COMPARATIVE ANALYSIS OF OUTCOME OF DISPLACED MIDDLE THIRD CLAVICLE FRACTURES IN PATIENTS TREATED WITH PLATE OSTEOSYNTHESIS AND INTRAMEDULLARY NAILING

Dissertation submitted to

THE TAMILNADU DR M.G.R MEDICAL UNIVERSITY
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In partial fulfilment of the regulations for the
Award of the degree of

M.S. (ORTHOPAEDIC SURGERY)-BRANCH –II

COIMBATORE MEDICAL COLLEGE

COIMBATORE

APRIL 2014

CERTIFICATE

This is to certify that **Dr.G.KHALIQ BASHA**, post graduate student (2011 - 2014) in the Department of Orthopaedics, Coimbatore medical College hospital has done this dissertation on **"COMPARATIVE ANALYSIS OF OUTCOME OF DISPLACED MIDDLE THIRD CLAVICLE FRACTURES IN PATIENTS TREATED WITH PLATE OSTEOSYNTHESIS AND INTRAMEDULLARY NAILING"** under my guidance and supervision in partial fulfilment of the regulation laid down by the**'THE TAMIL NADU DR. M.G.R MEDICAL UNIVERSITY, CHENNAI-32'** for MS(Orthopaedic Surgery) degree examination to be held on **April 2014**.

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COMPARATIVE ANALYSIS OF OUTCOME OF DISPLACED MIDDLE THIRD CLAVICLE FRACTURES IN PATIENTS TREATED WITH PLATE OSTEOSYNTHESIS AND INTRAMEDULLARY NAILING Dissertation submitted to THE TAMILNADU DR M.G.R MEDICAL UNIVERSITY CHENNAI-600 032 In partial fulfilment of the regulations for the Award of the degree of M.S. (ORTHOPAEDIC SURGERY)-BRANCH –II COIMBATORE MEDICAL COLLEGE COIMBATORE APRIL 2014 1 INTRODUCTION The clavicle is the most commonly fractured bone, which accounts for 5–10% of all fractures and 44% of all shoulder injuries.1-3 Biomechanical studies reveal that, due to the unique configuration and unique shape of the clavicle, the middle third is the weakest and accounts for 80% of...


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IN PATIENTS TREATED WITH PLATE
OSTEOSYNTHESIS AND INTRAMEDULLARY
NAILING

DECLARATION

I, **Dr.G. KHALIQ BASHA** solemnly, declare that Dissertation titled "**COMPARATIVE ANALYSIS OF OUTCOME OF DISPLACED MIDDLE THIRD CLAVICLE FRACTURES IN PATIENTS TREATED WITH PLATE OSTEOSYNTHESIS AND INTRAMEDULLARY NAILING"** is a bonafide work done by me at Coimbatore Medical College hospital between 2011 to 2014, under the guidance and supervision of my unit Chief, **Prof.Dr.S.ELANGOVAN M.S.Ortho, D.Ortho.**

This dissertation is submitted to "**THE TAMILNADU DR. M.G.R MEDICAL UNIVERSITY"**, towards partial fulfilment of regulations for the award of M.S.DEGREE BRANCH II in Orthopaedic Surgery.

Place: Coimbatore **(Dr.G.KHALIQ BASHA)**

Date: M.S Ortho Post Graduate

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CONTENTS

COMPARATIVE ANALYSIS OF OUTCOME OF DISPLACED MIDDLE THIRD CLAVICLE FRACTURES IN PATIENTS TREATED WITH PLATE OSTEOSYNTHESIS AND INTRAMEDULLARY NAILING

ABSTRACT:

INTRODUCTION:

The clavicle is the most commonly fractured bone, which accounts for 5–10% of all fractures.More than half of these fractures are displaced. Traditionally clavicle fractures are treated non operatively. But recent studies show higher rates of non union upto 15% and unsatisfactory functional outcomes despite fracture union with conservative management. Operative management of these fractures had better outcomes and a lower rate of non union and symptomatic mal union when compared with non operative treatment.

Commonly either plating or nailing is done for middle third clavicle fractures. It is imperative to know the complications and outcomes with both these procedures.

AIM:

The aim of our study is comparative analysis of outcome of displaced middle third clavicle fractures in patients treated with plate osteosynthesis and intramedullary nailing.

MATERIALS AND METHODS:

This is a prospective study undertaken in the department of orthopaedics, Coimbatore medical college hospital, Coimbatore from May 2011 to October 2013.Within the period of study,20 patients with displaced middle third clavicle fractures were operated alternatively with plating nailing(titanium elastic nail).We had 11 patients who were operated with plating (6-RECONSTRUCTION plate and 5-PRECONTOURED CLAVICLE PLATE) and 9 patients who were operated with nailing(titanium elastic nail).Outcome measures like Blood loss, operative time, wound size, union rate and union time and complications like infection, Non union, implant irritation and shortening were compared between the two groups. Functional outcome was based on Quick DASH score.

RESULTS:

The mean blood loss in plating group was 97.27 ml and nailing group was 62.22 ml($p<0.05$).The mean operative time in plating was

77.27 and in nailing was 61.67(p=0.005).Mean wound size in plating was 7.22 cms and nailing was 4.55 cms (p<0.05).We had 100% union rate in both the groups. The mean time for clinical and radiological union in plating group was 7.9 weeks and 14 weeks whereas in nailing group it was 7.55 weeks and 13 weeks(p=0.40 and p=0.070).We had excellent outcomes in 7 patients (63.63%),good outcome in 3 patients (27.27%) and poor outcome in 1 patient (9.09%) in the plating group whereas in the nailing group we had 6 patients (66.66%) with excellent,3 patients (33.33%) with good outcome. No poor outcome in nailing group. We had superficial infection in 2 patients (18.18%) in plating group and 1 patient (11.11%) in nailing group. Implant irritation occurred in 2 patients (18.18%) in plating and 1 patient (11.11%) in nailing groups. Shortening was 4.5 mm in plating and 4.8 mm in nailing group.

CONCLUSION:

We conclude that though nailing has advantage over plating during surgery and postoperative period, on long term follow up there is no significant functional difference between plating and nailing for displaced middle third clavicle fractures.

KEY WORDS:-

Clavicle fractures, Reconstruction plate, Precontoured plate, Titanium elastic nail.

INTRODUCTION

The clavicle is the most commonly fractured bone, which accounts for 5–10% of all fractures and 44% of all shoulder injuries.[1-3] Biomechanical studies reveal that, due to the unique configuration and unique shape of the clavicle, the middle third is the weakest and accounts for 80% of clavicle fractures and more than 50 percent of these fractures are displaced.[1,2]The rate of mid clavicular fractures is more than twice high in men as in women.The peak incidence occurs in the third decade of life.[4]

Various options for treatment of acute clavicle fractures are non operative treatment (mostly sling /figure-of-eight bandage), open reduction and internal fixation with plates and screws , and closed/open reduction and internal fixation with intramedullary device(wire,pins,or nail).

Traditionally, these fractures were treated non operatively. Earlier studies reported non union rate of less than 1% with conservative management.[5,6] But those, however, were all not standardised study.They had variable proportions of patients in various ages,variable site of fracture,and of variable nature of fracture.They also included many

cases of children who have excellent results with conservative treatment due to their good remodelling capacity.

Recent studies show higher rates of non union upto 15% and unsatisfactory functional outcomes despite fracture union with conservative management.[7-15] Moreover, even malunion of the fracture clavicle has been described to be a separate clinical entity.[19]

Operative management of these fractures had better outcomes and a lower rate of non union and symptomatic mal union when compared with non operative treatment. Primary internal fixation of displaced middle third clavicle fractures leads to predictable and early return to function.[22]

Surgical options include either plate osteosynthesis or intramedullary nailing. While both plating and nailing are commonly done for clavicle fractures, it is important to compare the outcome and complications with both these procedures.

AIM OF THE STUDY

The AIM of this study is comparative analysis of outcome of displaced middle third clavicle fractures in patients treated with plate osteosynthesis and intramedullary nailing.

REVIEW OF LITERATURE

In 400 BC, **Hippocrates** observed fracture of clavicle unite rapidly with prominent callus and eventhough it had deformity, healing was uneventful.He described that a physician need not feel sorry for neglecting a clavicle fracture as good healing and return to normal function are usually expected.[5]

Dupuytren (1839) – Noted all cumbersome devices used to maintain reduction were not needed and suggested simply the arm to be placed on a pillow till union occurs.

Malgaigne (1859) concluded that most treatment methods led to healing with residual clavicular deformity, However, interference with function, cosmesis and activity level satisfactory.

In 1960, **Neer** observed non union rate 0.1% in conservatively treated mid third clavicle fractures in 2235 patients.[6]**Rowe** in 1968 observed a non union rate of 0.8% in mid third clavicle fractures in 566 patients which were managed conservatively.[7]

Nordqvist et al. evaluated, in turn, the clinical significance of shortening of the clavicle following fracture in 85 patients and found thateventhough permanent shortening occurred commonly following fracture it had no clinical significance.[8]

Till then non-operative treatment was the standard treatment of clavicle fractures.

It was **Hill et al**.(1997) who reviewed 52 conservatively treated adults with mid-shaft clavicle fractures at a mean of 38 months after injury. Eight patients (15%) had non-union and sixteen patients (31 %) reported unsatisfactory results after non operative treatment. Initial shortening of $\geq$ 20 mm is associated more with non union($p<0.001$) and led to unsatisfactory results.They recommended open reduction and internal fixation for displaced middle third clavicle fractures.[9]

Matiset al in 1999 found an impaired shoulder function in half of their patients with a shortening of 1cm and in 100% when shortening was 2 cm.[10]

McKeeet al. examined the strength deficits following nonoperative care of displaced midshaft fractures. In an average of 54 months of follow up, they found strength deficits ranging from 10 to 35 % in 30 patients treated nonoperatively. The loss of strength can have a significant effect on an active young person recreationally and occupationally.[11]

In 2004, **Nowaket al** demonstrated that 46% of patients reported having “sequelae” of their clavicle fracture, indicating that these patients were “not fully recovered from their clavicle injury”. Further the study showed that 9% patients had pain at rest, 29%patients had pain while moving and 27% patients had a feeling of permanent cosmetic defect.[12,13]

Lazarides et al demonstrated in their retrospective review of 132 patients, evaluated 30 months post-injury that 25.8% of patients were dissatisfied with their clinical outcome, with 30.3% experiencing continued pain and 13.6% experience significant motion loss.[14]

Zlowodzki et al. evaluated 2144 midshaft clavicle fractures in a meta-analysis and found a non-union rate of 15.1% following nonoperative treatment.[15]

Narrowing of the space between the clavicle and the first rib for any reason may cause compression of the sub clavian vessels or brachial plexus.

