"SURGICAL MANAGEMENT OF MIDDLE THIRD FRACTURES OF CLAVICLE WITH LOCKING COMPRESSION PLATE"

By

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DISSERTATION SUBMITTED TO SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH CENTER, KOLAR, KARNATAKA

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MASTER OF SURGERY

IN

ORTHOPAEDICS

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LIST OF ABBREVATIONS USED

#	Fracture
AO	Association for osteosynthesis
AP	Arm pouch
ASIF	Association for the study of internal fixation
C	Comminution
D	Displacement
FB	Fall from bike
FOOH	Fall on outstretched hand
FS	Fall on shoulder
GA	General Anaesthesia
LT	Left side
LCP	Locking compression plate
M	Male
MID	Middle third clavicle fracture
F	Female
RT	Right side
RTA	Road traffic accident

ABSTRACT

Back ground and objectives:

Fractures of the clavicle is one of the most common injures of human skeleton system. It has been traditionally treated non-operatively. The present study was undertaken to study the role of surgical treatment in fresh displaced or comminuted fractures of clavicle with locking compression plate.

Methods:

Thirty adult patients with middle third clavicular fractures treated surgically with locking compression plate and screws between October 2014 to May 2016 were included for this study.

Result:

Among 30 patients with middle third clavicle fracture treated with locking compression plate and screws 26 fractures united at an average of 12 weeks. 3 patients had delayed union, 1 patient had plate breakage for which implant removal and replating was done. The functional outcome according to Constant and Murley score after fracture union in surgically treated middle third clavicle fractures were excellent in 22 patients, good in 6 patients, fair in 1 patient,poor in 1 patient.

Conclusion:

This study shows rigid fixation with locking compression plate and screws for fresh displaced or comminuted middle third clavicle fracture gives good anatomical reduction, immediate pain relief and prevents the development of shoulder stiffness and non union.

Key words:

Clavicle – injuries, fractures- fixation, internal –methods, fractures- surgery, internal – fixators.

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INTRODUCTION

Clavicle fractures is one of the most common bony injuries. They account for 2.6% to 4% of adult fractures and 35% of injuries to the shoulder girdle.

The clavicle is an S-shaped bone that acts as a strut between the sternum and the glenohumeral joint. It also has a suspensory function to the shoulder girdle .The shoulder hangs from the clavicle by the coracoclavicular ligament[1].

The most commonly used system of classification of clavicular fractures is that of Allman. It is divided into 3 groups.[1]

- Group I: Middle-third fractures.
- Group II: Lateral-third fractures.
- Group III: Medial- third fractures.

A weak spot in the clavicle is present at the midclavicular region, which accounts for most fractures occurring in this region. Numerous muscular and ligamentous forces act on the clavicle, and knowledge of these differing forces is necessary to understand the nature of displacement of clavicle fractures and why certain fracture patterns tend to cause problems if not reduced and surgically stabilized.

Midclavicular fracture is one of the most common injuries of the skeleton, representing 3% to 5% of all fractures and 45% of shoulder injuries. The annual incidence of midclavicular fracture is 64 per 100 000 population. Breaks of the shaft form 70% to 80% of all clavicular fractures, lateral fractures contribute 15% to 30%, and medial fractures at 3%, are relatively rare. Open clavicular fracture is an absolute rarity, found in only 0.1% to 1% of cases. The rate of midclavicular fractures is more than twice as high in men as in women. The peak incidence occurs in the third decade of life.[2]

The incidence of nonunion of midclavicular fractures is usually quoted as being from 0.1 to 0.8% and the mainstay of treatment has been nonoperative. These data, however, are based on studies in which clavicle fractures were not adequately classified regarding patient age and fracture displacement. More recent data, based on detailed classification of fractures, suggest that the incidence of nonunion in displaced comminuted midshaft clavicular fractures in adults is between 10 and 15%.[3]

Midshaft fractures have traditionally been treated non-operatively. Surgical treatment of acute midshaft fractures was not favoured due to relatively frequent and serious complications. However, the prevalence of non-union or mal-union in dislocated midshaft clavicular fractures after conservative treatment is higher than previously presumed and fixation methods have evolved.

Surgery is accepted more and more as primary treatment for dislocated mid shaft clavicular fractures, mainly because the results of non-operative treatment are interpreted as inferior to operative treatment both clinically and functionally.

Also persistent wide separation of fragments with interposition of soft tissue may lead to failure of closed reduction. There is 15% nonunion rate in widely displaced fractures of middle-third of the clavicle treated without surgery. And all fractures with initial shortening of more than 2cm resulted in nonunion.[4]

Several studies have examined the safety and efficacy of primary open reduction and internal fixation for completely displaced midshaft clavicular fractures and have noted high union rate with a low complication rate.[5] In a large number of complex clavicle fractures a satisfactory outcome is possible with a low complication rate using a locked compression plate.[6] Primary internal fixation of displaced comminuted mid-shaft clavicular fractures leads to predictable and early return to function.[7]

While the overwhelming majority of clavicle fractures are benign, associated life-threatening intrathoracic injuries are possible. Complications vary based on location of fracture. Fracture of the clavicle is associated with delayed union or nonunion, brachial plexus compression resulting from hypertrophic callus formation, compression or laceration of the great vessels, trachea, or esophagus, injuries to the neurovascular bundle and the pleural dome, poor cosmetic appearance, pneumothorax and intrathoracic injury.

The present consensus that great majority of clavicular fractures heal with non operative treatment is no longer valid. The amount of pain and disability during the first three weeks of conservative treatment has been underrated and the common view that nonunion does not occur is wrong. Pressure from a displaced fragment on the retroclavicular part of the brachial plexus may cause symptoms after conservative treatment. Recent studies have shown that higher rate of non union and specific deficits of shoulder function in subgroups of patients with these injuries. Hence they can be treated as a spectrum of injuries requiring careful assessment and individualized treatment. Nonunion after a clavicular fracture is an uncommon occurrence, although the prevalence is higher than previously reported. There are subgroups of individuals who appear to be predisposed to the development of this complication either from intrinsic factors such as age or gender, or from the type of injury sustained.

There are various methods for treating clavicle midshaft fractures, such as intramedullary K-wires or Steinmann pins fixation and plate fixation. In particular, plate fixation can help obtain firm anatomical reduction in severe displaced or comminuted fracture.

There are various plates including Sherman plates, dynamic compression plates and semitubular plates. Among them, a reconstruction plate and reconstruction locking compression plate (LCP), which can be bent to the S-shaped curvature of the clavicle, are the most preferred. We have taken up this study to gain a deeper understanding of results and problems associated with this procedure, to evaluate the functional outcome after fixation of middle third clavicular fractures with locking compression plate.

AIMS AND OBJECTIVES

- To study the functional outcome of surgical fixation of middle third clavicular fractures with locking compression plate.

REVIEW OF LITERATURE

In 1981, Zenni EJ Jr, Krieg JK and Rosen MJ concluded that the indications for open reduction and internal fixation should be: (1) neurovascular compromise due to posterior displacement and impingement of the bone fragments on the brachial plexus, subclavian vessels, and even the common carotid artery; (2) fracture of the distal third of the clavicle with disruption of the coracoclavicular ligament; (3) severe angulations or comminution of a fracture in the middle third of the clavicle; (4) the patient's inability to tolerate prolonged immobilization and (5)symptomatic non-union following treatment by closed methods.[8]

In 1987, JB Jupiter and RD Leffert reported that of all the etiological factors that were reviewed the extent of displacement of the original fracture was the most significant cause of non-union. Associated complications were limited mobility of the shoulder, neurovascular symptoms, and thoracic outlet syndrome.[9]

In 2002, Iannotti MR et al., concluded that clavicles plated at the superior aspect exhibit significantly greater biomechanical stability than those plated at the anterior aspect. Also concluded that the LCDC plate offers significantly greater biomechanical stability than the reconstruction and DC plates.[10]

In 2003 Michael McKee et al., reported that malunion following clavicular fracture may be associated with orthopedic, neurologic, and cosmetic complications. They concluded that in selected cases, corrective osteotomy results in a high degree of patient satisfaction and improves patient-based upper-extremity scores.[11]

In 2006 Michael McKee et al., concluded that although good results with minimal functional deficits have been reported following nonoperative treatment of

clavicular fractures, surgeon-based methods of evaluation may be insensitive to loss of muscle strength. They detected residual deficits in shoulder strength and endurance in this patient population, which may be related to the significant level of dysfunction detected by the patient-based outcome measures.[12]

2007- In a multicenter, prospective trial by the Canadian Orthopedic Trauma Society of displaced midshaft fracture, outcome and complication rates were compared for nonoperative treatment and plate fixation. Constant Shoulder scores and Disability of the Arm, Shoulder and Hand (DASH) scores were greatly improved in the operative fixation group. Mean time to radiographic union was faster in the operative group than in the nonoperative group. There were lower rates of nonunion in the operative group than in the nonoperative group. Symptomatic malunion was present in none of the operative group. At 1 year after injury, the operative-group patients were more likely to be satisfied with the appearance of the shoulder and with the shoulder in general than the nonoperative-group patients.[13]

In 2007, Huang et al., concluded apex of the superior bow of the clavicle is typically located along the lateral aspect of the bone, whereas the medial aspect of the superior surface of the clavicle remains relatively flat, making it an ideal plating surface. They also opined that displaced midshaft clavicular fractures that are treated with plate fixation have better functional outcomes than those that are treated nonoperatively.[14]

In 2008, Wg Cdr V Kulshrestha 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. 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 fully functional recovery in four months. 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.[7]

In 2008, Wun-Jer Shen M.D.et al operated on 251 fresh completely displaced mid-third clavicle fractures in adult. The fractures were plated with a Mizuho C-type plate or an AO/ASIF 3.5 mm reconstruction plate. The mean time to radiographic union was 10 weeks. Seven patients (3%) developed nonunion. Healing with angulation occurred in 14 patients. Deep infection developed in one patient, and superficial infection in four cases; 21 patients reported soreness with changes in the weather and activity; 28 patients had residual skin numbness caudal to the incision. No patient had shoulder droop, and none had impairment of range of motion or shoulder strength. None developed new or late neurovascular impairment; 171 patients eventually had the hardware removed at an average 401 days post operatively. Overall, 94% were satisfied with the procedure. For completely displaced clavicle fractures in adults, plating is a reliable procedure.[3]

Between April 2003 and October 2009, N.Modi et al operated on 62 clavicle fractures using LCP plates through infraclavicular approach. All patients were followed up until clinical and radiological union was achieved (radiological union was determined by the presence of bridging callus and absence of fracture lines). At the final follow-up 53 patients were available for review. There were 42 male and 11 female patients with an average age of 45 years. The fractures were classified using the system described by CM Robinson (28 Type B1 fractures and 25Type B2 fractures). The

average union time was 4.6 months. There was 1 superficial infection treated with oral antibiotics. There was 1 stress fracture medial to the plate which was treated non-operatively and the fracture united. There were 2 plate failures which required revision, one at 8 days post-op and other at 6weeks.[6]

In 2010, Gereon Schiffer et al presented and evaluated the current treatment options on the basis of a selective review of the literature. They confirmed some long-held concepts and refused others. The risk of non-union after conservative treatment was previously reported as 1% to 2% but has turned out to be much higher in selected subgroups such as in patients with severe displacement, female patients, and patients of advanced age. Furthermore, new implants and techniques have made surgery safer and more likely to result in bony union.[2]

In 2010, Cho et al did a comparative study of reconstruction plate and reconstruction locking compression plate for the treatment clavicle midshaft fractures. Forty one patients with a clavicle midshaft fracture were treated by internal fixation with a reconstruction plate (19 patients) or reconstruction LCP (22 patients). The mean time to union was 14.6 weeks in the reconstruction plate group compared to 13.2 weeks in the reconstruction LCP group ($p > 0.05$). The mean score to Quick DASH was 33.85 points in the reconstruction plate group compared to 34.81 points in the reconstruction LCP group ($p > 0.05$). The complications in the reconstruction plate were hypertrophic scarring in 2 cases, painful shoulder in 2 cases, limitation of shoulder motion in 2 cases, and screw loosening in 3 cases. In addition, the complications in the reconstruction LCP group was hypertrophic scarring in 4 cases, painful shoulder in 1 case and a limitation of shoulder motion in 1case ($p > 0.05$). This study showed radiologically and clinically satisfactory results in both groups. Overall, operative treatment with a reconstruction

plate or reconstruction LCP for clavicle shaft fractures can be used to obtain stable fixation.[15]

In 2011, Darren S. Drosdowech et al in a biomechanical study compared four different techniques of fixation of middle third clavicular fractures. Twenty fresh-frozen clavicles were randomized into four groups. Each group used a different fixation device (3.5 Synthes reconstruction plate, 3.5 Synthes limited contact dynamic compression plate, 3.5 Synthes locking compression plate, and 4.5 DePuy Rockwood clavicular pin). All constructs were mechanically tested in bending and torque modes both with and without a simulated inferior cortical defect. Bending load to failure was also conducted. The four groups were compared using an analysis of variance test. The plate constructs were stiffer than the pin during both pure bending and torque loads with or without an inferior cortical defect. Bending load to failure with an inferior cortical defect revealed that the reconstruction plate was weaker compared with the other three groups. The limited contact and locking plates were stiffer than the reconstruction plate but demonstrated statistical significance only with the cortical defect.[16]

In 2013, randomized control analysis on open reduction and internal fixation versus non operative treatment for midshaft displaced clavicular fractures concludes reduced rate of non-union and better functional outcomes in fractures fixed with open reduction and internal fixation when compared to non operative treatment[17].

In 2013, clinical trials were conducted on operative vs non operative treatment of clavicle fracture. Results showed reduced rate of non union, mal union, neuro vascular deficits in operative cases when compared to non operative treatment[18].

In 2014, to assess the functional outcome of mid 1/3rd clavicle fracture after open reduction and internal fixation a study was done which shows in certain selected patients and certain fracture configuration there is higher incidence of adequate income in terms of union rate, cosmesis and functional ability[19].

In 2014, a prospective study done on changing trends in management of adult clavicular fractures shows traditional methods of managing mid third clavicle fractures conservatively gives poor functional results. Most predictable method to maintain anatomical reduction of displaced midshaft clavicle fracture including length and rotation is plate and screw fixation[20].

