then another main fragment was fixed with the previous fragment. Following fixation both soft tissue layers were closed with interrupted non-absorbable sutures. Sterilized wound dressing was applied and suction drain was used in some patients.

Postoperative evaluation:-
Post operatively the arm was placed in a standard sling for comfort and gentle pendulum exercise was allowed. Patient was followed up at 10-14 days, the wound was checked and stitches were removed. The sling was discontinued and unrestricted range of motion exercise was allowed, but no strengthening, resisted exercises or sporting activities were allowed. [11] At six weeks post operative radiograph was taken to evaluate the bony union (Fig 3). Intermittent physiotherapy by a trained physiotherapist was advised.

Follow up evaluation:-
The follow up in the post operative period was done at 3 weeks, 6 weeks, 12 weeks and 6 months. In each visit patient was assessed by clinical examination and radiological examination. Clinical examination included incision site (infection, dehiscence) severity of pain, swelling, tenderness, distal neurovascular status, and deep infection, range of motion, power and fracture healing. Radiological examination included position of fragments, amount of callous, status of locking plate and screws and any other complication. After six months the patients were assessed by Constant –Murley Shoulder Outcome Score (1987). [6**,** 20, 32]

RESULTS

Twenty five cases of clavicular fractures were managed by open reduction and internal fixation with plates and screws. S-shaped clavicular LCP was used in 17 patients and 3.5mm reconstruction locking plate was used in 8 patients in this series over a period of 15 months.

Around 72% cases occurred in patients 35 years or less in age. These fractures were common in young people who were more involved in outdoor activities, sports and hence more prone to trauma. Clavicular fractures were more common in males (68%), who are more involved in outdoor activities and most of the vehicles are driven by males in our country. RTA was the most common cause of injury in our series accounting for 52%, other common cause was fall from height which accounts about 32% of the cases followed by fall of heavy weight and assault (8% each). Right side (56%) was more frequently involved than left (44%).

6 patients (24%) had associated injuries like head injuries, blunt trauma abdomen etc, this signifies the importance of high impact trauma associated with clavicular fractures. Majority of the cases 19(76%) were operated within 4 days of injury. Rest of the cases was delayed either because of the associated injury or due to any associated co- morbid conditions. More than half of the patients 13 (52%) in our series were discharged within first 3 days after surgery.

Radiological union which is defined when there is complete obliteration of fracture in atleast two radiological planes. In this study about 84% fractures united within 8 weeks and in 10 weeks 100% fractures united. Our series showed an overall complication in 8 (32%) of the cases. The most common complication in this study was a palpable implant, which was present in 20% of the patients followed by skin infection (8%) and shoulder stiffness(4%). 92% of the cases returned to full power and range of motion at shoulder within 16 weeks.

Majority of the patients i.e. 19 in our series did not require implant removal; however implant removal was required in 6 patients (Fig 4). Elective implant removal was requested by 5 patients with palpable implant and 1 patient requested for removal without any reason. Our study showed excellent results in 23 (92%) of the patients and good results in 2 (8%) of the cases.

DISCUSSION

Our study included 25 new cases of clavicular fractures all Allman type I, which were managed by ORIF with S-shaped clavicular LCP in 17 patients and 3.5 mm reconstruction locking plate in 8 patients. [1]

When compared with the study of Faldini C et al who used conservative method (figure-of-eight bandage) for treatment of midshaft clavicle fractures, our study showed an overall good results (92%) as compared to Faldini C et al study (81%), with less time taken for fracture union i.e. 6.92 weeks as compared to Faldini C where it took 9 weeks and zero nonunion rate as compared to their study (3%). [8]

The higher rate of the postoperative complications in our study as compared to the study of King PR et al who managed the acute midshaft clavicular fractures by locked intramedullary devices can be explained by the fact that, the most common complication in our study was a palpable implant, since we have used the extramedullary device which was placed on the superficial surface of the clavicle accounted for the palpable implant, which although is not a serious complication. [14]

On comparing this study with the studies of Dhoju D et al, Kulshrestha V & Zilberfarb J et al who used plate and screw fixation in their studies for the treatment of acute clavicular fractures (Table 1), average union time in this study was almost comparable with the other studies that used ORIF of clavicular fractures by plating techniques. We reported a superficial skin infection of 8% which is comparable to the study of Zilberfarb J et al

5.88%. No nonunion was found in our study, which is also true for the other above mentioned studies. There was no deep infection in our group, so is the case with the studies of Kulshrestha V & Zilberfarb J et al. The most common complication in our group was palpable implant in about 20% of the patients, as compared to 25% in the study of Dhoju D et al. We had 100% excellent & good results compared to 100%, 90% & 100% excellent & good results in the series of Dhoju D et al, KulshresthaV and Zilberfarb J et al respectively. [7, 16]

CONCLUSION:

The traditional method of managing middle third clavicular fracture conservatively gives poor functional results. Intramedullary fixation is not favored for its higher complication rate though better cosmesis.