Stienberg, Lord and **Rosati** noted that the healing of a clavicular fracture with inferior and posterior displacement of the distal fragment may cause such compression.[16]

In a systemic review of 2144 displaced midshaft clavicular fractures, non-operative treatment of 159 fractures was found to result in a non union rate of 15.1% [3].In addition, a non union rate of 14.3% (7/49 of displaced midshaft clavicular fractures) was reported in a multicentric, randomized clinical trial conducted by the **Canadian Orthopaedic Trauma Society**.[17]

Robinson in an analysis of 1000 clavicle fractures showed that displaced middle third clavicle fractures had 18.5 times more chances of delayed or non union compared with un displaced fractures.[18]

Wun-Jer Shen et al (1992-1994) reported a large series of 232 clavicle fractures operated with plating with 94% satisfactory results and suggested plating for completely displaced clavicle fractures.[20]

McKee (2010) reported that primary plating of displaced midlle third clavicle fractures has better outcome, quick functional recovery, and decreased rate of non union and symptomatic malunion when compared to non operative treatment.[21]

Elastic nailing of the clavicle clavicle fracture reported by **Jubel et al** in 2002 in which 65 cases of mid clavicular fractures managed by elastic nailing resulted in one case of non union and one case of

shortening. Since then there are various studies in support of management of midshaft clavicular fractures treated by elastic nailing.[23,24,25]

Ferran et al.(2006) analysed 17 nail fixed and 15 plate fixed patients and found no significant difference between plate fixed patients and nail fixed patients in terms of functional outcome after 12 months.[26]

Liu et al.,(2006) did a retrospective analysis of 110 displaced mid clavicular fractures patients in which 59 were plate-fixed and 51were nail-fixed.They observed that there is no significant difference in plating and nailing group in terms of non union rates and functional outcome.[27]

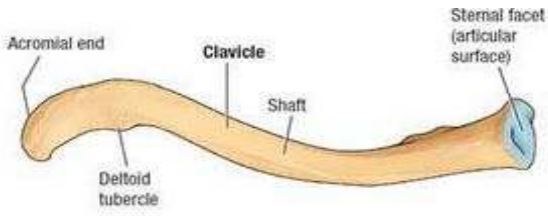
SURGICAL ANATOMY

The word **"Clavicle"** is originated from the latin word **"clavis"** meaning key because it serves as a key to fasten the upper skeleton together. The clavicle is the only bony attachment between the trunk and the upper limb. It has a gentle S-shaped contour and is palpable along its entire length due to its subcutaneous location.It has anteriorly facing convex part medially and the anteriorly facing concave part laterally.

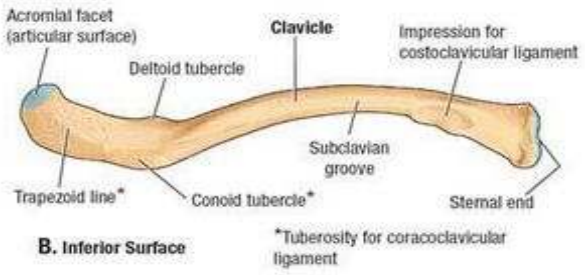
The acromial end of the clavicle is flat, whereas the sternal end is more robust and somewhat quadrangular in shape. There is a tuberosity on the inferior surface of lateral end of clavicle consisting of the **conoid tubercle** and the **trapezoid line,** where the coracoclavicular ligaments are attached.

Right clavicle superior view

Right clavicle inferior view



A. Superior Surface



B. Inferior Surface

*Tuberosity for coracoclavicular ligament

LIGAMENTOUS ANATOMY:

MEDIAL LIGAMENTS:

The medial end of clavicle end functions as the lateral end of the sterno clavicular joint. Few important ligaments attach to this area.

Capsular ligaments:

Thickened sterno clavicular capsule are called the capsular ligaments. These are strong ligaments. They function to prevent upward displacement of the medial end of clavicle.

Interclavicle Ligament:

This is a strong band extending from medial end of one clavicle to the medial end of opposite clavicle. It functions to prevent inferior displacement of the lateral end of clavicle.

Costoclavicular Ligaments:

These extend from superior aspect of first rib to the inferior aspect of clavicle into the rhomboid fossa at the medial end of clavicle. The anterior fibres of this ligamentlimit the upward rotation of medial end of clavicle and posterior fibres limit the downward rotation of medial clavicle.

LATERAL LIGAMENTS:

Coraco-clavicular ligaments:

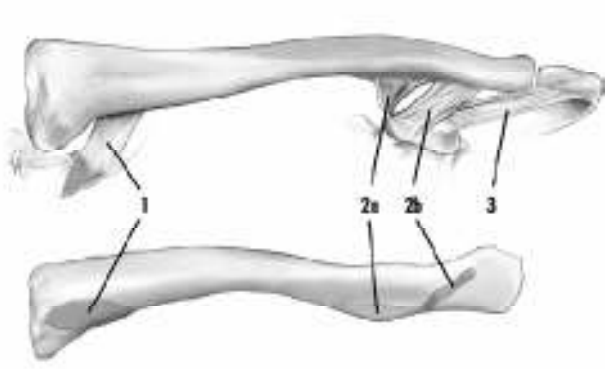
The coraco-clavicular ligaments function as a suspensory ligament. It suspends the upper extremity and the scapulae with the clavicle. These ligaments function as a single ligament but consist of two parts. They are conoid (medial) and trapezoid (lateral) ligaments. Both these attach from base of coracoid process to the inferior surface of the lateral end of clavicle.

Harris and co-workers observed that the insertion of the ligaments showed a high degree of variation in 24 specimens. Both ligaments showed nearly identical length despite the shorter appearance when viewed anteriorly. The trapezoid ligament does not cover 11-15 mm of the under surface of the lateral part of the acromialend of the clavicle. The clinical implication of this would be to avoid resecting more than 10 mm when doing an acromial resection of the clavicle.

Acromioclavicular Ligaments:

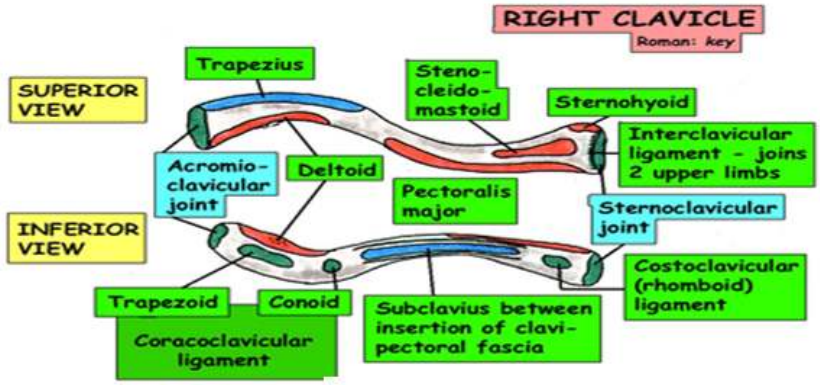
It consists of 2 parts, superior and inferior acromion clavicle ligaments. Both are attached from the distal margin of clavicle to the acromion process. The superior acromio clavicular ligament fibres join with the aponeurosis of deltoid and trapezius. The main function of acromioclavicular ligaments is to prevent anteroposterior translation of distal clavicle.

The ligamentous attachments - frontal and cephalic view



1.Costoclavicular ligament 2. Coraco-clavicular ligaments: 2a. Conoidligament 2b. Trapezoid ligament 3.Coraco-acromial ligament

MUSCULAR ANATOMY:



The sternocleidomastoid muscle (clavicle head) originates from the medial third of upper surface. Anteriorly, pectoralis major is attached to the medial half and deltoid originates from the lateral third. Trapezius is attached to the lateral third posteriorly.

Sub clavius muscle is inserted into the undersurface of middle of clavicle.

NEUROVASCULAR ANATOMY:

The supraclavicular nerve divides into anterior, middle and posterior nerves which lie over the superficial surface of the clavicle just below the platysma. **Jupiter and Ring** have suggested to identify, isolate and preserve these nerves during the surgical approach to the clavicle.[28]

The clavicle functions as a bony protector of the brachial plexus, subclavian vessels and jugular vessels. The inferior border of posterior triangle of the neck is formed by the superior surface of middle third of clavicle. The main contents of posterior triangle are the subclavian artery and the brachial plexus. The close proximity of these vital structures should be understood especially during surgery.

The female clavicle is relatively short, thin, less curved and smooth, with the acromial end is slightly lower than the sternal end when compared with the male. In males the acromial end is on same level with, or slightly at a higher level than the sternal end when the arm is dependent. The clavicle is thicker, more curved and have prominent ridges for muscular attachments in manual workers.[29]

OSSIFICATION:

In 1913 - **FAWCETT J** described ossification and development of clavicle. Clavicle is the first bone in the body to ossify. It ossifies from two primary centres and one secondary centre.

During the **fifth** and **sixth weeks** of intrauterine life two **primary centres** appear in the clavicular shaft. They unite together around 45 days after birth. The **secondary centre** for medial end of clavicle appears at the age of **15-17 years,** and fuses with the shaft by **21-22 years.**

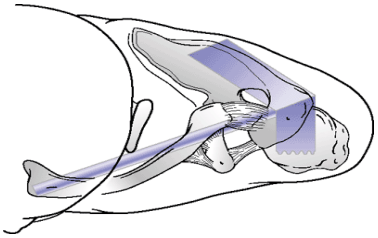
FUNCTIONS OF CLAVICLE

In 1954 - **ABBOT LC** and **LUCAS DB** described functions of clavicle and its surgical significance.