In 2014, a population based analysis on rate of risk factors for reoperations after open reduction and internal fixation of mid shaft clavicle fractures. Out of 1350 patients treated with ORIF one in four patients underwent re operation.Most common procedure was implant removal.[21]

In 2015 a prospective, randomized controlled trial on fifty-nine patients with displaced midshaft clavicular fracture were randomly assigned to receive fixation with either a reconstruction plate (thirty-three patients), known as the plate group or elastic stable intramedullary nailing (twenty-six patients), known as the nail group The mean six-month DASH score was 9.9 points in the plate group and 8.5 points in the nail group ($p = 0.329$).[22]

In 2015 a cadaveric study done on Safety zone for surgical access in the middle third of the clavicle showed The mean distances from the middle third of the clavicle to the suprascapular nerve, subclavian vein, upper trunk, anterior division of the upper trunk and posterior division of the upper trunk were respectively, for the right side: 15.92 cm, 10.77 cm, 23.68 cm, 14.60 cm and 15.42 cm; and for the left side: 12.69 cm;

9.82 cm; 22.19 cm; 12.16 cm and 13.46 cm There was a statistical difference in the distances to the suprascapular nerve and anterior division of the upper trunk, in comparing between the right and left sides. The closest neurovascular structures to the middle third of the clavicle were the suprascapular nerve and subclavian vein.[23]

In a study by Alex and co. on functional outcomes of operative fixation of clavicle fractures in patients with floating shoulder girdle injuries between 2002 and 2010, 32 consecutive floating shoulder injuries were identified in skeletally mature patients at a level I trauma center and followed in a single private practice. Results showed early fracture union and excellent shoulder range of motion in majority of cases.[24]

In 2015 study was done on saw bone clavicle specimens about unicortical versus bicortical locked plate fixation in midshaft clavicle fractures.Results showed no significant differences were found between unicortical and bicortical fixation in failure load, cantilever bending, and cross body stiffness.[25]

A densitometric study of the clavicle shows the clavicle on the non-dominant side is denser than the clavicle on the dominant side. Like wise, the middle third of the clavicles, both on the dominant and on the non-dominant side, is denser than the distal third. Thus, the occurrences of clavicular fractures more on the left side, as found in the present study, could be due to greater bone mineral density on the non-dominant side, which would diminish bone flexibility and, hypothetically, increase the propensity to fractures.[26]

A case report has been published on extrinsic subclavian vein compression after osteosynthesis of a midshaft clavicular fracture in an athlete.It concludes saying although vascular complications associated with clavicle fixation are rare, they may be

limb and even life threating. It is advisable that surgeons take measures to avoid them especially when placing the medial screws. In a patient with clinical suspicion of a vascular complication, it is essential not to delay imaging studies to confirm the diagnosis and to start prompt treatment to avoid serious complications.[27]

A comparative study was between Titanium elastic nail (TENS) and reconstruction plate. In both loading configurations, TEN generated the highest displacement of the distal clavicle, followed by the intact clavicle and the reconstruction plate. TEN showed higher peak bone and implant stresses, and is more likely to fail in both loading configurations compared with the reconstruction plate. TEN led to a stress distribution similar to that of the intact clavicle in both loading configurations, whereas the stress distribution with the reconstruction plate was non physiological in cantilever bending. Fixation with a reconstruction plate was more stable but showed obvious stress shielding. Therefore, for patients with a demand for early return to activity, reconstruction plate fixation may be preferred.[28]

ANATOMY

EVOLUTION:

- As humans evolved into a biped and assumed an orthograde posture the shoulder girdle underwent changes in order to comply with the demands of a non weight bearing joint.
- Clavicle is present in animals including man who use their upper limb for holding, grasping and climbing.
- Mammals adapted for running and swimming have lost their clavicle to further mobilize their shoulder girdle.[29]

PECULIARITIES OF CLAVICLE:

- It is the only long bone to lie horizontally in the body
- It is the only bone with membranous ossification
- It is the first bone to ossify in the body
- It lacks a well defined medullary cavity
- It is subcutaneous throughout its whole extent
- The shaft ossifies from two primary centres[29].

CLAVICLE ANATOMY:

When discussing clavicle anatomy we can divide the anatomical structures into following components, the osseous structures, the ligamentous structures, the muscular anatomy and the joints[29].

I) OSSEOUS STRUCTURE:

The clavicle is a relatively straight bone when viewed anteriorly where as in the transverse plane it resembles an italic S.

Its name is derived from latin word clavis; the diminative of which is clavicula which refers to the musical symbol of similar shape. Greater radius of curvature occur at its medial curve which is convex anteriorly and smaller lateral curve which is convex posteriorly.

In cross section of the clavicle there is a gradual transition like flat lateral aspect, tubular middle portion and an expanded prismatic medial end.

The obvious process of the bone includes the lateral and medial articular surfaces.

The medial end of the bone has rhomboid fossa on its inferior surface where the costoclavicular ligament is inserted.

The mid portion of the clavicle contains the subclavian groove where the subclavius muscle has a fleshy insertion.

CLAVICLE BONE

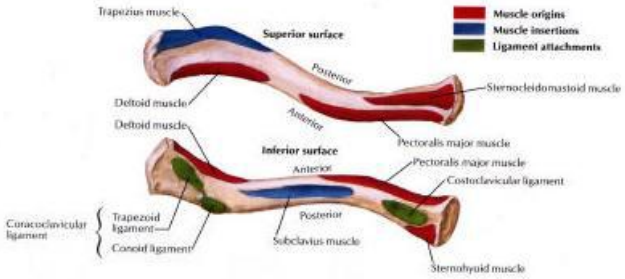


FIGURE 1: CLAVICLE BONE

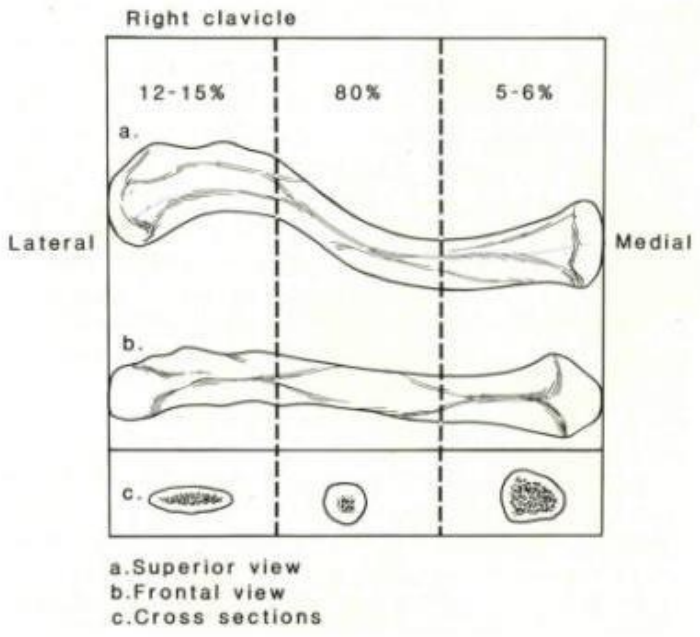


FIGURE 2: SHAPE AND CONFIGURATION OF CLAVICLE

At the lateral end of the bone is the conoid tubercle on the posterior portion of the lateral curve of the clavicle where conoid ligament is attached. The trapezoid line where trapezoid ligament is attached[29].

OSSIFICATION:

- It ossifies from two primary and one secondary centre
- Primary centres (medial and lateral) appear in the shaft between 5-6weeks of intrauterine period and fuse by about 45th day
- A secondary centre for sternal end appears at 15th year in females and 17th years in males and unites with shaft at 21st year in females and 22nd year in males. A secondary centre sometimes develops in the cartilage at the acromial end at 18- 20 years and rapidly unites by 24th years
- Medial clavicular epiphysis is responsible for the majority (80%) of longitudinal growth[29].

II) LIGAMENTOUS ANATOMY:

A) Medial ligamentous anatomy:

a) Interclavicular ligament:

This ligamentous band spans from the medial clavicle to the superior sternum and to the contralateral clavicle. It loosens with shoulder elevation but serves as a support to prevent downward displacement of lateral end of the clavicle.

b) Costoclavicular ligament:

This ligament runs from the upper aspect of the first rib and adjacent aspect of the sternum to the clavicle. The anterior and posterior fibers of the costoclavicular ligament stabilize the medial clavicle during upward and downward rotation.

c) Capsular ligaments:

Specific thickenings of the sternoclavicular joint capsule are referred to as the capsular ligaments. The strongest and most important are the anterosuperior and posterior aspect of the capsule which are responsible for limiting superior displacement of medial end of clavicle and inferior displacement of the lateral end of clavicle.[30]

B) Lateral ligamentous anatomy

a) Coracoclavicular ligaments:

The trapezoid and conoid are thick strong ligaments travelling from the base of the coracoid process of the scapula to the inferior aspect of the lateral clavicle. These ligaments serve as the important function of suspension of the shoulder girdle from the clavicle and it provides vertical stability.

b) Acromioclavicular ligaments:

The capsule of the acromioclavicular joint forms the acromioclavicular ligaments. Posterosuperiorly the ligament serves to resist anteroposterior displacement of the distal clavicle. The coracoclavicular ligament also helps to stabilize the clavicle during rotation on its long axis in overhead activities.[30]

III) MUSCULAR ANATOMY:

Clavicle acts as a bony frame work for muscle origin and insertion.

i) Muscles that insert on the clavicle:

Upper third of trapezius inserts on to the superior surface of the outer third of the clavicle.

Subclavius muscle arises from first rib anteriorly at the costochondral junction. It proceeds obliquely and inserted into a groove on the under surface of the clavicle. This muscle appears to aid in depressing middle third of the clavicle.

ii) Muscles arising on the clavicle:

Clavicular head of deltoid arises from the outer third of clavicle opposite to the insertion of trapezius. Sternocleidomastoid muscle arises from the posterior edge of the medial third of the clavicle.

Pectoralis major arises from the anterior portion of medial two thirds of the clavicle.

Sternohyoid contrary to its name does have a small origin in the

clavicle just medial to the origin of the sternocleidomastoid.

Platysma originates over the deltoid and pectoralis major. It crosses the superficial anterior surface of the clavicle.[30]

IV) JOINTS:

The clavicle provides the connection between the upper limb and the thorax through its articulation at sternoclavicular and acromioclavicular joints.

i) Sternoclavicular joints:

The sternoclavicular joint is formed laterally by the proximal end of the clavicle and medially by clavicular notch of manubrium and cartilage of 1st rib.

This joint is the only true articulation between the upper extremity and the axial skeleton.

The sternoclavicular joint is a diarthroidal type of plane synovial joint which allows 6 degrees of freedom.

The sternoclavicular joint has relatively little bony stability and the bony surfaces are some what flat. The ligamentous structures provide the stability to the joint.

Anterior sternoclavicular ligament is covered anteriorly by sternomastoid and it blends posteriorly with intra articular disc.

Posterior sternoclavicular ligament blends with the tendons of sternothyroid and sternohyoid muscle.

Posteriorly joint surface is covered with hyaline cartilage. A complete disc is found to separate the joint into two compartments.

Elevation and depression occur in the joint between the disc and the sternum.

Range of motion is approximately 30 to 35 degrees of upward elevation about 35 degrees in anteroposterior direction and rotation along long axis is about 44 to 50 degrees.

Most sternoclavicular elevation occurs between 30 and 90 degrees of arm elevation.

Rotation occurs at 70 to 80 degrees of arm elevation.

Fusion of sternoclavicular joint limits abduction to 90 degrees.[29 31]

ii) Acromioclavicular joint:

Acromioclavicular joint is the only articulation between the clavicle and scapula. It is formed medially by acromial end of clavicle and laterally by medial margin of acromion.

It is a plane synovial joint because the articulating surfaces are relatively flat and allows 3 degrees of freedom.

It is surrounded by a thin capsule that is reinforced by superior, inferior, anterior and posterior acromioclavicular ligaments and it contains a perforated disc.

The upward and downward movements allows rotation of about 20 degrees between the acromion and clavicle. It occurs during the first 40 degrees and last 20 degrees of elevation.

Motion of the acromioclavicular joint is significantly less than at the sternoclavicular joint but it does play a critical role in allowing full arm motion.[29 31]

RELATIONSHIP: Anterior surface of the clavicle is essentially subcutaneous over its course with only the thin platysma and cervical fascia covering it. The supraclavicular nerves which provide sensation to the overlying skin are consistently found deep to the platysma muscle layer. The strong tubular portion of the clavicle is clothed on its underside by the subclavius muscle and it overlies these vital structures which may account for the low incidence *of neurovascular injury associated with clavicular fractures.* Sometimes it may be entrapped within the fracture site and inhibit healing.

Immediate relationships of the sternoclavicular joint are the origins of the sternocleidomastoid infront and sternohyoid and sternothyroid muscles behind the joint. Of prime importance however are the great vessels and the trachea which are endangered during posterior dislocation of the clavicle from the sternum. The Medial anterior curve is often described as an accommodation for subclavian vein, subclavian artery and brachial plexus and the curve is a land mark for finding the subclavian vein.[29]

Costoclavicular space:

It is the space between medial clavicle and the first rib.[29]

Superficial infraclavicular space:

It is formed by pectoralis major and deltoid portion of the clavicle.[29]

Grants space:

It is formed by investing layer of cervical fascia anteriorly and omohyoid fascia posteriorly. Here external jugular vein join subclavian vein at its confluence with internal jugular vein.[29]

Blood supply:

Main nutrient artery enters just medial to the attachment of coracoclavicular ligament.[29]

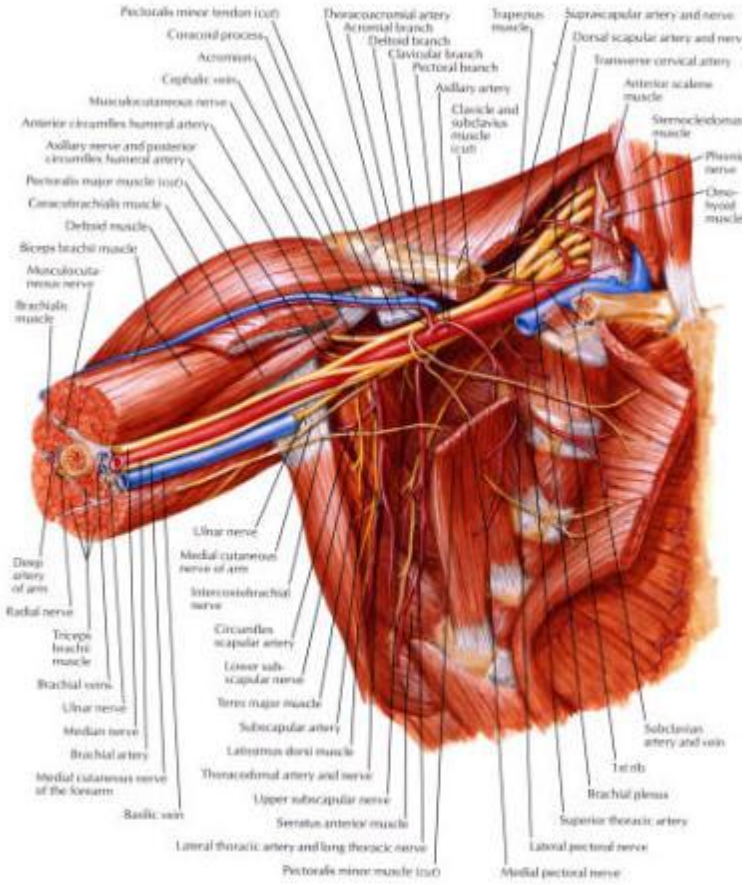


FIGURE 3: DEEP RELATION OF CLAVICLE

BIOMECHANICS

The study of biomechanics refers to the movement of joint through space and it attempts to explain both the quality and quantity of joint movement.

There are three axis of clavicular motion.

a)Anteroposterior b)Superoinferior

c)Rotational

The function of the shoulder girdle requires the integrated motion of the sternoclavicular, acromioclavicular, glenohumeral and scapulothoracic joints.

This motion is created by the delicate interaction of almost 30 muscles.

It is generally accepted that scapulohumeral rhythm occur in a 2:1 ratio with the humerus moving 2 degrees for every 1 degree of scapular motion.

During arm elevation the clavicle must elevate to allow the scapula to rotate upwards.

Clavicle rotates totally 70 degrees in an upward fashion during arm elevation.

During elevation of the extremity clavicular elevation of about 30 degrees occur with maximum elevation occurring at about 130 degrees of arm elevation and depression occur approximately 5 degrees in sagittal plane. The clavicle also rotates forwards approximately 10 degrees during the first 40 degree of arm elevation.

No change take place during the next 90 degrees of arm elevation but an additional 15 to 20 degrees of forward rotation subsequently occur during the terminal arc. If the clavicle is not allowed to rotate elevation of arm to only about 110 degrees is possible.