The most predictable method to maintain the anatomic reduction of displaced midshaft clavicular fractures, including length and rotation is plate and screw fixation. Locking plates ensure angular and rotational stability eliminating the possibility of screws to toggle, slide or dislodge and thus reduces the risk of post operative loss of reduction. Reconstruction plates can be contoured according to need. Six cortical purchases on either side of the fracture gives stable construct, predictable union and optimum functional outcome. Interfragmentary screws should be used cautiously wherever they are required. Primary bone grafting is justified in communited fractures. Owing to the subcutaneous anatomy of clavicle, superior implantation of implant might cause hardware prominence especially in thin lean individuals demanding subsequent removal.

The low rate of serious intraoperative complications can be achieved by careful preoperative planning, meticulous surgical dissection, careful handling of fracture ends, careful use of drilling instruments, and appropriate use of antibiotics and programmed rehabilitation.

Although there is a learning curve with this form of treatment, once one becomes proficient in fixing two part clavicle fracture, displaced comminuted clavicle fractures becomes far less intimidating. The choice to proceed with operative intervention for a displaced midshaft clavicular fracture will be a decision made between the surgeon and the patient

Fig 1: Exposure of fracture

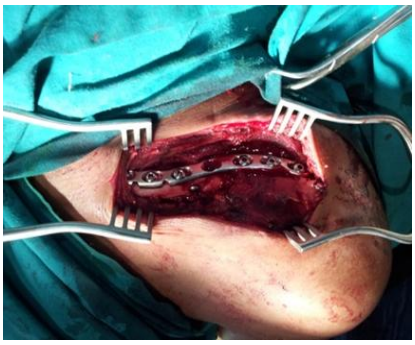

Fig 2: Fixation with plate and screws

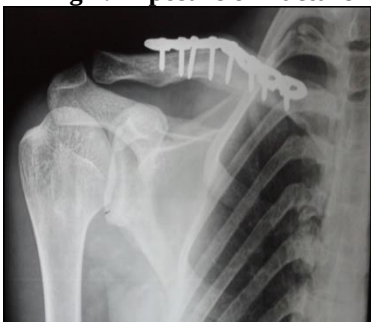

Fig 3: At Union AP View Shoulder

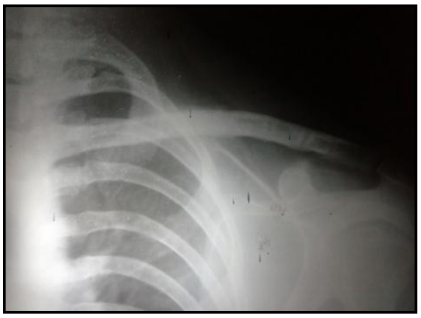

Fig 4: AP View Shoulder after implant removal

	Present study	Dhoju D et al	Kulshrestha V	Zilberfarb J et al
Total cases	25	20	20	17
Age in years	18-50	15-60	21-46	19-67
Male : female	17:8	16:4	20:0	12:5
Mode of injury				
RTA	13 (52%)	10 (50%)	15 (75%)	
Fall from height	8 (32%)	9 (45%)	5 (25%)	
Fall of heavy weight	2 (8%)	-	-	
Assault	2 (8%)	1 (5%)	-	
Sports	-	-	-	
Industrial	-	-	-	
Others	-	-	-	
Union time	10 weeks or less	16 weeks or less	9 weeks or less	9 weeks or less
Nonunion	0	0	0	0
Superficial infection	2 (8%)	0	0	1 (5.88%)
Deep infection	0	1 (5%)	0	0
Palpable implant	5 (20%)	5 (25%)	1 (5%)	7 (41.11%)
Implant failure	0	0	0	0
Results				
Excellent	23 (92%)	20 (100%)	12 ((60%)	17(100%)
Good	2 (8%)	0	6 (30%)	0
Satisfactory	0	0	0	0
Fair	0	0	2 (10%)	0
Poor	0	0	0	0

Table 1

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