The clavicle functions like a strut by bracing the shoulder girdle and propping it away from the sternum and thoracic cage thereby helps to have cross-body and internal rotation positions without medial collapse. This strut/prop function of the clavicle allows the thoraco humeral muscles to maintain their optimal working distance. Thus, the clavicle increases the strength of shoulder girdle movements.[30]

Further, the coraco clavicular ligaments hold the shoulder girdle with the clavicle and stabilises the shoulder girdle against downward pull. The sterno clavicular ligaments keeps the clavicle in position to withstand this downward load.

The clavicle transmits force from upper limb to axial skeleton.



MECHANISM OF INJURY

The most common mechanism of injury is direct blow on the point of the shoulder .[31]

Indirect Trauma:

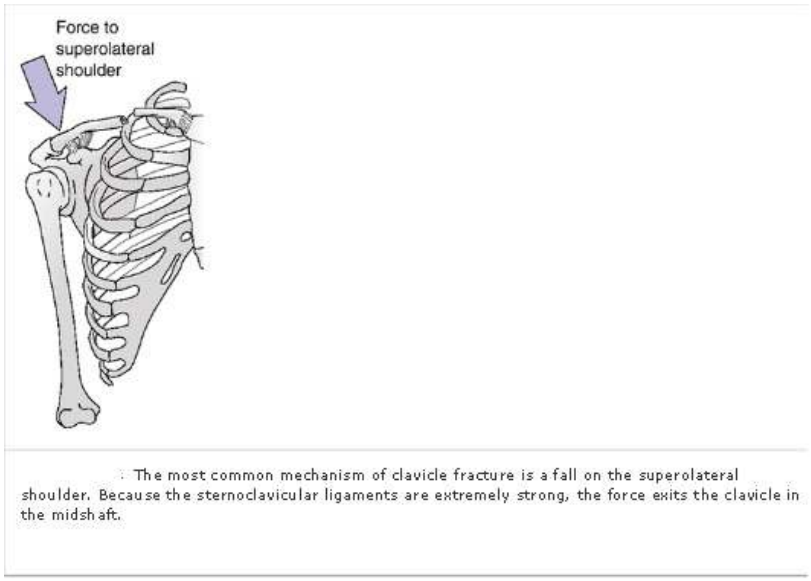
Previously it was thought that the most common mechanism of injury is fall on outstretched hand. The clavicle fracture occurs indirectly during transmission of force from upper limb to axial skeleton. Allman described that the most common mechanism of injury is either fall on outstretched hand or fall on the point of the shoulder.[33]

Direct Trauma:

Recent studies suggest the most common mechanism of injury to be direct blow to the shoulder. Stanley et al. described in his observation of 122 patients with clavicle fractures 94% of patients had direct blow on the shoulder as the mechanism of injury.[32] His observations are in concordance with other studies that the most common mode of clavicular failure is direct trauma.[34, 35,36]

Direct trauma can occur to any region of clavicle and all region of clavicle are vulnerable to fracture. Sporting activities like bicycling and skiing can result in direct injury to clavicle. A Swedish study reported bicycling accident as the most common mode of clavicle fractures.

The authors concluded that fall on an outstretched hand for clavicle fractures is an uncommon mechanism of injury.[37]Few cases of stress fractures of the clavicle have also been reported which occurs when radical neck dissection was done for carcinoma.[38,39,40, 41]In athletic ,stress fractures occur most commonly in the medial third of clavicle.[42,43]



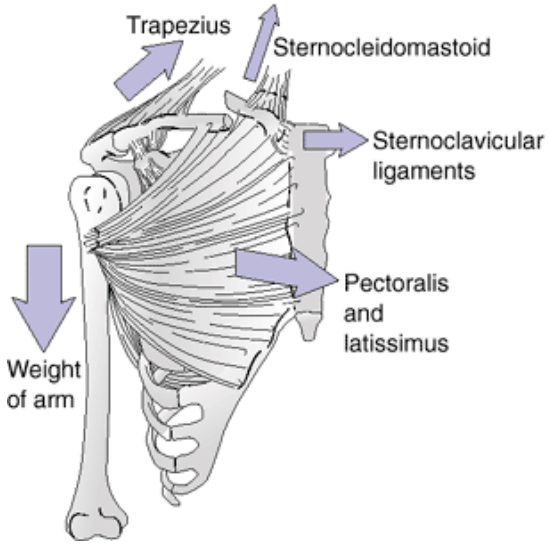
: The most common mechanism of clavicle fracture is a fall on the superolateral shoulder. Because the sternoclavicular ligaments are extremely strong, the force exits the clavicle in the midshaft.

FRACTURE BIOMECHANICS

There are various muscular attachments that serve as displacing force in the case of fracture of clavicle.[44]

For a middle third fracture of clavicle, the displacing forces are as follows (Figure).

- The sterno clavicular ligaments provides a stabilizing force on the medial fragment.
- The sternocleidomastoid pulls the medial fragment superiorly.
- The pectoralis major displaces the lateral fragment inferiorly and medially.
- The weight of the arm through the coraco clavicular ligaments exert an inferior force on the lateral fragment.



The downward displacement of lateral fragment is prevented by the trapezius muscle.

The clavicle stabilizes the glenohumeral joint in the sagittal plane, providing a center of rotation for the shoulder joint. During elevation of the arm, the glenohumeral joint moves twice as much as the scapula thoracic joint and the clavicle rotates, relatively lengthens, and moves through an arc of 60^0. The middle third lateral third junction is the weakest part of the bone and there is relatively no muscular or ligamentous attachments. Therefore it is subjected to the greatest bending and torsional stresses. This makes middle third area to be more prone for fracture particularly when there is impact on the shoulder resulting in axial load to clavicle.

CLASSIFICATION OF CLAVICLE FRACTURES

ALLMAN CLASSIFICATION [33]

1967 - **ALLMAN F** devised the classification of clavicular fractures first.

GROUP I	Middle third clavicle fractures
GROUP II	Lateral third clavicle fractures
GROUP III	Medial third clavicle fractures

Disadvantages:

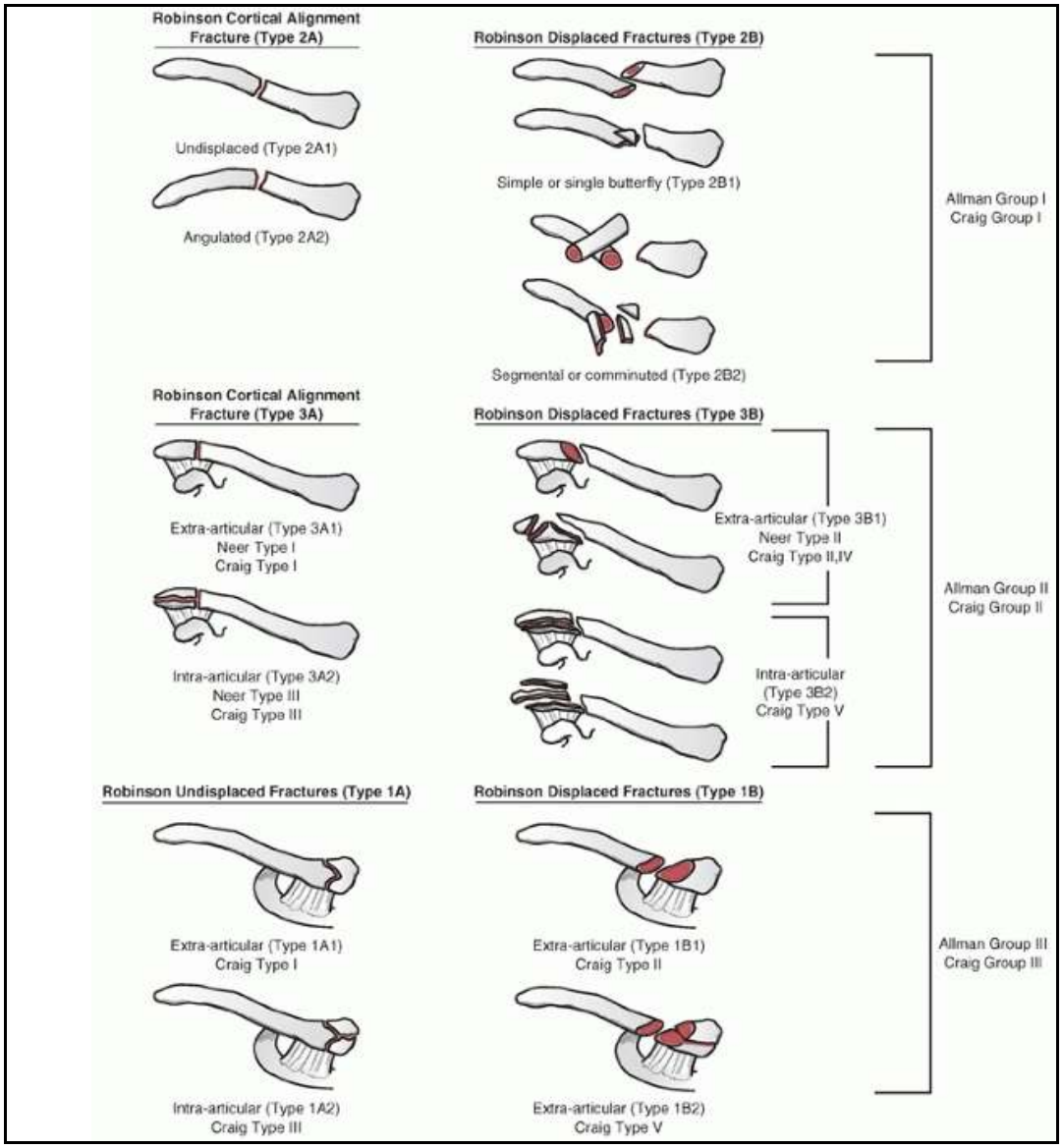
This system does not describe the potentially important prognostic and treatment variables like displacement, comminution, or shortening.

Neer's classification

Type 1	Middle third clavicle fracture (80%)
Type 2	Distal third clavicle fracture (15%)
Type 3	Medial third clavicle fracture (5%)

ROBINSON CLASSIFICATION [48] (Figure)

TYPE 1 – MEDIALTHIRD	SUB TYPES
A- Non displaced fractures	A1-Extraarticular A2-Intraarticular
B-Displaced fractures	B1-Extraarticular B2-Intraarticular
TYPE 2 – MIDDLE THIRD A-cortical alignment present	A1-nondisplaced A2-angulated
B-Displaced	B1-simple or single butterfly fragment B2-comminuted or segmental
TYPE 3 – DISTAL THIRD A-Non displaced	A1-Extraarticular A2-Intraarticular
B-Displaced	B1-Extraarticular B2-Intraarticular



Advantages:

- It divides the clavicle in thirds-which is traditionally accepted practice.
- It includes variables such as degree of displacement, degree of comminution and intra-articular extent which are prognostically important.