Approximately 15 degrees of clavicular protraction and retraction occurs in the frontal plane.[29 31]

FUNCTIONS OF THE CLAVICLE

Codman has stated that "We are proud that our brains are more developed than the animals we can also boast of our clavicles. It seems that the clavicle is one of the man's greatest skeletal inheritances for he depends to a greater extent than most animals except the apes and monkeys on the use of his hands and arms".

1) Power and stability of the arm:

The clavicle serves as a bony link from thorax to shoulder girdle. It contributes significantly to the power and stability of the shoulder especially in movement above the shoulder level.

The long clavicle may facilitate placement of the shoulder in a more lateral position so that the upper limb can be positioned more effectively to deal with the three dimensional environment.

2) Motion of the shoulder girdle:

Lateral curvature of clavicle permits it to act as a crank shaft effectively allowing half of the scapular movements. This so called crank shaft mechanism on shoulder abduction provides 30 degrees of the total 60 degrees contribution from scapulothoracic motion.

3) Muscle attachments:

It provides a bony base for muscle origin and insertion.

4) Protection of neurovascular structures:

Subclavian vessels, brachial plexus and lungs are directly behind the medial third of the clavicle. The tubular cross section of the medial third of the clavicle increases its strength which along with subclavius muscle adds to its protective function at this level.

Loss of clavicle can cause exacerbation of thoracic outlet symptoms because of drooping of the shoulder and resultant draping of brachial plexus over the first rib.

5) Respiratory function:

Because of the connection with the first rib elevation of the shoulder girdle brings about a cephalad motion of the thorax corresponding to inspiration. This relationship is used in some breathing exercises and in some form of artificial respiration.

6) Cosmosis:

Cosmetic function is served by the smooth subcutaneous bony clavicle by providing a graceful curve to the base of the neck.

7) Protection to lungs:

It protects the superior aspect of the lungs.[17]

Thus the clavicle plays an important functional role in the shoulder girdle and every effort should be made to preserve the normal length and alignment during the treatment of clavicular disorders.

INCIDENCE OF INJURY

Fractures of the clavicle account for approximately 5 to 10% of all fractures and upto 44% of all injuries to the shoulder girdle.

The site of fracture also depends upon the age of the patient and mechanism of injury.

Elderly men - proximal third clavicle fracture.Children - middle third clavicle fracture, undisplaced.Adolescents - middle third clavicle fracture, displaced. Middle aged patient- distal third clavicle fractures

The incidence of both lateral and medial clavicular fracture rose sharply after the age of 75 years suggesting that these areas become substantially more susceptible to fracture when osteoporotic.[29 32]

MECHANISM OF INJURY

The primary mechanism of clavicular failure is by compression it may be caused by either low energy or high energy impact like.

i) fall on the shoulder-87%

ii) direct blow on to shoulder-7%

iii) fall on to an outstretched hand-6%

Clavicles when axially loaded they tended to fracture at the middle third in the region where the curve of the lateral aspect of the clavicle changes to the curve of the medial aspect of the clavicle.

Another mechanism of fracture of the clavicle is a direct force when applied to the top of the shoulder the clavicle is forced against.

The first rib and a spiral fracture of the middle third is produced Another variation in the mechanism which is seen more commonly in the past few years is referred to as "seat belt fractures". The shoulder strap from the seat belt acts as a fulcrum typically at the mid point of the clavicle and the forward force on the clavicle against this fulcrum causes the clavicle to fracture in a transverse or oblique pattern with little comminution. Stress fracture of the clavicle has been reported in athletes. It is seen in a variety of sports like baseball, diving, gymnastics etc.[30]

FRACTURE BIOMECHANICS

For mid shaft fracture the displacing forces are

a) superior displacement of medial segment-sternocleidomastoid

b) inferior displacement of lateral segment - pectoralis major and latissimus muscles

The trapezius provides a stabilizing force against inferior displacement of the lateral segment.

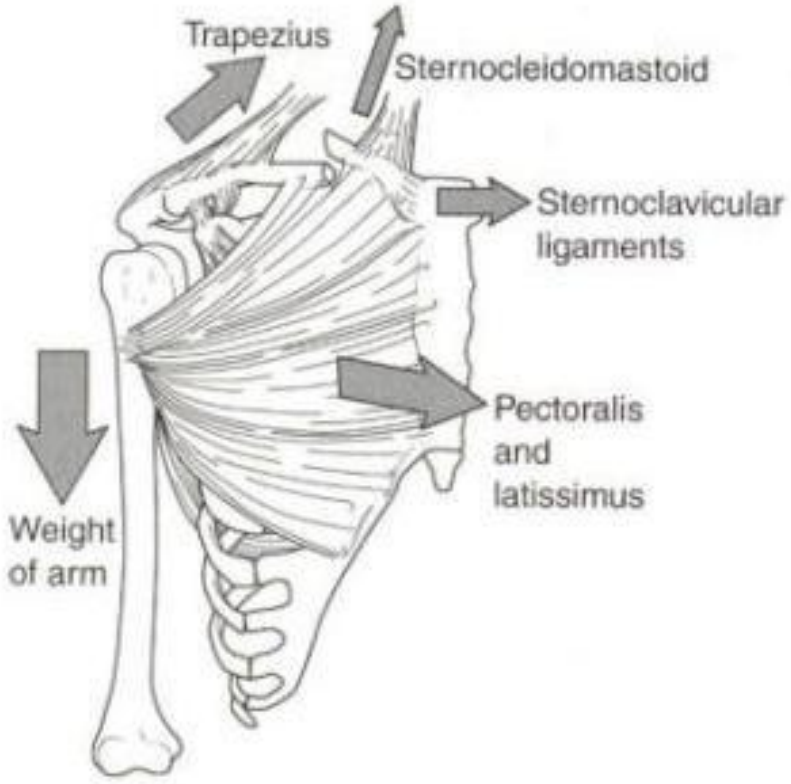


FIGURE 4: DISPLACING FORCES ON MIDDLE THIRD CLAVICLE FRACTURE

CLASSIFICATION

There are several classification scheme for fractures of the clavicle ranging from the simple to complex. The most commonly used system is that of Allman. He separated clavicle fracture into three groups according to location in the bone because prognosis and treatment vary according to the type

Group-I - middle third clavicle fractures

Group-II - lateral third clavicle fractures

Group-III- medial third clavicle fracture.[29 30]

Neer recognized the unique behaviour of distal clavicle fracture and proposed a separate classification system for this group. He divided Allman's group II into three distinct types.

Type-I Coracoclavicular ligament intact

Type-II Coracoclavicular ligament detached form the medial segment but trapezoid part intact to distal segment

Type –III Intraarticular extension into the acromioclavicular joint.[29 30]

In 1990 Craig introduced a more detailed classification scheme that combines the Allman and Neer classification.[29 30]

Robinson's classification of clavicular fractures:

The classification proposed by Robinson was based on the observation on 1000 adult clavicle fracture and taken into the account the anatomical site, extent of displacement, comminution, articular extension and stability of the fracture.

It is as follows

Type- 1 medial third

A - Undisplaced

A1 - Extraarticular

A2 - Intraarticular

B - Displaced

B1 - Extraarticular

B2 - Intraarticular

Type- 2 middle third

A - Cortical alignment

A1 - Undisplaced

A2 - Angulated

B - Displaced

B1 - Simple or single butterfly fragment

B2 - Comminuted or segmental

Type- 3 distal third

A - Nondisplaced

A1 - Extraarticular

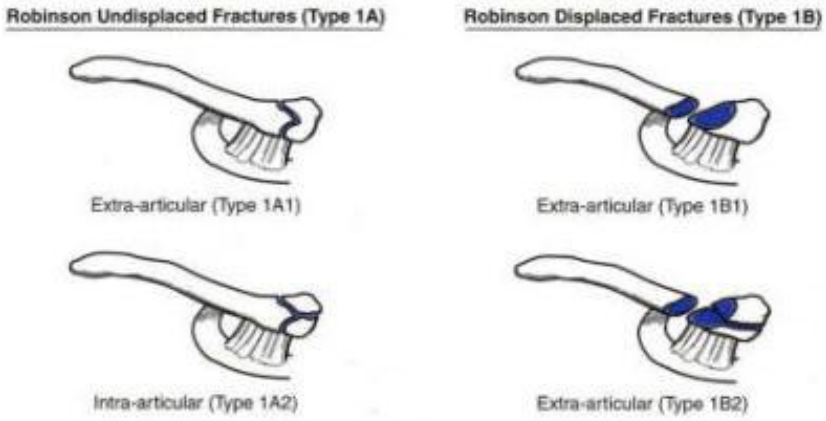
A2 - Intraarticular

B - Displaced

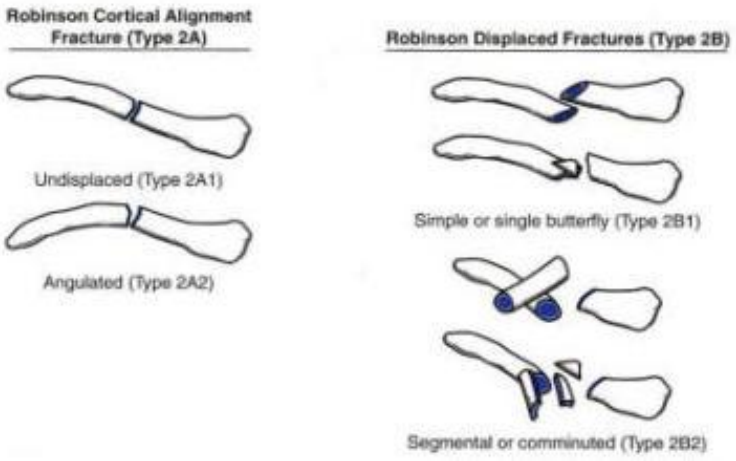
B1 - Extraarticular

B2 – Intraarticular.[29 30 33]

TYPE - 1 : MEDIAL THIRD CLAVICLE FRACTURE



TYPE - 2 : MIDDLE THIRD CLAVICLE FRACTURE



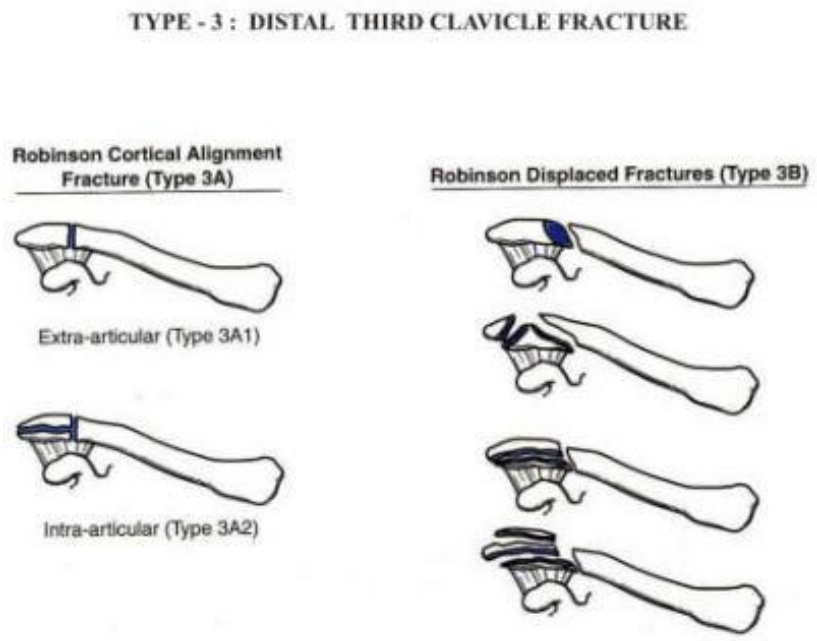


FIGURE 5: ROBINSON CLASSIFICATION

CLINICAL FINDINGS

Patient usually provides a clear history of some form of either direct or indirect injury to the shoulder.

The vast majority of fractures will result from a simple fall, a fall from a height, a fall during a sport activity or a motor vehicle accident.

Patient may angle their head towards the side of injury in an attempt to relax the pull of trapezius muscle on the fragment and splint the involved extremity because any movements of affected extremity will elicit pain.

The involved arm droops forwards and downwards because of the weight of the arm and pull of the pectoralis minor muscle. This drooping further accentuates the posterosuperior angulation seen in most clavicular fracture.

Ecchymosis may be noted over the fracture site and severe displacement of bone fragments will produce tenting of the skin. Physical examination reveals tenderness directly over the fracture site.

Gentle palpation and manipulation will usually produce crepitus. All movement of the arm is painful.[29 30]

ASSOCIATED INJURIES:

Associated injuries accompany acute fracture of the clavicle. It may be divided into –

1) Associated skeletal injuries

2) Injury to lung and pleura

3) Vascular injuries

4) Brachial plexus injuries.

Skeletal injuries may include sternoclavicular or acromioclavicular dislocation or fracture dislocation of these joints.

Head and neck injuries.

Fracture of the first rib.

Associated with dislocation – disruption of scapulothoracic articulation.

Fracture of both the clavicle and the scapula are associated with an extremely unstable shoulder girdle – floating shoulder.

Pneumothorax, heamothorax with fractures of the clavicle because the apical pleura and upper lung lobes lie adjacent to this bone. Vascular injuries include laceration, occlusion, spasm or acute compression. The vessels most commonly injured are the subclavian artery, subclavian vein and internal jugular vein.

Injury to brachial plexus is often associated with subclavian vascular injury.[29]

RADIOGRAPHIC EVALUATION

Evaluation of clavicle middle third clavicle fractures:

The clavicle not only shortens but also become angulated inferiorly and rotated medially and the deformity is truly in two planes. To obtain an accurate evaluation of fragment position at least two projections of the clavicle should always be obtained –

An anteroposterior view and a 45 degrees cephalic tilt view.

For evaluation of internally fixed clavicle the abduction lordotic view with the arm abducted 135 degrees and beam angled 25 degrees cephalad is extremely helpful.

In patients with minimal displacement of the fracture fragments and with no gross motion tomography or even bone scan may be useful to demonstrate the presence of non-union in asymptomatic patients.[29 30 32]

TREATMENT

The exact method of treatment of a fractured clavicle depends on several factors including the age, medical condition of the patient, the location of the fracture and associated injuries. It is important to achieve anteroposterior and lateral alignment of the fracture because the clavicle is a curvilinear bone.[29]

In adults with clavicular fractures the goal of treatment as with other fractures is to achieve healing of bone with minimal morbidity, loss of function and residual deformity. General methods of treatment of fractures of the clavicle can be broadly grouped into the following ways –

Conservative or non-operative treatment.

Operative treatment.

OPERATIVE TREATMENT:

The chief goal in this method of treatment is to achieve a healed clavicular strut in an normal anatomical position as possible. The healed clavicular bone in good position provides stability to the shoulder girdle.

It may be by any of these methods:

i) Intramedullary fixation

ii) Internal fixation with plates and screw

iii) External fixation.

Indications:

Indications for operative treatment of clavicular fractures are:

1. Severe displacement caused by comminution with resultant angulation and tenting of the skin severe enough to threaten its integrity and that fails to respond to closed reduction.
2. Symptomatic non-union like shoulder girdle dysfunction neurovascular compromise.
3. Neurovascular injury or compromise that is progressive or that fails to revert after the closed reduction of the fracture.
4. Open fracture.
5. Type II distal clavicular fracture (displaced).
6. Multiple trauma, when mobility of the patients is desirable and closed methods of immobilization are impractical or possible.
7. Floating shoulder.
8. Inability to tolerate closed immobilization such as neurological problems of Parkinsonism, seizure disorders.
9. Cosmetic reasons.
10. Relative indications include shortening of more than 15 to 20mm and displacement more than the width of the clavicle.[29 30 32 34]

I INTRAMEDULLARY DEVICES:

Before the advent of AO/ASIF techniques, the smaller thin plates that were used gave poor results leading many to prefer intramedullary fixation with smooth or threaded Kirschner wires, steinman pins, knowles pins, Hagie pins, or cannulated screws, wires or screws.