Disadvantages:

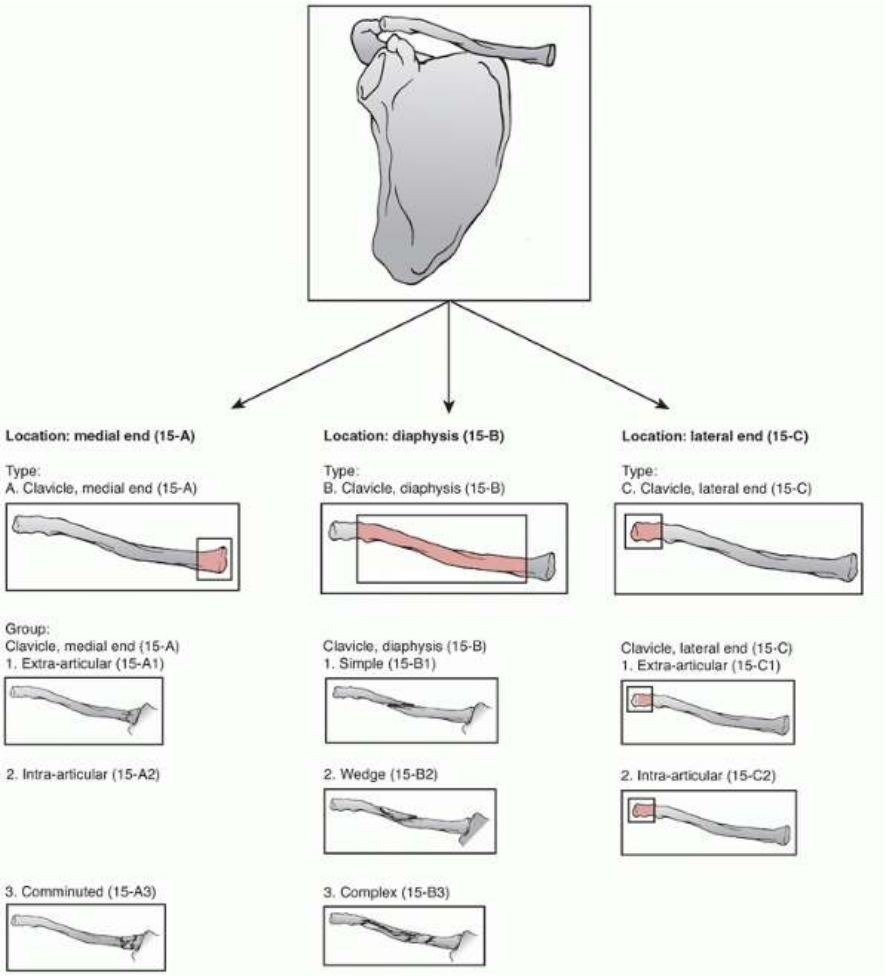
- Unusual fracture types are not included
- The number scheme is different and do not correspond to Allman and Neer.

AO/OTA CLASSIFICATION (2007)

Clavicle designated as segment 15.

Type A - medial end	**A1**- Extra-articular **A2**- Intra-articular **A3**- Comminuted
Type B – diaphysis	**B1**- Simple **B2**- Wedge **B3**- Complex
Type C - lateral end	**C1** - Extra-articular **C2**-Intra-articular

AO/OTA CLASSIFICATION (2007)



CLINICO-RADIOLOGICAL EVALUATION

Thorough clinical evaluation should be done. Whenever suspected trauma profile x rays should be taken i.e.,X ray of cervical spine,X ray pelvis.Particular attention is given to air entry.Associated chest injuries,scapula injuries,brachial plexus injuries and vascular injuries are screened.

RADIOGRAPHS

- 1926 - **QUENSA** described special x-ray views.

Xray chest PA view-to evaluate chest injuries and to evaluate the shortening ofthe involved clavicle relative to the normal side.

- X ray of the involved shoulder- AP view.
- An apical oblique view: a roll is placed under the opposite scapula and the beam is angled 20 degrees cephalad to the involved clavicle to bring the clavicular image away from the thoracic cage.
- Serendipity view: to evaluate medial third fractures when it extends into the sterno clavicular joint.
- An axillary radiograph: to evaluate intra-articular Type III fractures.
- CT scan: for evaluating medial and lateral third fractures.

VARIOUS MODALITIES OF TREATMENT

1. Non operative treatment
2. Operative treatment

Non operative treatment:

1. Immobilization with figure of 8 bandages.
2. Immobilization with sling.

The figure of eight bandage is known to be the most common closed method of clavicular mid-shaft fracture treatment. Andersen et al. did a- prospective randomised trial and analyzed seventy-nine out-patients with middle third clavicular fractures comparing treatment with a figure of eight bandage and a simple sling and found that the functional and cosmetic results of the both methods were identical with no difference in alignment after healing. Treatment with a simple sling had little discomfort and minimal complications when compared with the figure of eight bandage.[49]

OPERATIVE TREATMENT

Operative fixation of clavicle fractures is indicated in healthy, physically active adults with any of the following Indications:

- Shortening of > 2 cm
- Displaced fractures with skin tenting and/or an impending open fracture.
- Fractures asscociated with neurovascular injury
- An open fracture of the clavicle
- A floating shoulder
- Fractures with obvious clinical deformity
- Fracture of lateral end near acromio clavicular joint.
- Associated lower extremity trauma.

Modes of operative treatment:

a. Plate fixation

b. Intramedullary fixation

c. External fixation

OPEN REDUCTION AND PLATE OSTEOSYNTHESIS

Advantages

- Rigid fixation
- Cortical compression can be achieved
- Provides rotational control

Restoration of length and alignment of clavicle is good

Disadvantages

- Large wound size and scar
- Hardware irritation
- Numbness inferior to skin incision
- Chance of infection

Implants used

- 3.5 reconstruction plate.
- Precontoured superior dynamic compression plate.
- Anatomical precontoured locking compression plate (precontoured superior anterior locking compression plate).

CLOSED/OPEN REDUCTION AND INTRAMEDULLARY FIXATION

Advantages

- Limited exposure with minimal soft tissue disruption
- Can be performed closed
- Implants can be removed under local anaesthesia

Disadvantages

- ❖ Hardware prominence and migration
- ❖ Infection
- ❖ Non union
- ❖ Does not provide rotational control

Implants used

- ❖ ‘K’ wire
- ❖ Hagie pin /Rockwood pin
- ❖ Titanium elastic nail
- ❖ Intramedullary compression clavicular nail

EXTERNAL FIXATION

1954 - **COOK. T.W** described external fixation for infected clavicle fractures.

- Reports available in literature on the use of external fixator is very less.
- Indications were open fracture, severe soft tissue injury with risk of soft tissue necrosis.

MATERIALS AND METHODS

This comparative analysis of displaced middle third clavicle fractures in 20 patients treated with plate osteosynthesis and intramedullary nailing is a prospective study undertaken at the Department Of Orthopaedics, Government Coimbatore medical college hospital,Coimbatore from May 2011 to October 2013.This study is a non randomised control study. The study was approved by the ethical committee of our college. Prior informed consent was obtained from all the patients.

Inclusion criteria:

- Displaced middle third clavicle fractures(Robinson type II b)
- Open fractures of the clavicle
- Fractures with impending skin perforation

Exclusion criteria:

- Fractures associated with ipsilateral scapula or humerus fractures
- Old age debilitated patients
- Psychiatric patients
- Seizure disorders

Our study consisted a total of 20 patients with middle third clavicle fractures over a period of 30 months from May 2011 to October 2013.

The patients who were admitted with displaced middle third clavicle fractures meeting the inclusion criteria are operated alternatively with plating(Recon plate/Precontoured plate) and nailing(TENS). Over the period of study in which 20 patients were operated, the patients are grouped into two. One group with 11 patients were operated with open reduction and internal fixation with plate osteosynthesis (6 patients with RECON plate and 5 patients with PRECONTOURED clavicle plate) and another group with 9 patients were operated with closed / open reduction and titanium elastic nailing.

The patients were followed up 1 month, 3months and 6 months postoperatively and clinical and radiological union are assessed.

All the cases were analysed as per the following criteria:

1. Age distribution
2. Sex distribution
3. Side of injury
4. Mode of injury
5. Classification of fracture
6. Planning of treatment
7. Time interval between injury and surgery
8. Associated injuries

Table 1: AGE DISTRIBUTION

S.no	Age group	No. of patients		Percentage	
		Plating	Nailing	Plating	Nailing
1.	20-29	5	3	45.45%	33.33%
2.	30-39	3	3	27.27%	33.33%
3.	40-49	1	3	9.09%	33.33%
4.	50-59	2	0	18.18%	0
	Total	11	9	100%	100%

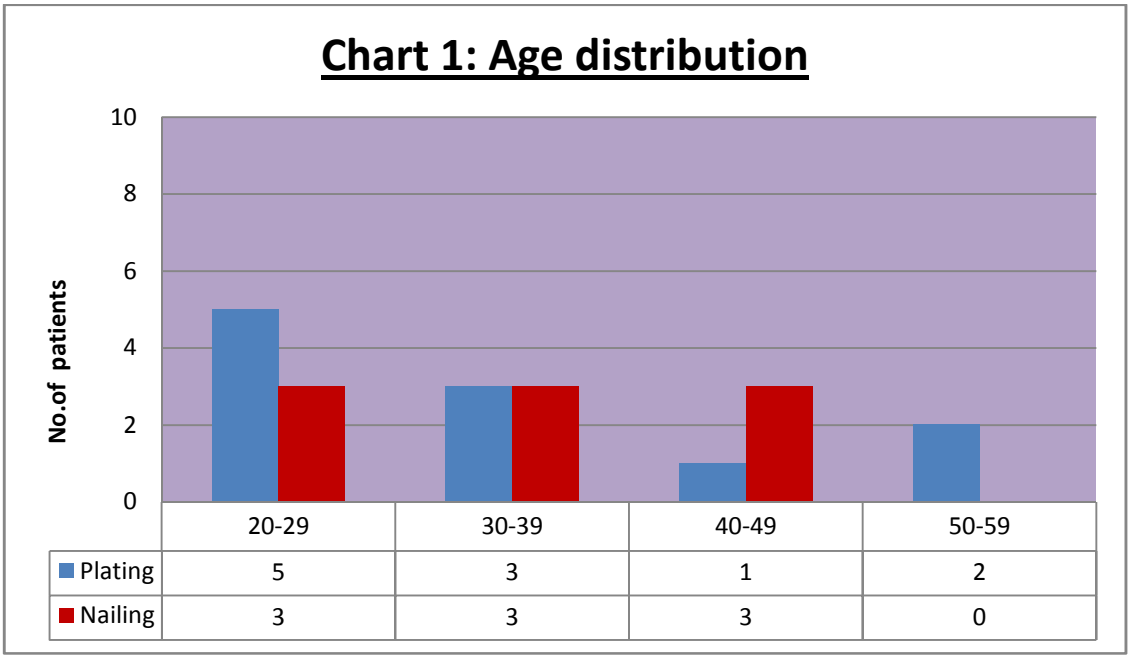


Table 2:SEX DISTRIBUTION

S.no	Sex	No.of patients		Percentage	
		Plating	Nailing	Plating	Nailing
1	Male	9	8	81.81%	88..88%
2	Female	2	1	18.18%	11.11%
3.	Total	11	9	100%	100%

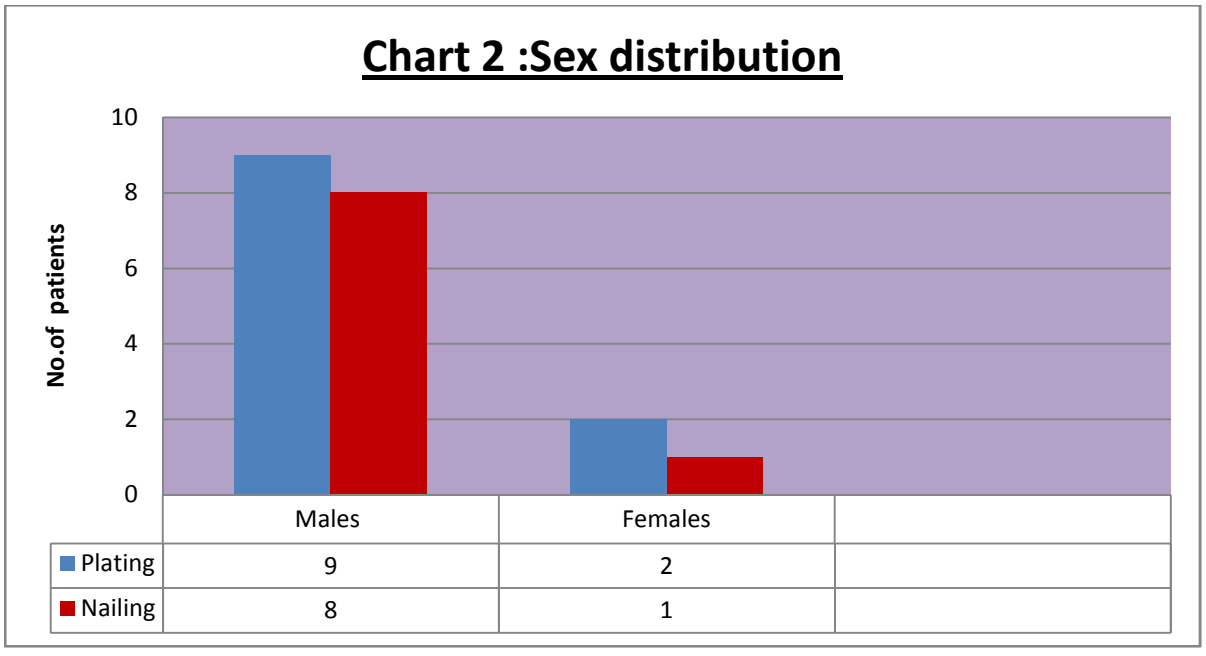


Table 3:SIDE OF INJURY

S.no	Side of injury	No. of patients		Percentage	
		Plating	Nailing	Plating	Nailing
1	Right	4	3	36.36%	33.33%
2	Left	7	6	63.63%	66.66%
3.	Total	11	9	100%	100%

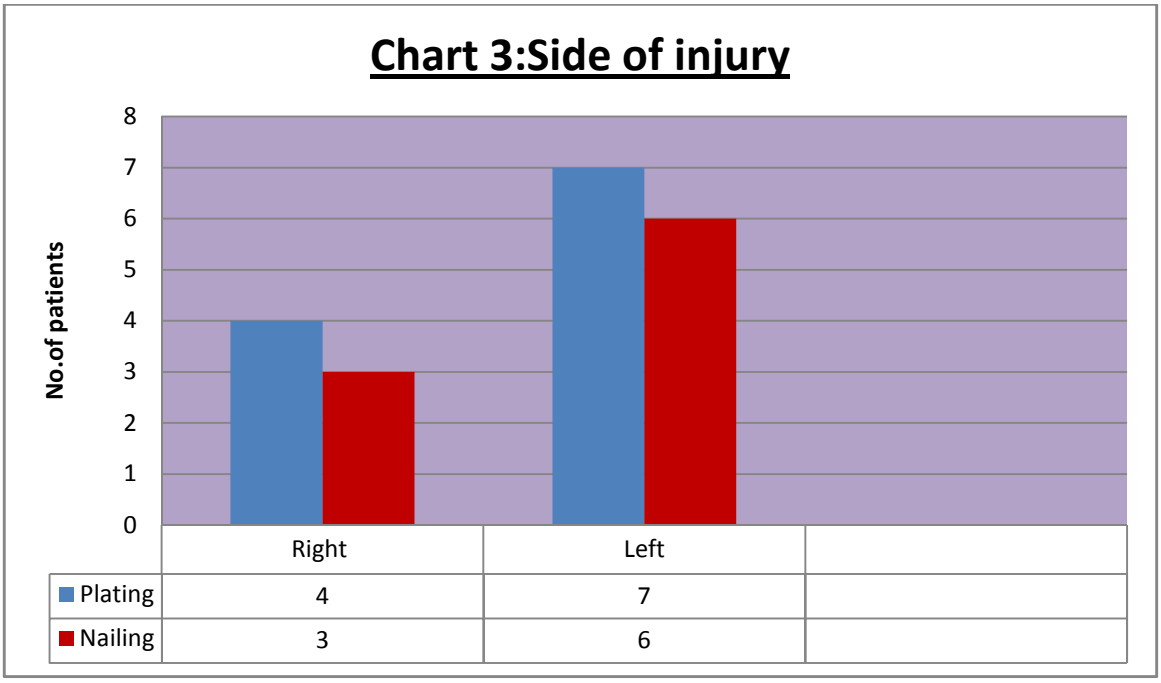
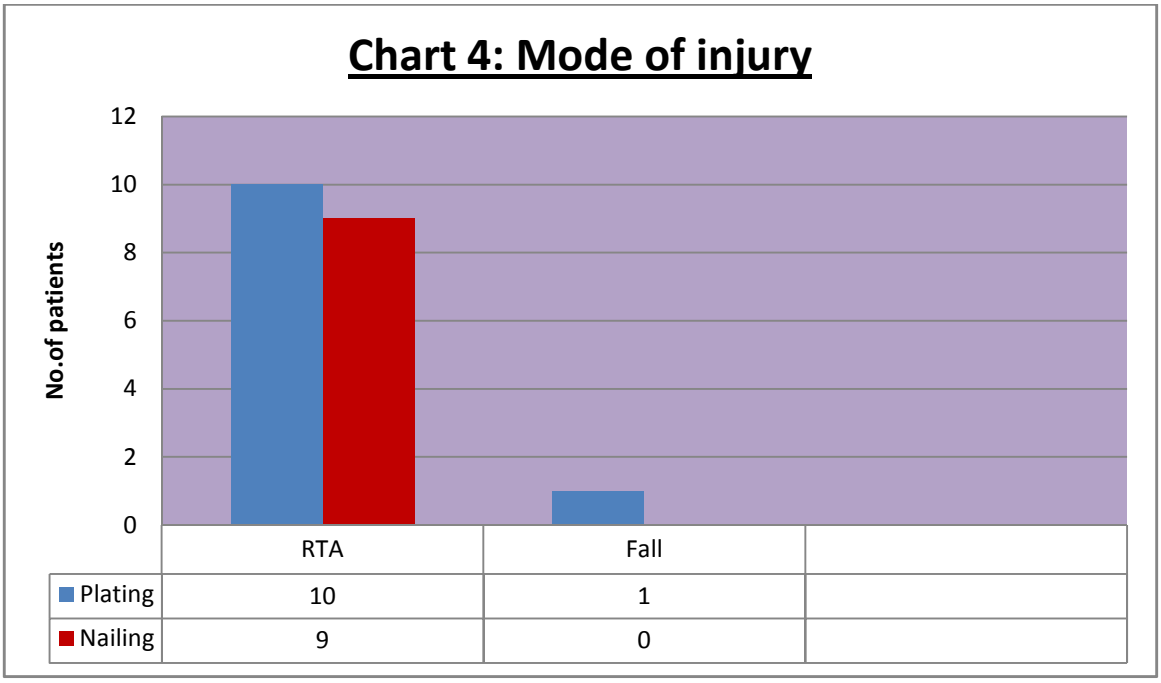


Table 4:MODE OF INJURY

S.no	Mode of injury	No.of patients		Percentage	
		Plating	Nailing	Plating	Nailing
1	RTA	10	9	90.90%	100%
2	Fall	1	0	9.09%	0%
3	Total	11	9	100%	100%



V. CLASSIFICATION AND TYPE OF FRACTURE

All cases falls on Robinson Type 2 B classification.