Advantages:

It can be performed through a small skin incision in Langer's lines. It requires minimal soft tissue stripping and can be removed under local anaesthesia.

In setting of comminution the canti lever effect for a pin extends to medial most portion of the pin there by providing better fixation in bending loads. It allows axial compression so it enhances healing.

Disadvantages:

Intramedullary fixation of the clavicle is technically very difficult owing to the curvature, high density and poorly defined intramedullary canal of the bone. And also intramedullary fixation does not have control over the rotational forces making postoperative immobilization necessary in vast majority of cases so plate fixation in used now.[29]

II PLATE AND SCREWS:

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.

Types of plate used:

i) AO Reconstruction plate

ii) Dynamic compression plate

iii) Low-contact dynamic compression plate

iv) One third semitubular plate

v) Locking compression plate

In relatively simple fractures standard 3.5mm AO dynamic compression plates are used.

The 3.5mm AO reconstruction plate with its lower profile and its ability to be contoured in two planes to fit the S-shaped clavicle more easily is the preferred implant. However it provides no compression and is weaker than a dynamic compression plate in terms of bending.

The low-contact dynamic compression plate allows ease of contouring with uniform plate bending. Smaller contact area with the underlying bone leading to less disruption of the underlying blood supply.

One third tubular plate has a high rate of fatigue failure because it does not provide strong enough fixation.[30,32,34,35,36]

Advantages:

1. For transverse fractures, compression across the fracture site is achieved.

2. For oblique fractures or butterfly fragments, lag screw fixation is possible with the plate functioning in a neutralization mode.

3. Rotational control of the fracture is achieved.

4. Fixation is rigid enough to allow the patient to bear weight minimally on the extremity or to use the arm for activities of daily living.[30]

Disadvantages:

1. It includes the necessity for increased exposure and soft tissue stripping.

2. Potential damage to the supraclavicular nerves which cross through the surgical field.

3. The plate itself sits subcutaneous and can be the source of irritation and poor cosmosis.

4. For plate removal another procedure is required and the patient is left with multiple stress rises in the clavicle and to prevent refracture removal of plate is done at 12 to 18 months.

5. Despite these short comings plate fixation utilizing careful surgical techniques is an excellent method of treatment for mid clavicular fractures.[30,32,34,35,37]

III EXTERNAL FIXATION:

External fixation of clavicle in mentioned for the sake of completeness, and the indications are few. It may be indicated for severe open fracture with poor quality of the overlying skin and infected non union after plate removal.[32,37]

COMPLICATIONS

a) Malunion:

Adults have no remodeling potential so shortening or angulation may occur after displaced clavicular fractures. Patients with shortening of the clavicular segment of more than 15mm at follow-up examination had significantly more pain than those without these findings. So it is recommended not to accept shortened clavicle.

b) Nonunion:

Clavicular non-union is defined as failure to show clinical or radiographic progression of healing at 4 to 6 months.

At 16 weeks period as long as some potential for healing was present it is called delayed union.

The incidence of non-union probably much higher than previously thought with an incidence of 15% to 25%.

Factors predispose to non-union of the clavicle are –

i) Inadequate immobilization: Clavicle is one of the most difficult bones to immobilize properly and completely after fracture.

ii) Severity of trauma: Since clavicle being subcutaneous bone it is subjected to severe soft-tissue injury so upto half of this fractures result in non-union.

iii) Refracture: Because the vascular anatomy of a fractured bone remains altered for a long period even after fracture union, reinjury might in some way prevent this altered blood supply from reaching to the new fracture.

iv) Location of fracture: The fractures of the distal third of the clavicle are more susceptible for nonunion because –

a) They are unstable and the muscle forces and weight of the arm tend to displace the fracture fragments.

b) It is difficult to secure adequate external immobilization.

c) These fractures usually result from severe trauma and usually associated with soft tissue injury.

v) Degree of displacement: 91% of delayed unions and nonunions had initial shortening of atleast 2cm. Marked displacement is often associated with other factors like soft tissue damage, open fracture and soft tissue interposition that will interfere with healing.

vi) Primary open reduction: Extensive soft tissue dissection, periosteal stripping and infection have been attributed to high rate of non-union in fractures treated with internal fixation. But it is probable that the operative fractures also included difficult cases (those associated with severe trauma, soft tissue damage and associated injuries) thus contributing to the poor results.

One cannot overlook the fact that most of the surgical complications are related to poor fixation techniques and it is not the concept of surgical treatment that is the problem but rather the choice of fixation.

c) Neurovascular sequelae:

In adults late neurovascular sequelae can follow both united and nonunited fractures. Abundant callus or significant fracture deformity in some patients may narrow the costoclavicular space sufficiently to cause symptoms which most frequently involve the subclavian and axillary vessels or the brachial plexus (especially the ulnar nerve). The ulnar nerve crosses the first rib directly under the medial third of the clavicle and the other two cords are further to the lateral side. Therefore the ulnar nerve is more frequently involved in complications arising from fractures of the medial third of the clavicle.

d) Post traumatic arthritis:

It may follow after intraarticular injuries to both the sternoclavicular and acromioclavicular joints. Often this is a result of an unrecognized intraarticular fracture.[29,30]

Complications of surgery and its treatment:

1) Hard ware problems:

As with fresh fracture fixation inadequate purchase or plate size, collapse of the intercalary graft are important predictors of failures like plate loosening, plate angulation, plate breakage which may be treated by replating.

In the case of perfect transverse fracture the point of fixation of the cantilever is the sternoclavicular joint and the plate acts to compress the fracture with bending. In most high energy clavicle fractures are comminuted and in this setting the fixation point of

the cantilever moves laterally to the fracture site and putting significant force on the lateral most screws so the plate fails by pullout of the lateral most screws.

2) Infection:

Infection after operative treatment for fracture or non-union can be a devastating complication.

Reconstruction for deep infection or osteomyelitis particularly in the non-union situation where bone loss maybe extensive is often difficult. Initial treatment should include operative debridement. Although consideration can be given for retaining a stable graft. If hardware configuration is unstable treatment should include removal of all graft and hardware followed by 6 weeks of intravenous antibiotics.

Revision surgery can be undertaken once clinically apparent infection is aborted. If there is a major bone loss vascularized graft may be needed.

3) Hypertrophic scar:

The potential for a hypertrophic uncosmetic scar after open plating is common. The remedy is scar excision at the time of plate removal.

4) Refracture:

Initial comminuted fracture is a risk factor for subsequent refracture.

5) Non union, delayed union and malunion:

It can be treated by replating and bone grafting[30,34,37].

REHABILITATION: Objectives:

Improve and restore the function of the shoulder for activities of daily living, vocational and sports activities.

Duration:

The expected duration of rehabilitation is for 10 to 12 weeks.

Rehabilitation protocol:

i) Day one to one week : Limb is immobilized in a sling with shoulder held in adduction and internal rotation. Elbow is maintained at 90° of flexion with no range of motion at shoulder.

ii) At two weeks: After suture removal gentle pendulum exercises to the shoulder in the sling as pain permits is allowed.

iii) At four to six weeks: At the end of 6 weeks gentle active range of motion of the shoulder is allowed. Abduction is limited to 80°.

iv) At six to eight weeks: Active to active – assistive range of motion in all planes is allowed.

v) At eight to 12 weeks: Isometric and isotonic exercises are prescribed to the shoulder girdle muscles.[38]

METHODOLOGY

The present study was carried out from October 2014 to May 2016 at the Department of Orthopedics R.L Jalappa Hospital And Research Centre attached to Sri Devaraj URS Medical College, Tamaka,kolar. During this period 30 patients of clavicle mid shaft fractures were treated surgically.

INCLUSION CRITERIA:

1) AGE > 18 YEARS
2) ALL MIDDLE THIRD CLAVICLE FRACTURES
3) ALL OPEN FRACTURES UPTO TYPE IIIA(GUSTILO ANDERSON)

EXCLUSION CRITERIA:

1) MEDICALLY UNFIT PATIENTS FOR SURGERY
2) PATHOLOGICAL FRACTURES

General information like name, age, sex, occupation and address were noted.

Then a detailed history was elicited regarding the mode of injury like fall on the shoulder,road traffic accident, direct injury to shoulder and fall on outstretched hand. Enquiry was made to note site of pain and swelling over the affected clavicle. Past medical illness and family history were also recorded.

General condition of the patients was examined for pallor, pulse rate and blood pressure.

Respiratory and cardio vascular system were examined for any abnormalities.

Local examination was done in the following steps:

1. On inspection the following points were noted:

   Patients with fracture clavicle often support the flexed elbow of the injured side with the other hand. Abnormal swelling was present over middle third of clavicle for middle third clavicle fractures. The condition of the skin over the clavicle was noted for any abrasion, laceration and contusion.

2. On palpation the following points were noted:

   Palpation of the entire length of the affected clavicle was done to check for tenderness. The fractured clavicle was also palpated gently for any crepitus.

3. Movements:

   The movements of the affected side shoulder was restricted due to pain

   The distal neurovascular status of the affected upper limb was examined and also the associated injuries along with fractured clavicle were noted.

   Plain radiograph of clavicle with shoulder in anteroposterior view was taken to assess the site of fracture and the fracture type (displacement and comminution). The fractures were classified according to Robinson's classification.

   The affected upper limb was immobilized in an arm pouch.

   Routine investigation like Hb%, Total count, Differential count, ESR, Blood urea, Sugar, Serum creatinine and ECG were done. HBsAg and HIV test were done before surgery on all patients.

   All patients were operated as early as possible once the general condition of the patients were stable and the patients were fit for surgery as assessed by the physician.

Preoperative preparation of patients:

Patients were kept nil per oral for 6 hours before surgery. A written informed consent for surgery was taken.

The neck, chest, axilla shoulders and arm were prepared.

Tranquilizers were given as advised by the anesthetist.

A systemic antibiotic usually Inj. Taxim 1gm intravenously was administered 30 minutes before surgery to all patients.

All patients were operated under general anaesthesia.

INSTRUMENTS

1. 3.5 mm 7 to 9 hole Clavicle locking compression plate
2. 3.0 mm drill bit
3. 3.5mm universal drill guide
4. Hand drill/ pneumatic drill
5. Depth gauge
6. 4.0 mm locking screw of varying sizes (12-20 mm)
7. 3.5mm cortical screw of varying sizes (12-20 mm)
8. Hexagonal screw driver
9. General instruments like retractor, periosteal elevator,
10. Reduction clamps and bone lever.

FIGURE 6: INSTRUMENTS

SURGICAL TECHNIQUE

i. Patient in supine position with one towel in between the scapula. Entire upper limb from base of neck to hand were prepared and draped.

ii. About 7-9 cms, incision was made in the anterior aspect centering clavicle over the fracture site.

iii. The skin subcutaneous tissue and platysma were divided without undermining the edges.

iv. The overlying fascia and periosteum were divided next. The osseous ends were freed from surrounding tissue.

v. Minimal soft tissue and periosteum dissection was done.

vi. Fracture fragments were reduced and plate was applied over the superior aspect of the clavicle.

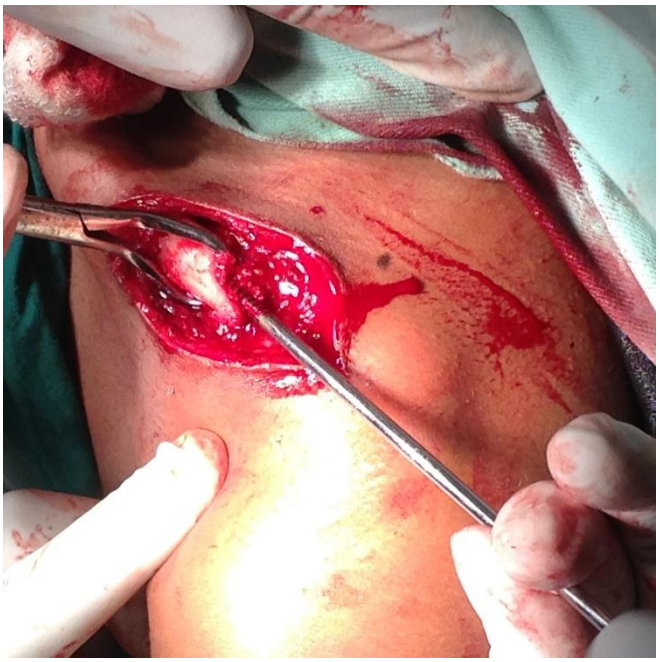
vii. At the junction of the medial and middle third of the clavicle, the inferior surface is exposed so that a protective instrument can be inserted during drilling to prevent injury to neurovascular structure underneath it.

viii. The locking compression plate was fixed to the medial and lateral fragment with locking screws/ cortical screws and minimum three screws in medial and lateral fragment were applied.

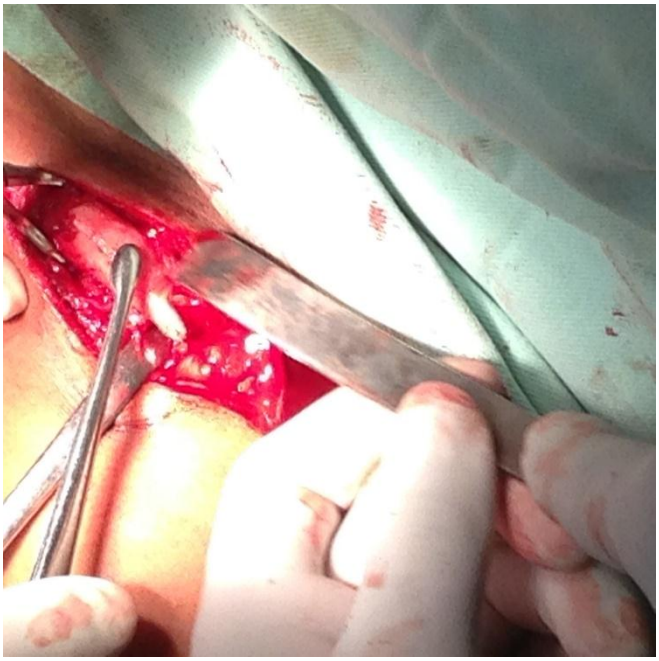
ix. Wound was closed in layers after ensuring meticulous hemostasis and sterile dressing was applied.