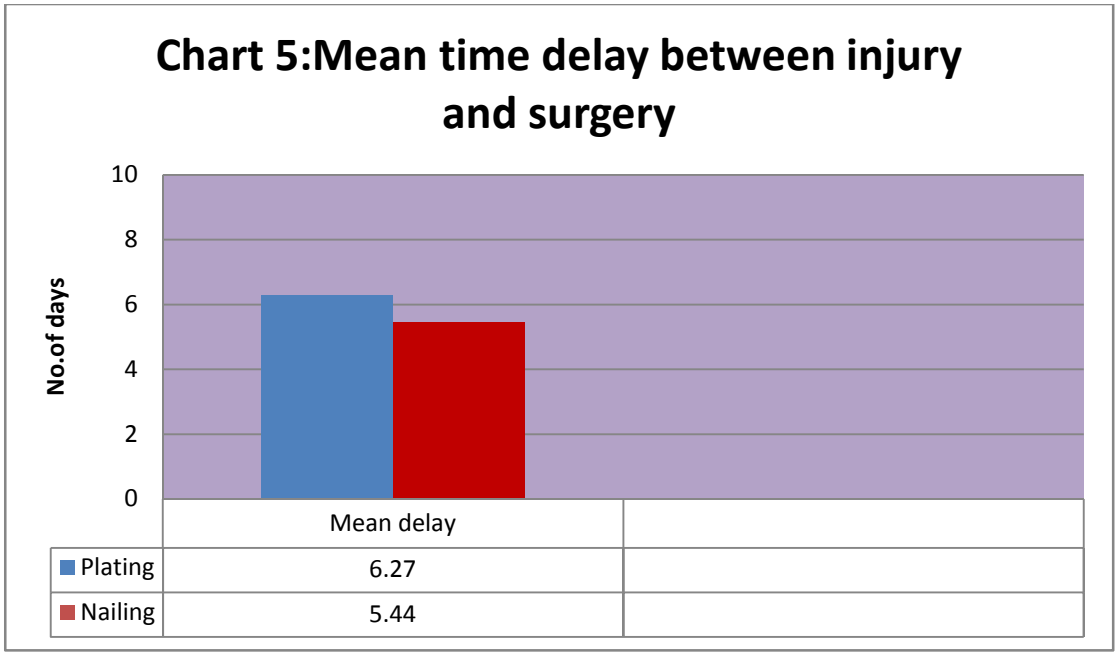
VI. PLANNING OF TREATMENT

Day 1 after injury cases were planned whether to manage conservatively or plating or nailing.

The appropriate plate length required is calculated from the pre op Xray.

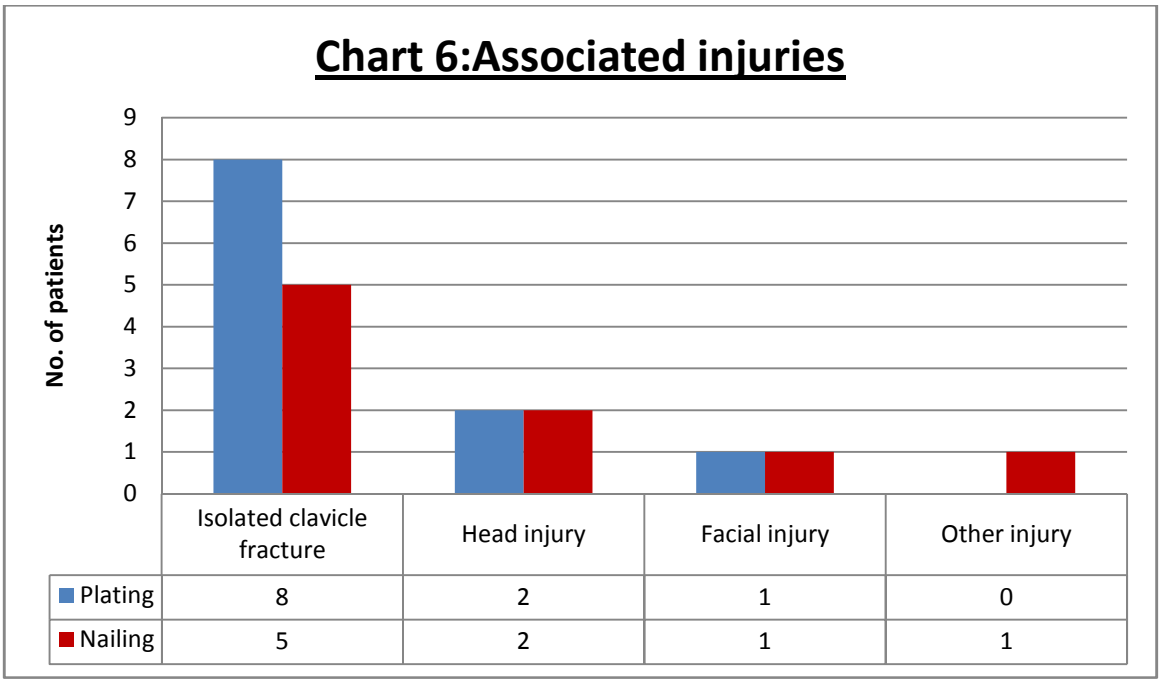
7. Table :5 MEAN TIME DELAY BETWEEN INJURY AND SURGERY

S.no	Parameter	Plating	Nailing
1	Mean delay between injury and surgery(days)	6.27	5.44



8.ASSOCIATED INJURIES:

S. No	Associated injuries	Plating	Nailing
1	Isolated clavicle fracture	8	5
2	Head injury	2	2
3	Facial injury	1	1
4	Other fractures	0	1 (pubic rami fracture)



IMPLANT:

PLATING:

Plating is done using 3.5 mm reconstruction plate or precontoured clavicle plates.

NAILING:

Titanium elastic nail made of alloy such as Ti-6A1-7Nb is used.

IMPLANTS

SURGICAL TECHNIQUE FOR PLATING:

Preoperative planning

The preoperative radiographic assessment was done to determine the length of the plate to be used and to determine the number and position of screws.

Anaesthesia

General anaesthesia/regional block

Position and preparation

Supine position with sand bag in the inter scapular region. Operative site including the arm was prepared and draped so that it can be intra-operatively mobilized and used as a reduction aid.

Pre operative antibiotics were usually given within one hour before surgery after a test dose.

Surgical approach for plating

Skin incision -A curvilinear incision along the skin crease lines was made.

The platysma was divided to expose the periosteum. Minimal dissection of periosteum was done to expose the fracture. The fracture ends were distracted and the fracture reduction was done. Temporary fixation with k wires are done if necessary.

Plate length

Appropriate plate was selected for the fracture. Plate bending was done using the plate benders in all cases of plating with RECON plate and 4 out of 5 cases of anatomically contoured precontoured plates. While bending the locking plates drill sleeve was inserted into the threaded hole to avoid damage to LCP threads.

Temporary fixation of the plate

Plate was positioned on the reduced bone and temporarily fixed with plate holding forceps.

Screw Insertion

If in case both locking and cortical screws was to be used, cortical screw was applied before locking screws to pull the bone to the plate.

Screw fixation-3.5mm cortical screws

Using the 2.5 mm drill bit along with the 3.5 mm universal drill guide both cortex were predrilled. Using the depth gauge the length of the cortical screw required was measured. The appropriate 3.5 mm cortical screw was inserted using the hexagonal screwdriver.

Fixation with 3.5 mm locking screws

If the locking screw is to be inserted first it was made sure that the fracture is well reduced and the plate is close to the bone. After measuring the screw length the locking screw was inserted using hexagonal screwdriver and tightened until it got locked. After thorough irrigation, absorbable interrupted sutures to close the myofascial layer was done so that it covers the hardware.

Subcutaneous layer closure done with absorbable interrupted sutures. Skin closed with subcuticular sutures to make it cosmetically better scar. Sterile dressing was applied. Suction drain not applied for any case. Arm sling was applied for protection and to minimize the operative site pain.

Patient positioning

Skin incision

Fracture exposure done and temporarily stabilised with k wire

Final position of plate

SURGICAL TECHNIQUE FOR TENS NAILING:

Anaesthesia:

General anaesthesia/regional block

Position:

Supine position with sand bag in the inter scapular region .

Approach:

Skin incision of size 1-2 cm was made 1.5 cm lateral to sterno clavicular end. With a 2.5mm drill bit, an opening was made in the anterior cortex of the clavicle and then widened using a small bone awl. The titanium elastic nail of 2-2.5 mm diameter depending upon the medullary diameter of the patient was taken and was fixed in a universal chuck with a T handle. With oscillating movements the nail was advanced upto the fracture site.

If closed reduction was not possible an additional small incision of size 2 to 3 cm was made over the fracture site to negotiate the fragments. The nail was advanced into the lateral fragment. The nail was cut off at the entry site leaving about 1 cm for removal. Skin was sutured without drain.

Patient positioning

Nail entry

Fracture reduced and nail advanced

POSTOPERATIVE CARE AND REHABILITATION

The post op protocol for both group of patients are same.

- The arm is not elevated above 120^0 in any plane till 4 weeks post op
- The arm was maintained in a sling on a full-time basis for two weeks.
- The patients are instructed not to lift objects > 2 kg in the operated side for 6 weeks.
- Ice fomentation 3-5 times (15 minutes each time) per day is adviced to control swelling and inflammation.
- The patients are encouraged to maintain good upright shoulder girdle posture.

1st Week:

Exercises (3x per day):

- Pendulum exercises
- Ball squeezing exercises
- Isometric exercises of rotator cuff external and internal rotations with arm by the side are started
- Isometric shoulder abduction, adduction, extension and flexion with arm at side are started.

Weeks 2 - 4:

- Suture removal done on 12th post operative day.
- Soft-tissue treatments for associated shoulder and neck musculature for comfort.
- Gentle pulley for shoulder ROM 2x/day.
- Elbow pivots PNF(proprioceptive neuromuscular facilitation), wrist PNF.
- Isometric scapular PNF, mid-range.

Weeks 4 - 8:

- Mid-range of motion rotator cuff external and internal rotation exercises started
- Active and light resistance exercises (through 75% of ROM as patient's symptoms permit) withoutshoulder elevation and avoiding extreme end ROM.

Weeks 8 - 12:

- Full shoulder Active ROM in all planes.
- Increase manual mobilizations of soft tissue as well as gleno humeral and scapula thoracic joints for ROM.
- No repeated heavy resisted exercises or lifting until 3 months.

Weeks 12 and beyond:

- More aggressive strengthening program as tolerated were started.
- Increase the intensity of strength and functional training for gradual return to activities and sports.

After clinical and radiological union, most patients were allowed to participate in sports activities usually by three to four months.

All the patients were reviewed on 2nd week, 4th week and then every monthly for the next three months and thereafter once in three months. During follow up, patients were clinically evaluated for pain, activities of daily life, range of movements of shoulder joint and power. Radiological evaluation of the union was done by taking serial x-rays. Radiological union was taken to be achieved when there is bridging trabeculations across the fracture on three of four cortices at the fracture line. Any changes in the previous alignment, screw pullout or implant failure also noted.

Functional outcome was based on the **Quick DASH** scoring system .

S. No	Outcome	Quick DASH score
1	EXCELLENT	< 10
2	GOOD	10 – 30
3	FAIR	31 – 50
4	POOR	Greater than 50

RESULTS

Statistical analysis of results were performed using student t test.The results are analysed under the following headings.

1. Intra operative details
2. Duration of hospital stay
3. Post operative complications
4. Outcome

1. INTRA OPERATIVE DETAILS:

The following parameters are analysed intra operatively

S.no	Parameter	Plating	Nailing	P value
1	Mean Blood loss (ml)	97.27	62.22	<0.05
2	Mean Operative time (mins)	77.27	61.66	0.005
3	Mean wound size (cms)	7.22	4.55	<0.05
4	Closed reduction	-	3	-
5	Open reduction	11	6	-

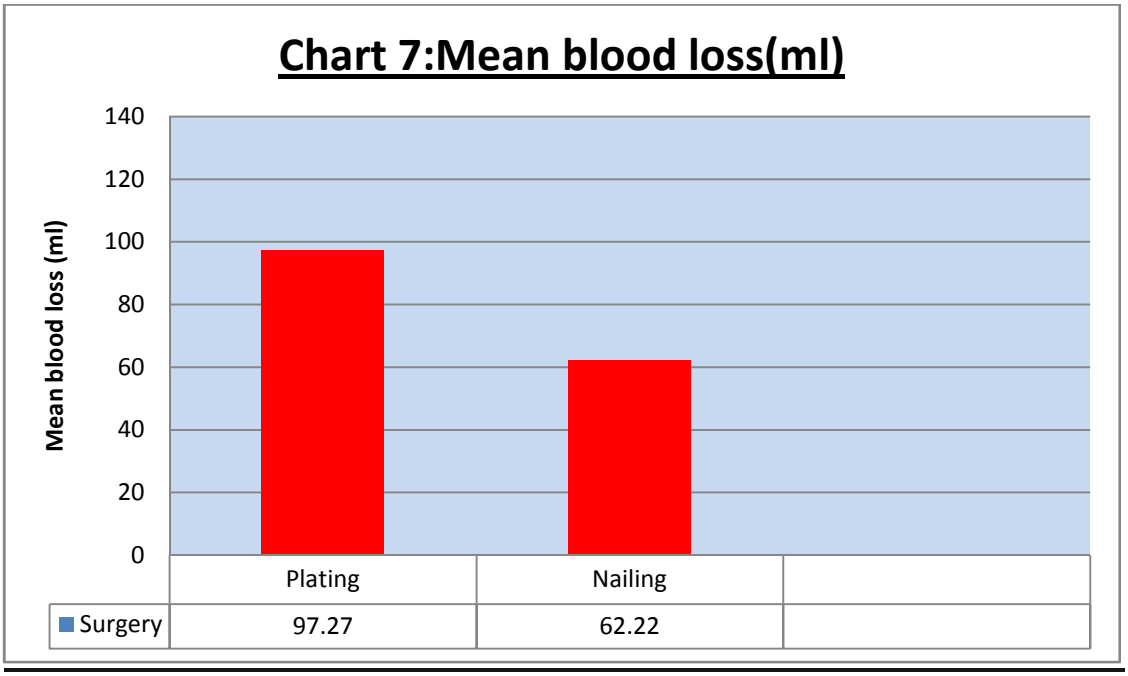


Chart 7:Mean blood loss(ml)
Mean blood loss (ml)
140
120
100
80
60
40
20
0
Plating
Nailing
Surgery
97.27
62.22

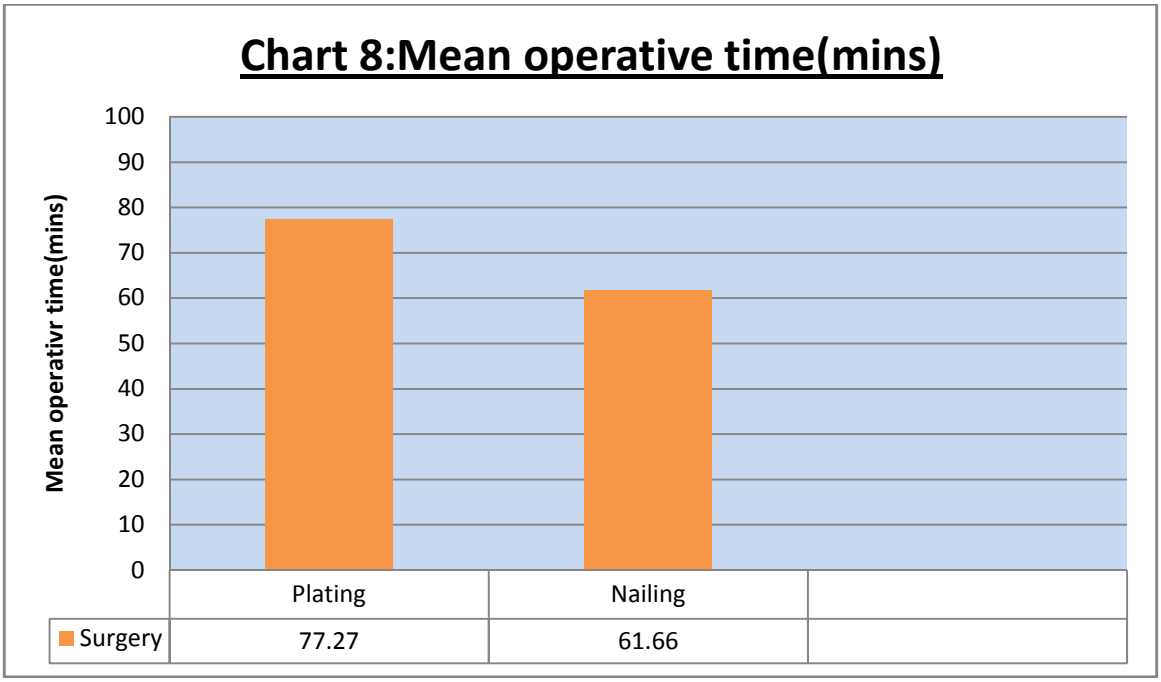


Chart 8:Mean operative time(mins)
Mean operativr time(mins)
100
90
80
70
60
50
40
30
20
10
0
Plating
Nailing
Surgery
77.27
61.66

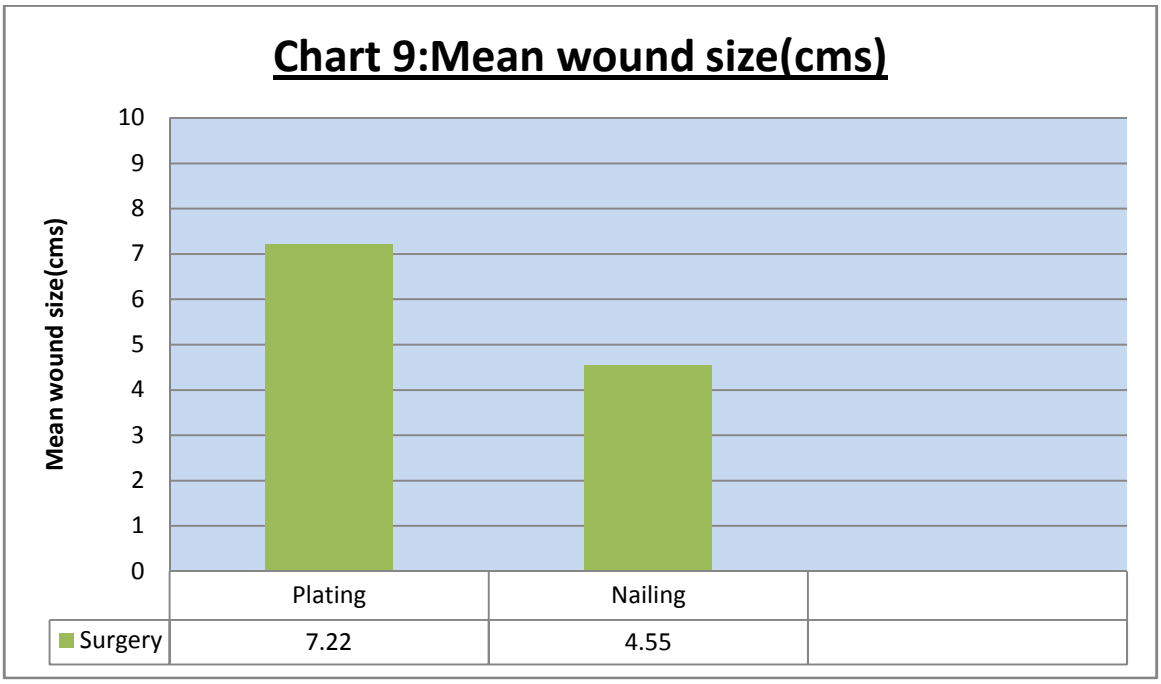
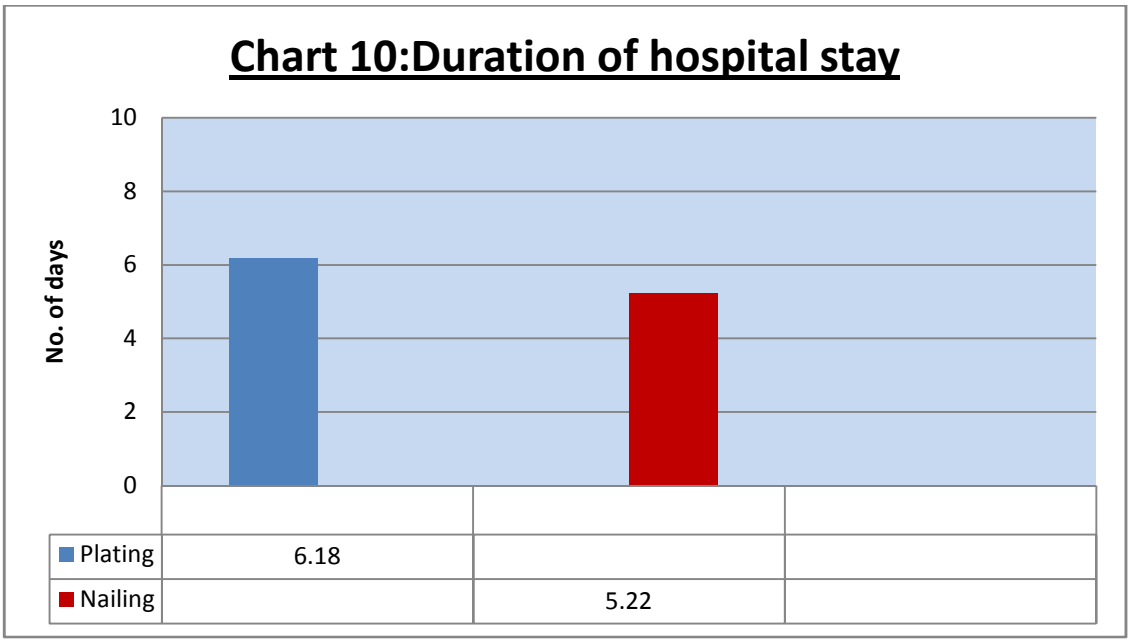