FIGURE 7 : OPERATIVE PHOTOGRAPHS

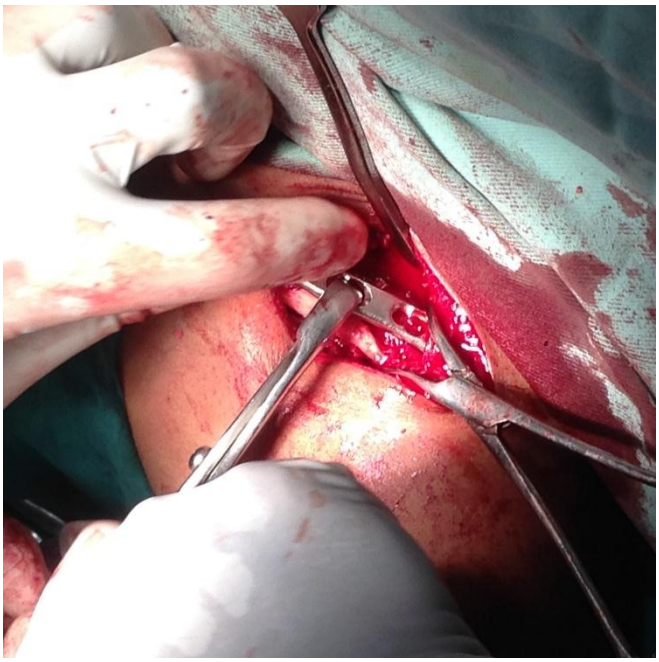
POSITION OF THE PATIENT



EXPOSURE OF FRACTURE FRAGMENTS AFTER INCISON OF SKIN, SUBCUATNEOUS TISSUE

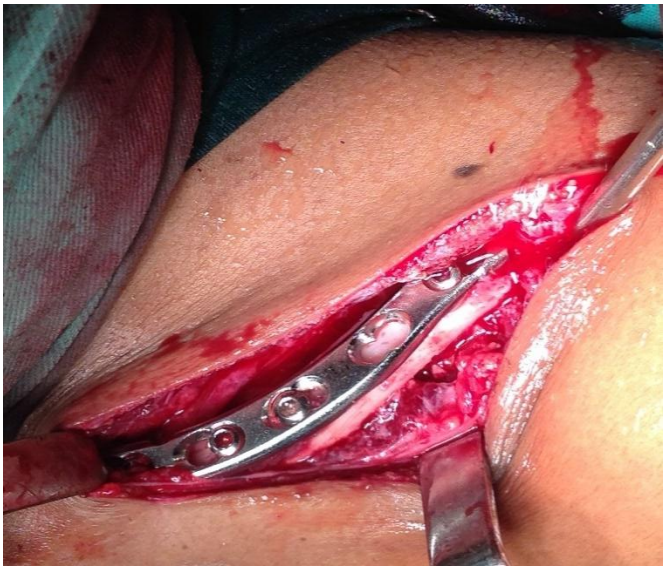


THE OSSEOUS ENDS ARE FREED FROM SURROUNDING TISSUE



REDUCTION OF FRACTURE FRAGMENTS AND PLATE POSITIONING

PLATE FIXATION WITH SCREWS



FINAL VIEW AFTER FIXATION

WOUND CLOSURE IN LAYERS

SKIN CLOSED WITH STAPLES.

POST OPERATIVE CARE:

Patients were kept nil orally for 4 to 6 hours post-operatively.

Intravenous fluids were given as needed.

Antibiotics were continued for 10 days.

Analgesics and tranquilizers were given according to the needs of the patient.

The operated upper limb was immobilized in an arm pouch

Check X- rays were taken to study the alignment of fracture fragments.

The wound was inspected on 2nd postoperative day. Suture/staple removal was done on 10th postoperative day. Patients were discharged with the arm pouch.

Rehabilitation of the affected arm was started at the end of 2 weeks.

Gentle pendulum exercises to the shoulder in the arm pouch were allowed. At 4 to 6 weeks gentle active range of motion of the shoulder was allowed but abduction in limited to 80 degrees. At 6 to 8 weeks active range of motion in all planes were allowed.

Follow up:

Regular follow up for every 4 weeks was done.

Local examination of the affected clavicle for tenderness, instability,deformity and shoulder movements were assessed.

X-rays were taken at each follow up visits to know about progressive fracture union and implant position.

Rehabilitation of the affected extremity was done according to the stage of fracture union and time duration from day of surgery.

Patients were followed up till radiological union.

The functional outcome was assessed by Constant and Murley score.[39]

CONSTANT AND MURLEY SCORING:

The patients are graded as follows

CATEGORY:

A) SUBJECTIVE:

1) Pain - 15 Points

No pain - 15

Bearable pain - 10

Disabling pain - 5

2) Activities of daily living: - 20 Points

Ability to perform full work - 04

Ability to perform Leisure activities/ Sports - 04

Unaffected sleep - 02

Level at which work can be done:

Up to Waist - 02

Up to Xyphoid - 04

Up to Neck - 06

Up to Head - 08

Above head - 10

B) OBJECTIVE:

RANGE OF MOVEMENTS: 40 POINTS:

a) Active flexion without pain

00 – 30 Degrees : 00

31-60 Degrees : 2

61-90 Degrees : 4

91-120 Degrees : 6

121-150 Degrees : 8

> 151 Degrees : 10

b)Functional external rotation:

Hand behind head with elbow forwards - 2

Hand behind head with elbow backwards - 4

Hand above head with elbow forwards - 6

Hand above head with elbow backwards - 8

Full elevation from on top of head - 10

c) Active abduction without pain:

With dorsum of hand on back, head of third metacarpal reaches

00 – 30 Degrees : 00

31-60 Degrees : 2

61-90 Degrees : 4

91-120 Degrees : 6

121-150 Degrees : 8

> 151 Degrees : 10

d)Functional internal rotation:

Ipsilateral buttock : 2

S1 spinous process : 4

L3 spinous process : 6

T12 spinous process : 8

T7 spinous process : 10 e)

Strength of abduction: 25 Points

A normal shoulder in a 25 year old man resists 25 pounds without difficulty. The score given for normal power is 25 points, with proportionately less for less power.

Patients were graded as below with a maximum of 100 points.

Total score Result

90-100 Excellent

80-89 Good

70-79 Fair

0-70 Poor

RESULTS AND OBSERVATIONS

The present study consists of 30 patients of fresh middle third fracture of the clavicle which were treated surgically with locking plate & screws between October 2014 to May 2016. Among them 13 patients were treated at R.L,Jalappa hospital and research institute. All the patients were available for follow-up and they were followed up every 6 weeks. Results were analyzed both clinically and radiologically.

RESULTS

Table 1: - Distribution of cases according to Age group

Age Group (in Years)	No of cases	Percent
19-29	14	46.66
30-39	8	26.66
40-49	6	20
50& Above	2	6.68
Total	30	100.0

The age distribution of the cases reveals that 14 cases(46.66%) lie between 19-29 years, 8 cases(26.66%) lie between 30-39 years, 6 cases(20%) lie between 40-49 years and 2 cases(6.68%) are 50 years and above.

Graph 1: - Graph showing Distribution of cases according to Age group

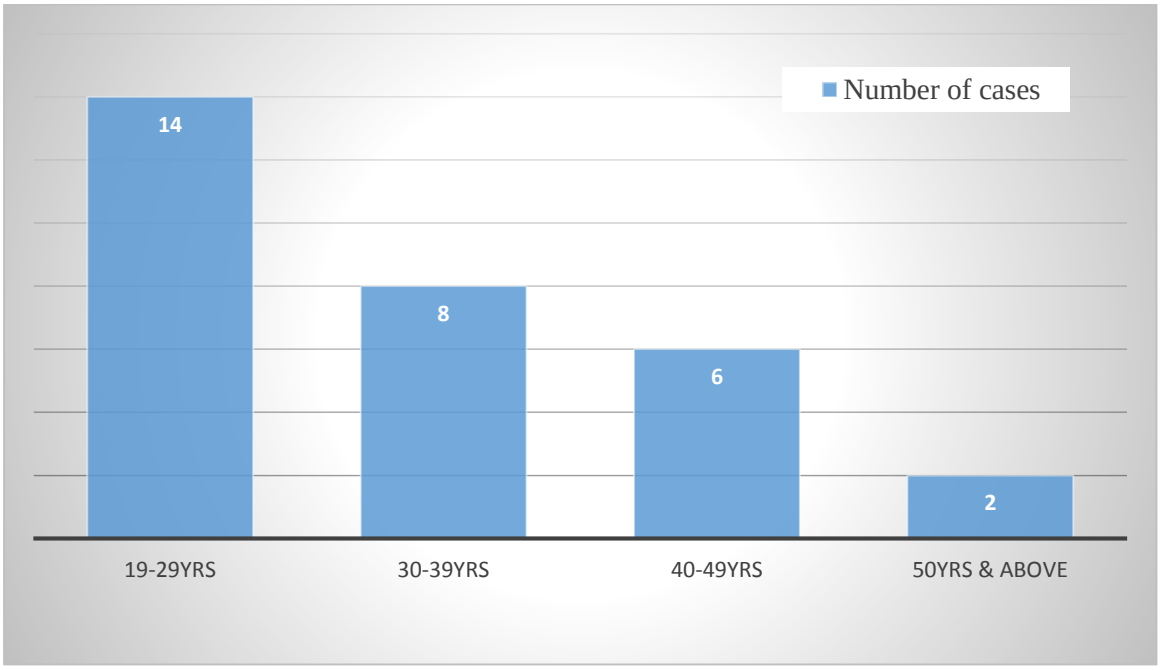


Table 2: - Distribution of cases according to sex

Sex	Number of cases	Percent
Female	8	26.7
Male	22	73.3
Total	30	100.0

Majority of the injury occurred in male patients- 22(73.3%) whereas a total of 8 cases(26.7%)was seen in females.

Graph 2: - Graph showing Distribution of cases according to sex

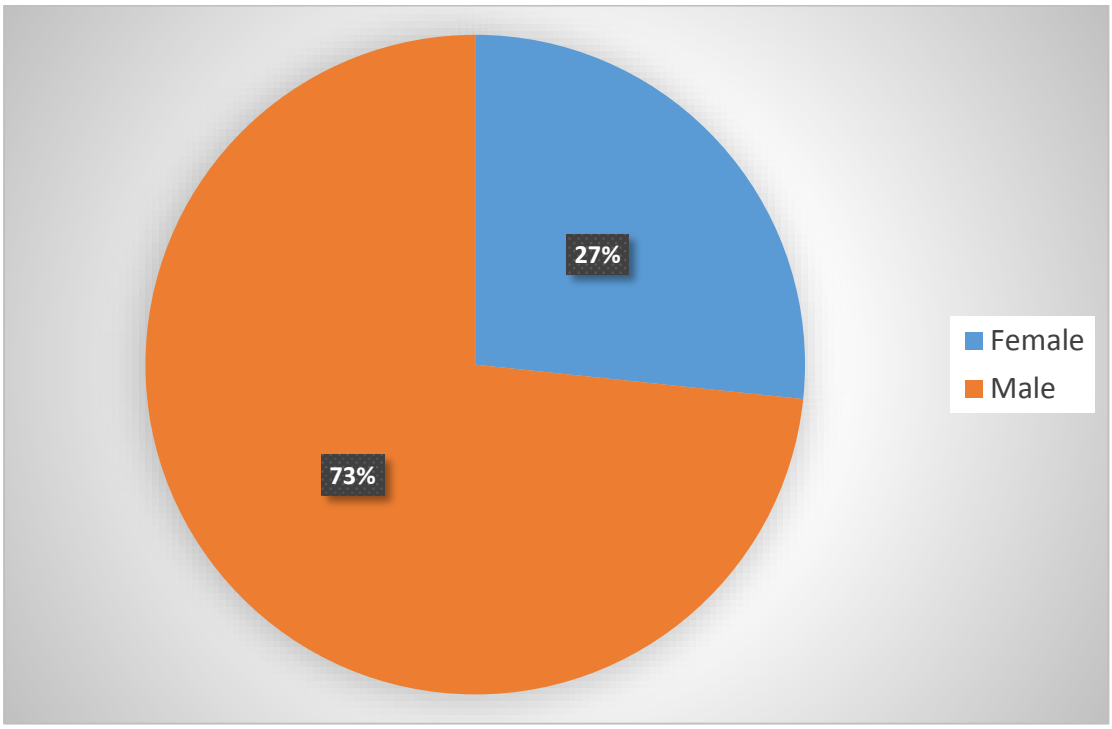


Table 3: - Distribution of cases according Time interval between trauma & surgery

Time interval between trauma & surgery	Number of cases	Percent
<3 Days	22	73.4
3 - 7 Days	6	20
7 - 14 Days	2	6.6
Total	30	100.0

In 22 cases (73.4%), the time interval between trauma and surgery was less than 3 days, in 6 cases (20%) it was between 3-7 days whereas in 2 cases(6.6%), surgery was conducted between 7 to 14 days.

Graph 3: - Graph showing Distribution of cases according Time interval between trauma & surgery

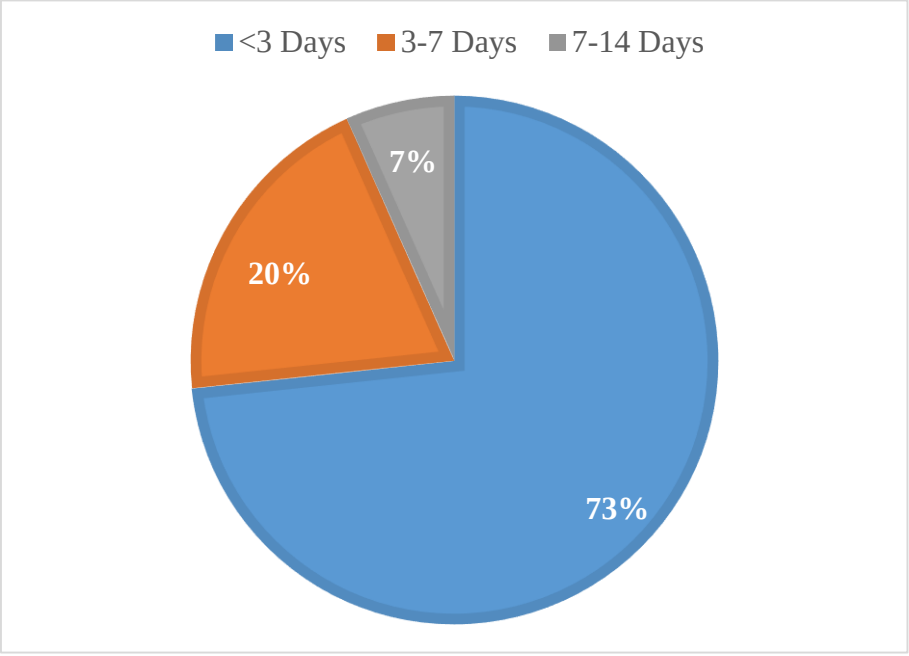


Table 4: - Distribution of cases according Mode of injury

Mode of injury	Number of cases	Percent
FALL	3	10.0
FB	8	26.7
FOH	5	16.7
RTA	14	46.7
Total	30	100.0

Majority of the cases 14(46.7%) occurred as a result of road traffic accidents, 8 cases(26.7%) as a result of fall from bike, 5 cases(16.7%) as a result of fall on an outstretched hand and 3 cases(10.0%) due to fall.

Graph 4: - Graph showing Distribution of cases according Mode of injury

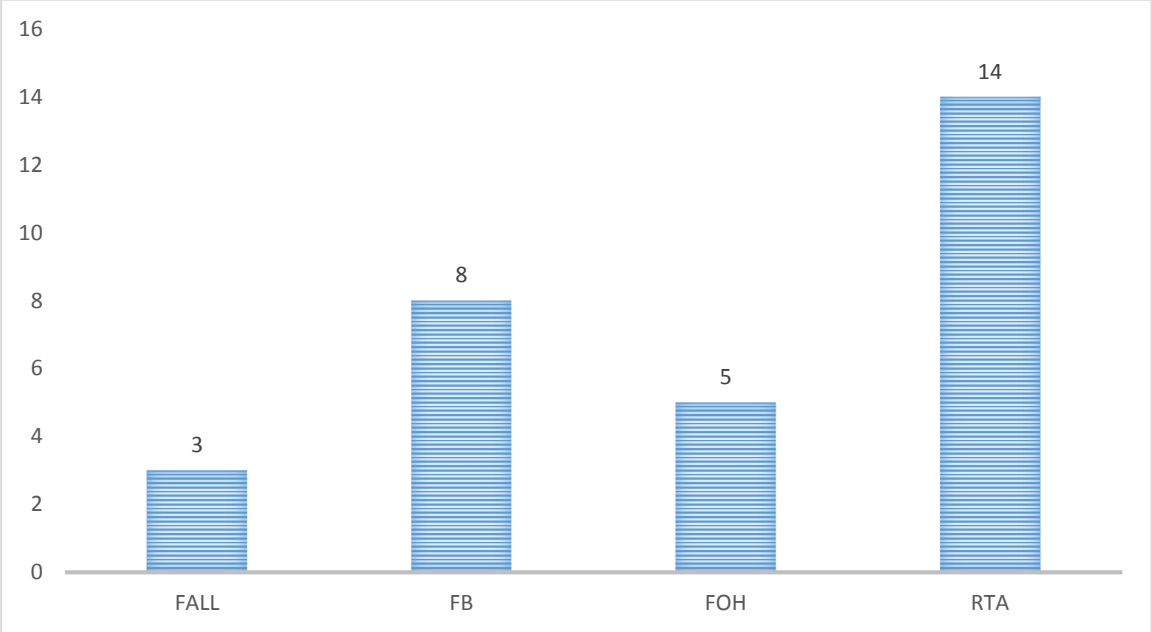


Table 5: - Distribution of cases according Side affected

Side affected	Number of cases	Percent
LEFT	11	36.7
RIGHT	19	63.3
Total	30	100.0

In this study, there were a total of 19 cases(63.3%)of right sided fracture, and left side was affected in 11 cases(36.7%).

Graph 5: - Graph showing Distribution of cases according Side affected

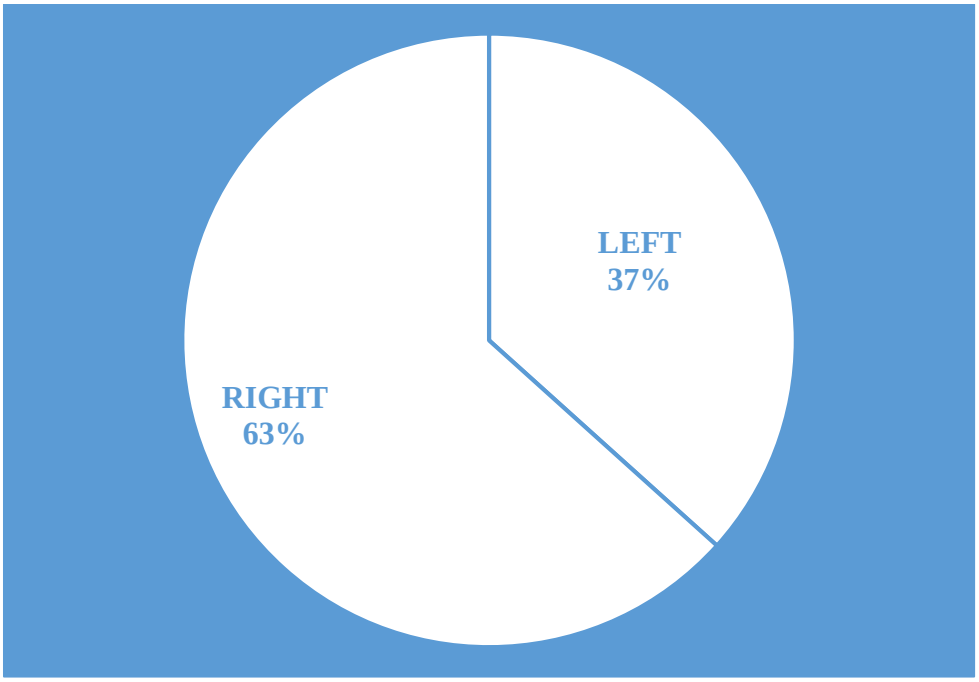


Table 6: - Distribution of cases according Robinson classification

Robinson classification (type)	Number of cases	Percent
2A1	1	3.3
2A2	4	13.3
2B	10	33.3
2B1	5	16.7
2B2	10	33.3
Total	30	100.0

According to Robinson classification, there were 10 cases(33.3%) each under 2B and 2B2, 5 cases(16.7%) classified under 2B1, 4 cases(13.3%) under 2A2 and 1 case(3.3%) under 2A1.

Graph 6: - Graph showing Distribution of cases according Robinson classification

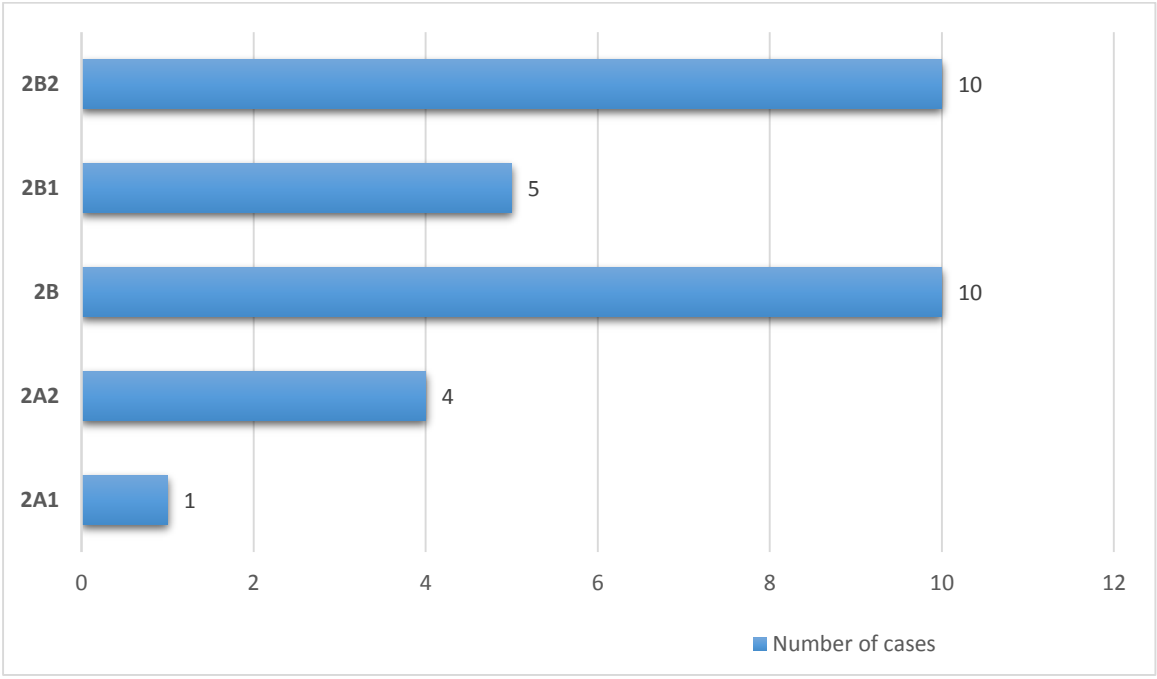


Table 7: - Distribution of cases according Associated Injury

Associated Injury	No of cases	Percent
NIL	29	96.7
PROXIMALTIBIA #	1	3.3
Total	30	100.0

Most of the cases, that is 29(96.7%) did not have any associated injury. Only 1 case (3.3%) had proximal tibia fracture as an associated injury.

Table 8: - Distribution of cases according Duration of stay in hospital

Duration of stay in hospital	No of cases	Percent
6	2	6.7
7	12	40.0
8	11	36.7
10	1	3.3
11	1	3.3
12	1	3.3
13	1	3.3
25	1	3.3
Total	30	100.0

12 cases(40%) had to stay in hospital for 7 days, 8 cases(36.7%) for 11 days, 2 cases(6.7%) for 6 days and 1 case(3.3%) each had to stay for 10, 11, 12, 13 and 25 days respectively.

Table 9: - Distribution of cases according Time of union

Time of union	No of cases	Percent
8-12 weeks	27	90
>12 weeks	3	10
Total	30	100.0

In 27 cases(90%), fracture united by the end of 12 weeks, but in 3 cases(10%) the union took longer than 12 weeks.

Graph 7: - Graph showing Distribution of cases according Time of union

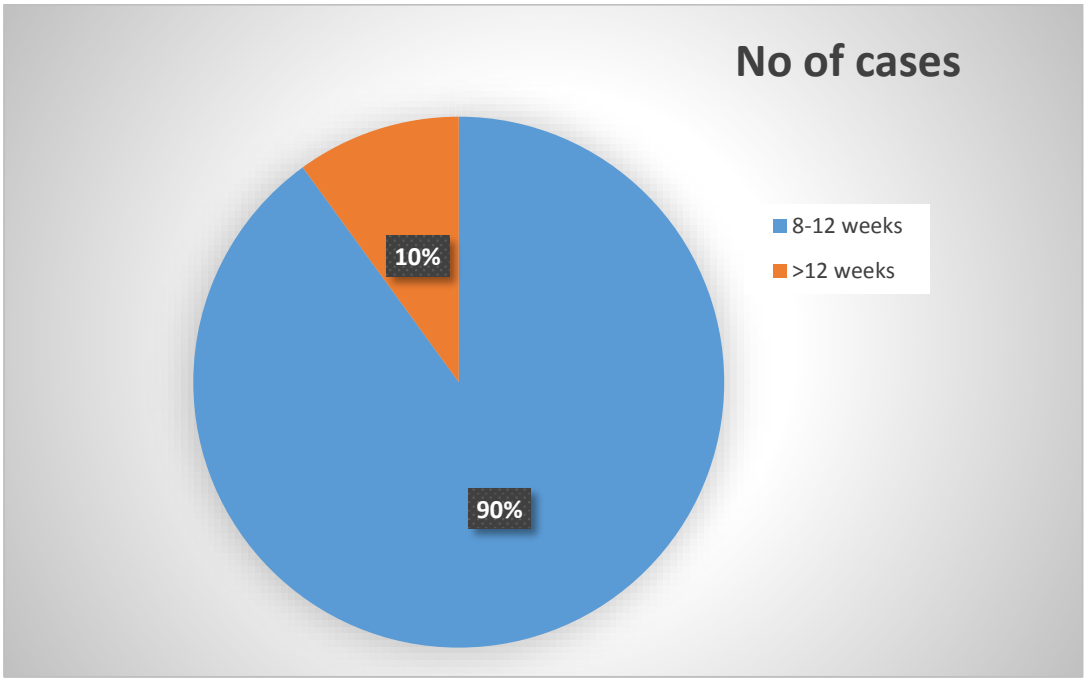


Table 10: - Distribution of cases according complication

COMPLICATION	NO OF CASES	PERCENT
Infection	0	0
Plate loosening	0	0
Plate prominence	1	3.3
Plate breakage	1	3.3
Delayed union	3	10
Malunion	0	0
Hypertrophic skin scar	3	10
Restriction of shoulder motion	2	6.7

In 3 cases(10%) each, the complication that followed was delayed union and formation of hypertrophic skin scar. 2 cases(6.7%) there was restriction of shoulder motion. 1 case(3.3%) each showed plate prominence and plate breakage. There were no complications of infection, plate loosening and malunion.

Graph 8: - Graph showing Distribution of cases according complication

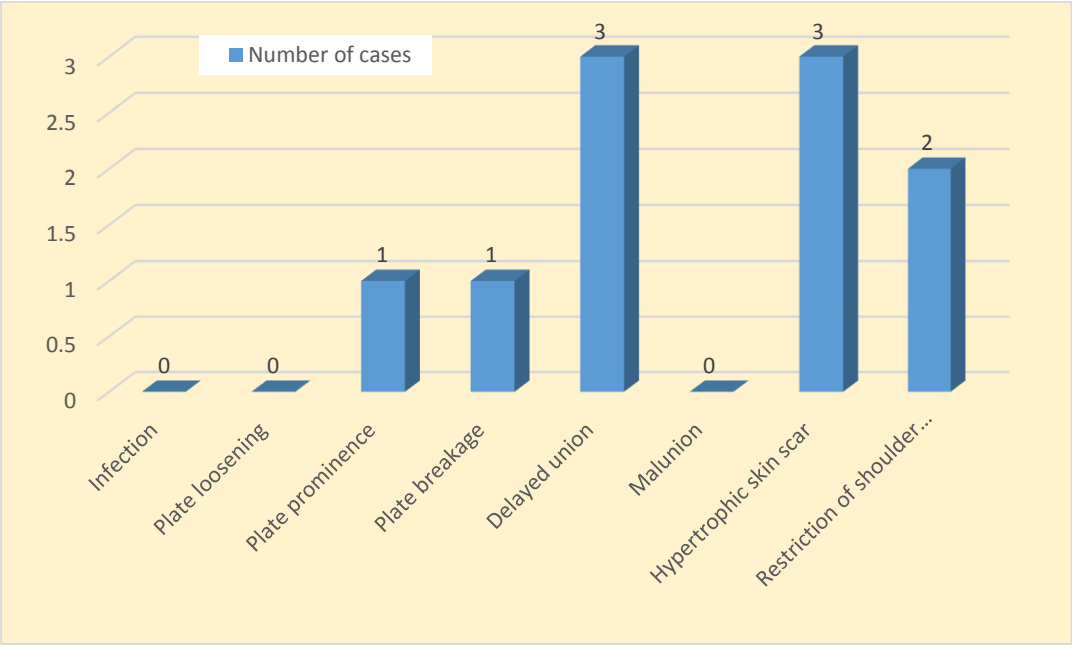
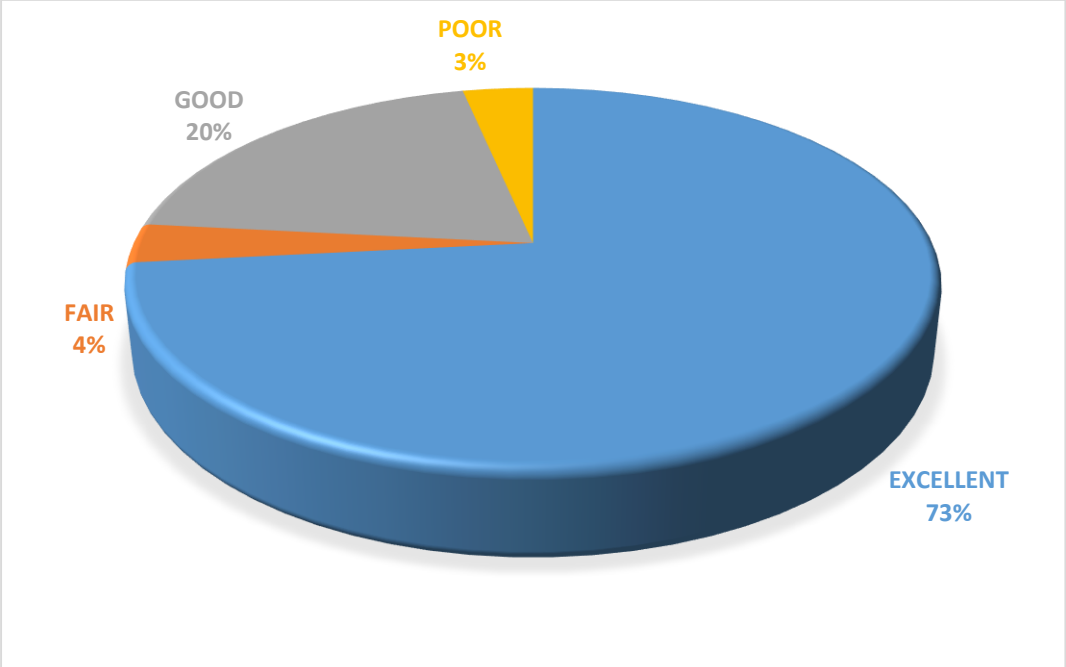


Table 11: - Distribution of cases according final outcome

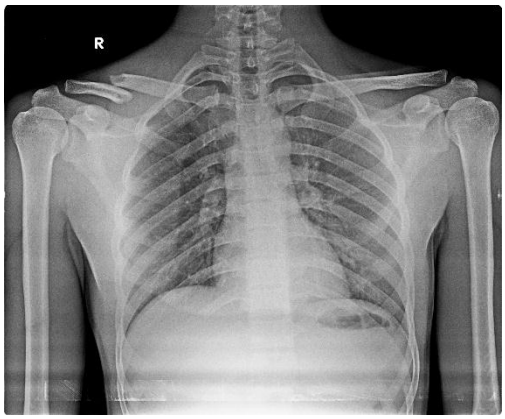
Final Outcome	Number of cases	Percent
EXCELLENT	22	73.3
GOOD	6	20
FAIR	1	3.3
POOR	1	3.3
Total	30	100.0

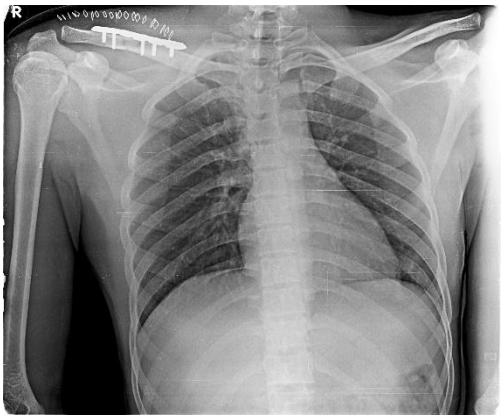
Out of 30 cases, a total of 22(73.3%) showed excellent final outcome, 6 cases (20%) had good outcome and 1 case(3.3%) each had a fair and poor outcome respectively.

Graph 9: - Graph showing Distribution of cases according complication

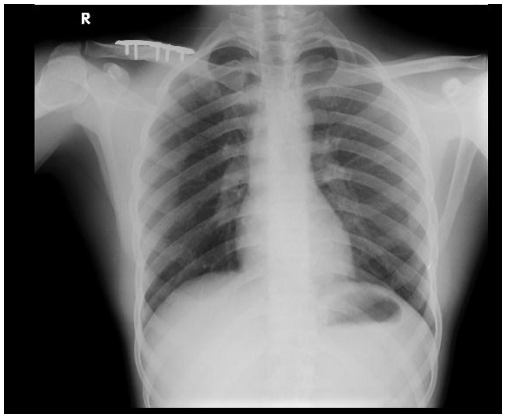


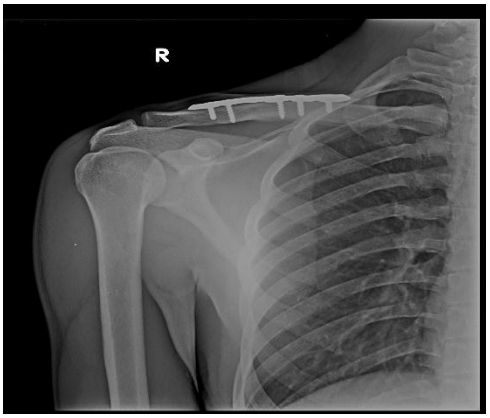
CASE 1





PRE OPERATIVE RADIOGRAPH POST OPERATVE RADIOGRAPH

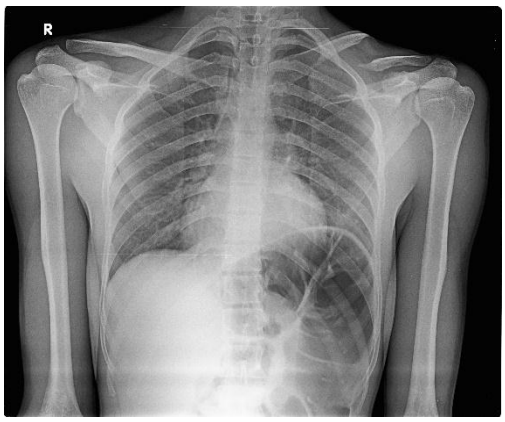




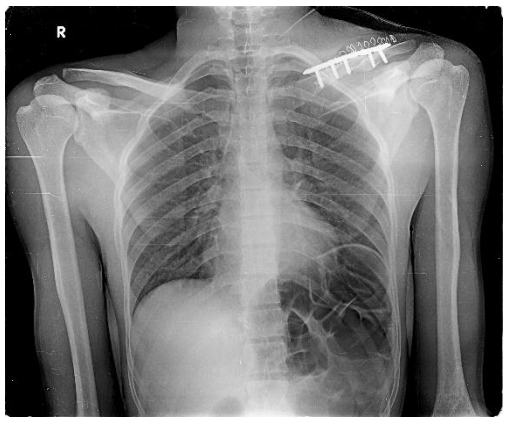
UNION AFTER 6 WEEKS GOOD UNION AFTER 10 WEEKS

CLINICAL PHOTOGRAPHS SHOWING SHOULDER ADDUCTION, ABDUCTION, FLEXION, EXTENSION, INTERNAL AND EXTERNAL ROTATION.

CASE 2



PRE OPERATIVE RADIOGRAPH



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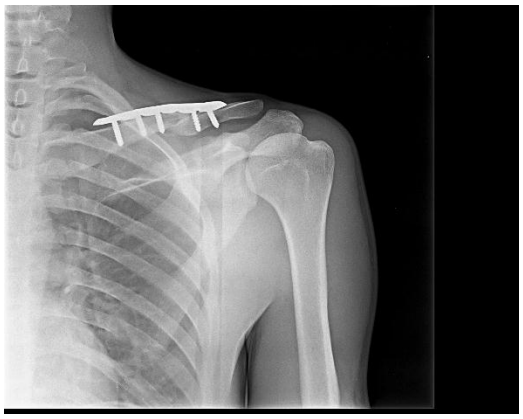
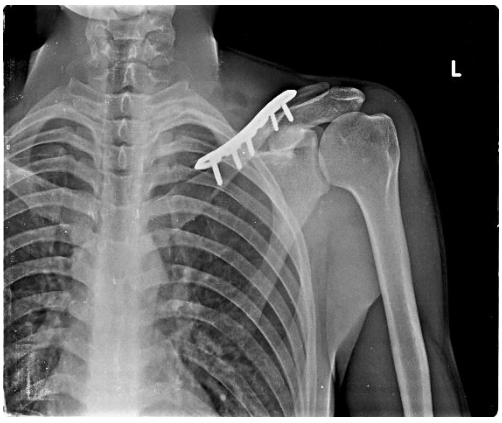


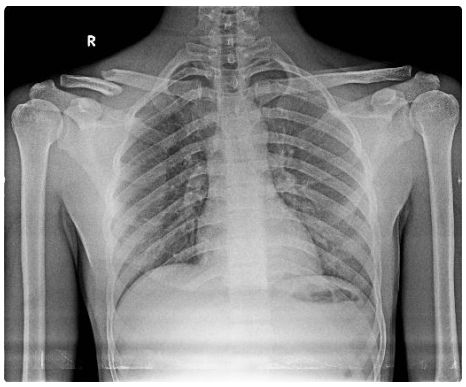
UNION AFTER 6 WEEKS



GOOD UNION AFTER 12 WEEKS

CLINICAL PHOTOGRAPHS SHOWING SHOULDER FLEXION, EXTENSION, ABDUCTION, INTERNAL AND EXTERNAL ROTATION,ABDUCTION.

CASE 3



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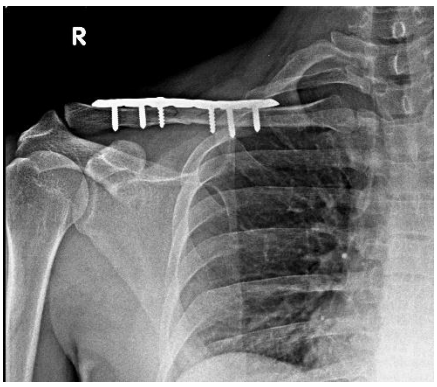

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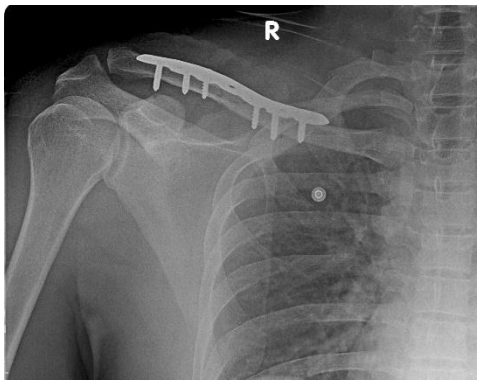
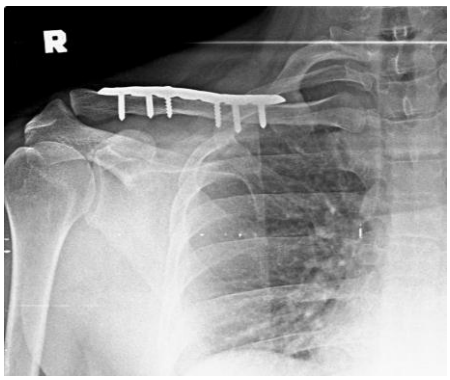


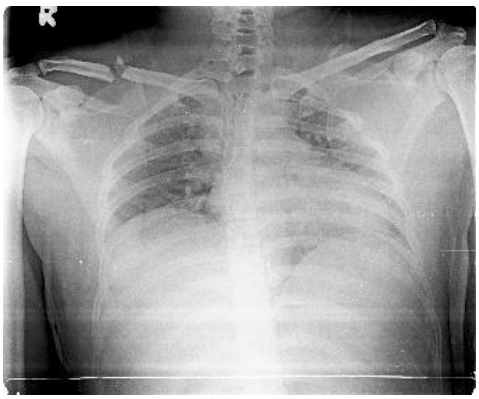
FOLLOW UP AFTER 6 WEEKS



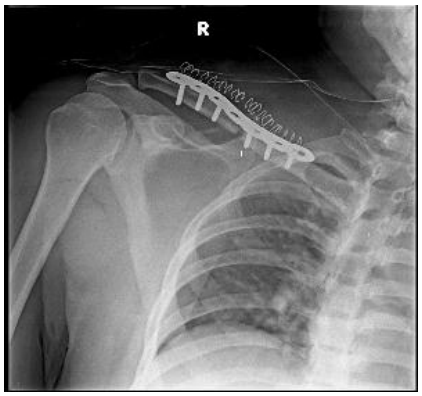
FOLLOW UP AFTER 12 WEEKS

CLINICAL PHOTOGRAPHS SHOWING SHOULDER ADDUCTION, INTERNAL AND EXTERNAL ROTATION, ABDUCTION, FLEXION AND EXTENSION.

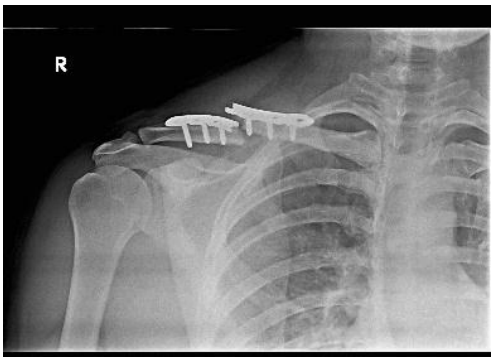
COMPLICATIONS: IMPLANT BREAKAGE



Pre Operative



Post Operative



Implant Failure

Replating radiograph

HYPERTROPHIC SKIN SCAR

PLATE PROMINENCE

DISCUSSION

Clavicle fractures are usually treated conservatively. In a study conducted to analyze the results of conservative treatment by Hill et al[41] in 1997, Nordqvist et al[42] in 1998 ,Robinson et al[43] in 2004,Suhail Ahmad Bhat et al[20] in 2014, found poor results following conservative treatment of displaced middle third clavicle fracture. There are specific indications like displacement, with or without comminuted middle third clavicle fracture (Robinson Type-2B1, 2B2).

The present study of patients with middle third clavicle fractures is compared with Bostman et al[35] study which treated only middle third clavicle fractures, in this totally 103 patients were treated by early open reduction and internal fixation with plate and screws. It was also compared with Cho et al study where 41 patients with a clavicle midshaft fracture were treated by internal fixation with a reconstruction plate (19 patients) or reconstruction LCP (22 patients) and also compared with Wajid et al [30] where nine patients with middle third fractures of clavicle have undergone open reduction and internal fixation.

Mechanism of injury:

In this study the patients with middle third clavicle fracture the mechanism of injury was due to fall on the shoulder from bike in 8 patients (26.7 %), Road traffic accident in14 patients (46.7 %), simple fall on the shoulder in 3 patients (10%), Fall on hand in 5 patients (16.7 %).

In Bostman et al[35] study the mechanism of injury was due to fall from the two wheeler in 38 patients (36.8%), slipping and fall in 24 Patients (23.30%), motor vehicle accident in 19 patients (18.45%) and sports in injury 22 patients (21.36%). In Cho et al[15] study,

in reconstruction plate group there were 13 patients who sustained Road Traffic Accident, 3 patients with slip down, 1 patient with sports injury, 1 patient with fall down and 169 patient with miscellaneous mode of injury. In locking compression plate group there 7 patients with Road Traffic Accident, 3 patients with slip down, 1 Patient with fall down and 1 Patient with miscellaneous mode.

This shows indirect injury to the shoulder is the common cause of this fracture.

Age Incidence:

Middle third clavicle fracture commonly occurred between the age group of 19 to 29 years in 8 patients (40%). The youngest patient age was 19 years and oldest patient age was 55 years. The average patients' age was 32 years.

In Bostman et al[35] study patients average age was 33.4 years and the youngest patient age was 19 years and oldest patient age was 62 years.

In Cho et al[15] study, in reconstruction plate group the mean age was 45 (range 22- 70) and that of the locking compression plate was 46 (range 19- 69).

From this we can infer that clavicle midshaft fractures occur in young and active patients.

Sex Incidence:

In this study there were 22 males and 8 females.

In Bostman et al[35] series also commonly males are affected 76 patients (73.79%) compared to females 27 patients (26.21%).

In Cho et al[15] study, the reconstruction plate group that 12 male and 7 female patients and in the locking compression plate group it was 17 male and 5 patients.

Male predominance can be drawn from this inference.

Associated injuries:

In this study only 1 patient had associated injury in the form of scapular fracture and was managed conservatively. This associated injury was caused by Road Traffic Accident.

In Bostman et al[35] series there was no associated injuries.

In Cho et al[15] study, an associated injury was found in 16 Cases: hemothorax and rib fracture in 5 cases, scapular fracture in 3 cases (floating shoulder was observed in 2 of them) and rotator cuff tear in 1 case.

In Alex et al[24] study, 32 consecutive cases with floating shoulder injuries were identified in skeletally matured patients.

Type of fracture:

In this study all patients with midshaft clavicle fractures were of closed type.

This is comparable to Bostman et al[36] and Cho et al[15] study which also showed all their patients had closed fractures.

Fracture classification:

In this present study, Robinson Type-2 B (Displaced) and Type-2 B2 (comminuted or segmental) were more common as they constituted 20 patients (66.6%) in the study. Type-2 B1 (simple or single butterfly fragment) occurred in only 5 Patients (16.7%). Type-2 A2 occurred in 4 patients (13.3%) and there was only 1 patient (3.3%) with Type-2 A1.

In Bostman et al[36] study also Robinson type-2B1 was common in 81 patients (78.64%). Robinson type-2 B2 occurred only in 22 patients (21.36%).

In Cho et al[15] study, in reconstruction plate group there were 7 Patients with B1 type and 12 Patients with B2 type and that of the locking compression group had 9 B1 type and 13 B2 type.

Time interval for surgery:

Most of the patient in our study were operated in the first week i.e. 28 patients (93.4%). 2 patients (6.6%) were operated in the second week due to issues regarding fitness for operative intervention.

In Bostman et al[36] study all the patients were operated within 3 days of injury.

In Cho et al[15] study, the reconstruction plate group was operated by 4 days and that of locking compression plate was 9 days.

Plate length:

In this study 7 hole plates were used in 22 Patients

(73.3%), 4 Patients (26.7%) each with 8 and 9 hole plates, depending upon type of fracture.

In Bostman et al[36] study plate length was above 6 holes to place atleast three screws in each fragment.

Plate length also depends upon the amount of comminution.

Duration of union:

In this study majority of the middle third clavicle fracture cases united between 8 to 12 weeks i.e.27 Patients (90%). In 2 Patients (6.6%) delayed union occurred as there was a displaced butterfly fragment which united with the main fragment at the end of 16 weeks. In 1 patient (3.3%) union occurred after 18 weeks as there was implant failure (breakage) after 1 month for which replating was done.

Lazarus MD[32] stated radiological union occurred approximately between 6 to 12 weeks.

In Cho et al[15] study, bony union for reconstruction plate was 14.6 weeks and that of locking compression plate was 13.2 weeks.

Complications:

A. Major Complications:

In 1 patient implant failure (breakage) occurred 4 weeks after surgery as this patient had ipsilateral proximal tibia fracture for which ORIF with LCP was done and patient started to weight bare on the operated clavicle site after 15 days of surgery.

Both Bostman et al[36] and Cho et al[15] didn't have any major complications either.

B. Minor complication:

Plate loosening:

In this study plate loosening was not seen in any patients.

In Bostman et al[36] study 7 patients (6.80 %) had implant loosening. In all the patients loosening occurred at 6 postoperative weeks. Malunion of varying degree followed in all of these patients and no reoperations were performed.

In Cho et al study[15], only the reconstruction group that plate loosening in 3 Patients (15.8 %)

Delayed union:

Delayed union occurred in 2 patients (6.6%) due to a large butterfly fragment in the inferior aspect of clavicle which went on to unite with the main fragments at the end of 16 weeks. In 1 patient (3.3%) union occurred after 18 weeks as there was implant failure (breakage) after 1 month for which replating was done.

In Bostman et al[36] study delayed union occurred in 3 patients (2.91 %).

Skin complications:

There were hypertrophic skin scar in 3 patients (10%). Plate prominence through the skin was reported in 1 Patient (3.3%).

The total complication in this study were 16.6% excluding skin related minor complications.

The total complication rate of Bostman et al[36] study was 23%.

Functional outcome:

The functional outcome according to Constant and Murley[39] in this study of total 30 Patients of fresh middle third clavicle fracture fixed with locking compression plate and screws showed excellent results in 22 patients (73.3 %) and good functional outcome in 6 patients (20 %). Fair functional outcome in 1 Patient (3.3%) occurred due to improper postoperative follow up by the patient which resulted in shoulder stiffness.

The advantage of rigid internal fixation and early mobilization of fresh displaced clavicle fracture is that it (displaced comminuted middle third) gives immediate pain relief and prevents the development of shoulder stiffness and non-union.

CONCLUSION

The operative methods for the treatment of clavicle midshaft fractures involve intramedullary K-wire fixation or Steinmann pin fixation and plate fixation.

The procedures using the former two materials result in low resistance to torque, carry risks of pin loosening and infection, and require a long-term fixation period.

Open reduction and internal fixation with plates, such as Sherman plates, dynamic compression plates, and semitubular plates, can be effective in obtaining anatomical reduction, applying direct compression to the fracture site, and producing resistance to torque.

However, it is disadvantageous in achieving firm fixation because it is difficult to hold the plates to the clavicle in severely comminuted fracture cases.

In contrast, reconstruction plates can be manipulated to fit the contour of the clavicle and fracture pattern to obtain firm fixation, are lighter and thinner than dynamic compression plates and are durable to multidirectional mechanical stress imposed on the fracture site.

On the other hand, penetration of the opposite cortical bone for screw fixation may cause damage to the subclavian artery and firm fixation can be difficult to maintain in osteoporotic patients over 50 years of age. In this study, the use of locking compression plates did not result in complications, such as subclavian artery injuries and brachial plexus injuries despite piercing either cortex in a few badly comminuted cases.

Although nonunion, pain, or functional disabilities were not observed in these cases, it is believed that reconstruction LCPs could be used as an alternative to reconstruction plates to reduce the number of complications.

The advantages of reconstruction LCPs include strong fixation due to locking between the screw and plate, and blood supply preservation due to minimal contact between plate and cortical bone.

With conventional screws and plates, fracture site stability is provided by friction between the plate and bone cortex.

Accordingly, screws need to be fixed onto both cortexes. In contrast, when an LCP is used, an external force is transmitted from the cortical bone through the conically threaded plate hole to the plate because the screw head is locked firmly in the threaded plate hole.

Therefore, the plate does not need to be compressed onto the cortical bone for stability, which results in good preservation of the blood supply, and the plate thread is also helpful in preventing screw loosening or instability.

When LCPs are used to treat clavicle midshaft fractures, the risks of injury to the subclavicular artery or brachial plexus can be reduced because fixation can be achieved without the tip of the screw reaching the opposite bone cortex and periosteal stripping can be minimized to promote rapid union.

It is believed that the surgery time can be reduced using LCPs because accurate plate contouring is not necessary and periosteal stripping could be minimized using self-tapping screws.

Nevertheless, a reconstruction LCP can be an effective replacement for a reconstruction plate considering that complications, such as screw loosening and plate failure, were not observed in the reconstruction LCP group.

Contour of the plates was performed with locking sleeves inserted into screw holes considering the problem of LCPs that screw fixation can be weakened if breakage of the screw holes occurs in the plate thread during plate contouring.

Unfortunately, surgical treatments for clavicle fractures leave distinct scars on the shoulder. Surgical scars are currently considered major complications due to the increasing demand for aesthetics.

3 of our patients had hypertrophic scarring after surgery. However, none of them had associated pain or requested cosmetic surgery. However, the patients should be informed of the possible appearance of surgical scars preoperatively and surgical techniques should be improved to address the problem.

This study had some limitations. The conclusions drawn from this analysis cannot be generalized because of the small number of cases.

In conclusion, bony union could be achieved with LCP clavicle and the clinical outcomes were satisfactory. Overall, operative procedures using LCP, which can be shaped to match the contour of the clavicle, can be effective in the treatment of clavicle midshaft fractures. All the fractures united and there was no nonunion.

No implant removal was done till the end of this study. We were able to achieve excellent results in 22 patients.

SUMMARY

Thirty patients with middle third clavicular fractures were treated surgically with locking compression plate and screws between October 2014 to May 2016.

Patients above 18 years were included in this study and the patients age ranged from 19 to 60 years. Middle third clavicle fracture is common between 19 to 29 years.

RTA was the cause for this fracture in most of the patients and among our patients were 22 were males and 8 were females. 63.3 % of the fractures were of the right side. 3 % of the patient i.e one patient had associated injury of ipsilateral proximal tibia fracture for which ORIF with LCP.

In 28 patients (93%) surgery was done within the 1st week. The indication for surgery in middle third clavicle were 10 cases(33.3%) each under 2B and 2B2, 5 cases(16.7%) classified under 2B1, 4 cases(13.3%) under 2A2 and 1 case(3.3%) under 2A1.

All our patients were operated under general anesthesia with locking compression plate and screws for middle third clavicular fractures.

Rehabilitation of the affected arm was started at the end of 2 weeks.

Gentle pendulum exercises to the shoulder in the arm pouch were allowed. At 4 to 6 weeks gentle active range of motion of the shoulder was allowed but abduction in limited to 80 degrees. At 6 to 8 weeks active range of motion in all planes were allowed.

The duration of union range from 8-12 weeks (average 11.13 weeks) in 27 patients, 3 patients went for delayed union and united >12 weeks.

The functional outcome assessment according to Constant and Murley score showed excellent functional outcome in 22 patients (73.3 %) and good functional outcome in 6 patients (20 %) and 1 fair functional outcome(3.3%) and in 1 patient with poor functional patient (3.3%).

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ANNEXURE-I

PROFORMA

Case No: Hospital No: IP No:

Name : Age: Sex:

Occupation : Address:

D.O.A: D.O.D:

Diagnosis:

1) HISTORY :

Compliants :

Mode of injury: i) fall on hand
ii)fall from bike
iii)fall on hand
iv)road traffic accident

2) PAST HISTORY:

3) GENERAL PHYSICAL EXAMINATION

Pulse: B.P:

Respiratory Rate: Temperature:

SPO_2 :

4) SYSTEMIC EXAMINATION

CVS:

RS:

CNS:

PER ABDOMEN:

5) LOCAL EXAMINATION

i) Inspection :

Attitude of swelling

Deformity of skin

ii)Palpation:

Local rise of temperature

Tenderness

Bony Irregularity

Crepitus

iii)Movement:

iv)Neuro vascular status:

v)Associated Injuries:

6) MANAGEMENT:

Investigations :

I) Blood : Hb%- Platelet-
TC - DC-

ESR-

II) Renal Function Test:
Blood Urea- Serum creatinine-

III) Random Blood Sugar:

IV) Electrolytes:
Sodium:
Potaasium:

V) ECG :

VI) Viral Markers
HIV-
HBsAG-

VII) X-RAY Clavicle with shoulder AP-View:

TREATMENT:

I) Surgical Procedure:

II) Indication:

III) Date Of Surgery:

IV) Anaesthesia :

V) Post Operative Medication

VI) Immobilisation After Surgery

a)Type

b)Duration

VII) Check X-ray:

VIII) Rehabilitation:

7)COMPLICATIONS:

8)FOLLOW UP:

	10^{th} day	1 month	3 months	6 months
PAIN				
DEFORMITY				
MOVEMENTS OF SHOULDER GIRDLE				
X-RAY FINDINGS				

9)ASSESSMENT OF RESULTS:

By Constant And Murley scoring grading is done as follows

Total score		Result
90-100	:	Excellent
80-89	:	Good
70-79	:	Fair
0-70	:	Poor

ANNEXURE-II

CONSENT FORM

FOR OPERATION/ANAESTHESIA

I Hosp No. in my full senses hereby give my complete consent for or any other procedure deemed fit which is a diagnostic procedure/biopsy/transfusion/operation to be performed on me/my son/my daughter/my ward age under any type of anaesthesia deemed fit.The nature and risks involved in this procedure have been explained to me to my satisfaction.For academic and scientific purpose operation or procedure may be televised or photographed.

Date:

Signature/Thumb Impression of

Patient/Guardian

Name :

Designation: Guardian

Relationship

Full address

ANNEXURE-III

MASTER CHART

Sl. No.	Hospital No.	Age	Sex	Mode of injury	Side affected	Robinson classification (type)	Associated Injury	Time interval between trauma & surgery	Duration of stay in hospital	Rehabilitation started (weeks)	Time of union	Infection	Plate loosening	Plate prominence	Plate breakage	Delayed union	Malunion	Restriction of shoulder motion	Hyertrophic skin scar	Result
1	131578	24	F	RTA	LT	2B	NIL	2	7	2	10	-	-	-	-	-	-	-	-	EXCELLENT
2	134652	28	M	FB	RT	2B	NIL	3	8	2	10	-	-	-	-	-	-	-	-	EXCELLENT
3	133047	33	M	FALL	RT	2B2	NIL	2	7	2	12	-	-	-	-	-	-	-	-	EXCELLENT
4	123453	56	M	FOH	RT	2A2	NIL	6	11	2	8	-	-	-	-	-	-	-	-	GOOD
5	116474	44	M	RTA	RT	2B1	NIL	2	7	2	10	-	-	-	-	-	-	-	-	GOOD
6	116871	35	F	RTA	RT	2B	NIL	2	7	2	10	-	-	-	-	-	-	-	-	EXCELLENT
7	59350	31	M	RTA	RT	2B2	NIL	3	8	2	12	-	-	-	-	-	-	-	-	EXCELLENT
8	65081	26	M	FB	LT	2B1	NIL	2	7	2	10	-	-	-	-	-	-	-	-	EXCELLENT
9	74332	23	M	FB	LT	2B	NIL	2	8	2	12	-	-	-	-	-	-	-	-	EXCELLENT
10	78724	37	M	RTA	LT	2B2	NIL	3	8	2	12	-	-	-	-	-	-	-	-	EXCELLENT
11	80369	49	F	FOH	LT	2A1	NIL	7	12	2	14	-	-	-	-	+	-	-	-	GOOD
12	91620	29	M	FB	RT	2B2	NIL	1	6	2	12	-	-	-	-	-	-	-	-	EXCELLENT
13	96560	27	F	FB	RT	2B2	NIL	4	10	2	12	-	-	-	-	-	-	-	-	EXCELLENT
14	100781	39	M	RTA	LT	2B	NIL	3	8	2	12	-	-	-	-	-	-	-	+	EXCELLENT

15	102805	26	M	RTA	LT	2B1	NIL	2	7	2	10	-	-	-	-	-	-	-	EXCELLENT
16	101309	41	F	FALL	RT	2B2	NIL	3	8	2	12	-	-	-	-	-	-	+	GOOD
17	102418	45	M	FOH	LT	2A2	NIL	3	8	2	12	-	-	-	-	-	+	-	FAIR
18	106661	19	M	RTA	RT	2B2	NIL	1	6	2	12	-	-	-	-	-	-	+	EXCELLENT
19	238827	21	M	RTA	RT	2B	NIL	2	7	2	8	-	-	-	-	-	-	-	EXCELLENT
20	172231	32	M	FB	RT	2B	NIL	2	7	2	10	-	-	-	-	-	-	-	EXCELLENT
21	166552	34	F	RTA	LT	2B2	NIL	2	7	2	12	-	-	-	-	-	-	-	EXCELLENT
22	140991	26	F	RTA	LT	2B1	NIL	3	8	2	10	-	-	-	-	-	-	-	EXCELLENT
23	131491	25	M	RTA	LT	2B2	NIL	3	8	2	12	-	-	-	-	-	-	-	EXCELLENT
24	168474	65	M	FOH	RT	2A2	NIL	8	13	2	14	-	-	+	-	+	-	-	GOOD
25	205645	25	M	FB	RT	2B	PROXIMALTIBIA FRACTURE	1	25	2	16	-	-	-	+	+	-	+	POOR
26	203627	28	M	RTA	RT	2B	NIL	3	8	2	8	-	-	-	-	-	-	-	EXCELLENT
27	100011	45	M	FOH	RT	2A2	NIL	2	7	2	8	-	-	-	-	-	-	-	EXCELLENT
28	199150	36	F	FALL	RT	2B2	NIL	3	8	2	12	-	-	-	-	-	-	-	EXCELLENT
29	70521	27	M	FB	RT	2B1	NIL	2	7	2	10	-	-	-	-	-	-	-	EXCELLENT
30	204536	48	M	RTA	RT	2B	NIL	2	7	2	10	-	-	-	-	-	-	-	GOOD