Chart 9:Mean wound size(cms)
Mean wound size(cms)
10
9
8
7
6
5
4
3
2
1
0
Plating
Nailing
Surgery
7.22
4.55

2. DURATION OF HOSPITAL STAY

S.no	Parameter	Plating	Nailing	P value
1	Mean duration of hospital stay	6.18	5.22	0.414

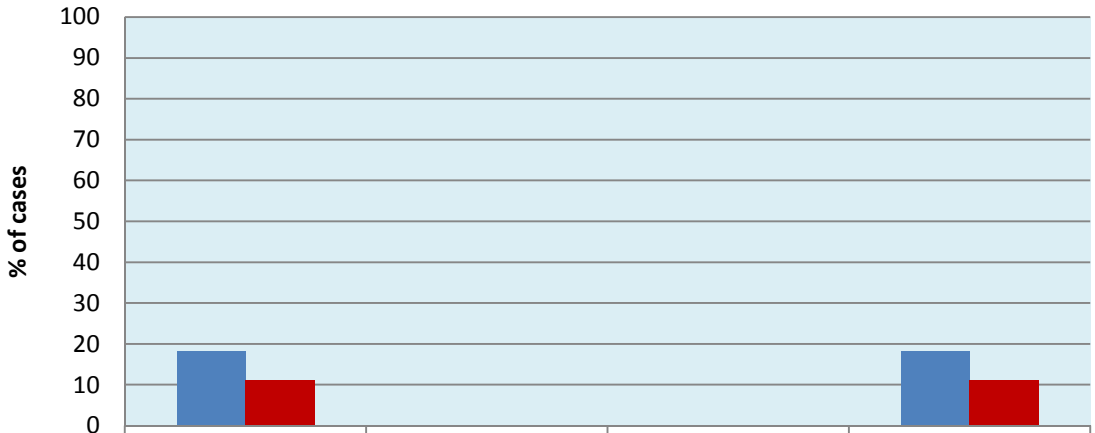


3. POST OPERATIVE COMPLICATIONS:

- 2 (18.18%) patients in the plating group developed superficial infection on the 3rd post operative day which subsided with i.v antibiotics.
- 1 (11.11%) patient in the nailing group developed infection which subsided with i.v antibiotics. There was no deep infection in either group.
- We had no cases of Non union/malunion.
- 2 (18.18%) patients in the plating group had implant irritation due to the prominent hardware.
- 2 (22.22%) patients had lateral TEN protrusion and 1 (11.11%) patient had medial TEN protrusion (which led to implant irritation) in the nailing group.
- There was no implant failure in either group and there was no need for re osteosynthesis/ secondary procedure to achieve union in either group.

S.no	Complication	Plating	Nailing
1	Infection A.Superficial B.Deep	 2 (18.18%) 0	 1(11.11%) 0
2	Non union	0	0
3	Mal union	0	0
4	Implant failure requiring removal	0	0
5	Implant irritation	2(18.18%)	1(11.11%)
6	Medial TEN protrusion	-	1(11.11%)
7	Lateral TEN protrusion	-	2(22.22%)
8	Re-osteosynthesis	0	0
9	Secondary procedures	0	0
10	Mean Shortening (mms)	4.5	4.8

Chart 11:Complications



	Infection	Malunion	Non union	Implant irritation
Plating	18.18	0	0	18.18
Nailing	11.11	0	0	11.11

4.OUTCOME:

The final outcome measure consists of union rate,union time (clinical and radiological) and Quick DASH scoring.

S.no	Parameter	Plating	Nailing	P value
1	**Union rate**	**100 %**	**100%**	**-**
2	**Mean Union time**			
	Clinical union	**7.90 weeks**	**7.55 weeks**	**0.40**
	Radiological union	**14 weeks**	**13 weeks**	**0.070**
3	**Mean QUICK DASH score**			
	1 month	**22.98**	**16.89**	**0.28**
	3 months	**13.73**	**7.95**	**0.38**
	6 months	**9.29**	**6.20**	**0.68**

FUNCTIONAL OUTCOME:

Based on the Quick DASH scoring, the following are the outcomes.

S.No	OUTCOME	PLATING	NAILING
1	EXCELLENT	7 (63.63%)	6 (66.66%)
2	GOOD	3 (27.27%)	3 (33.33%)
3	FAIR	0	0
4	POOR	1 (9.09%)	0

Chart 12:Union rate

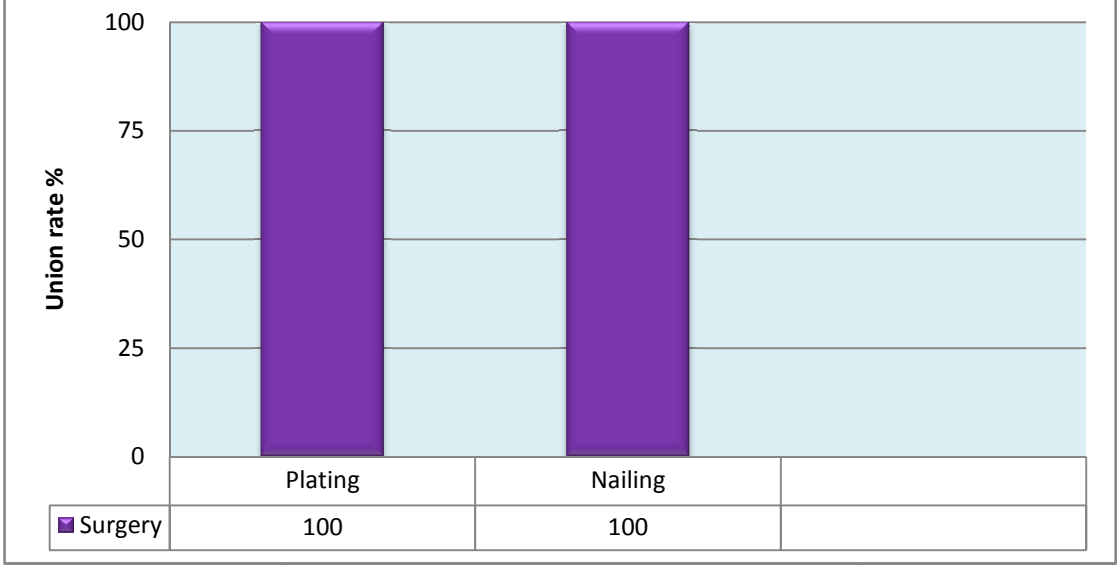
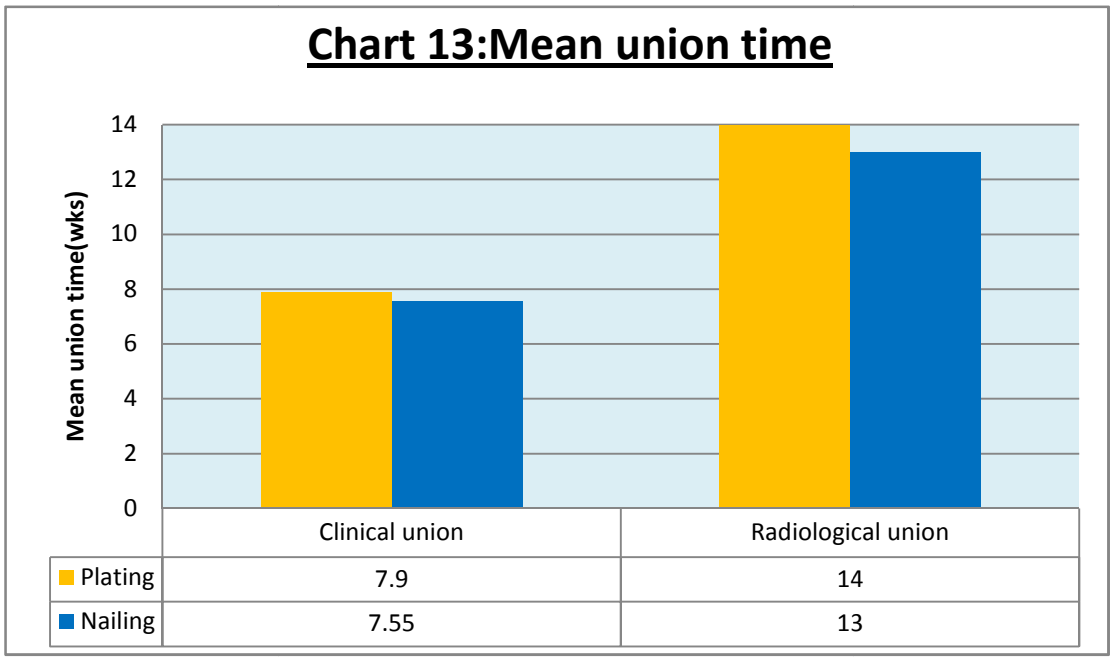


Chart 13:Mean union time

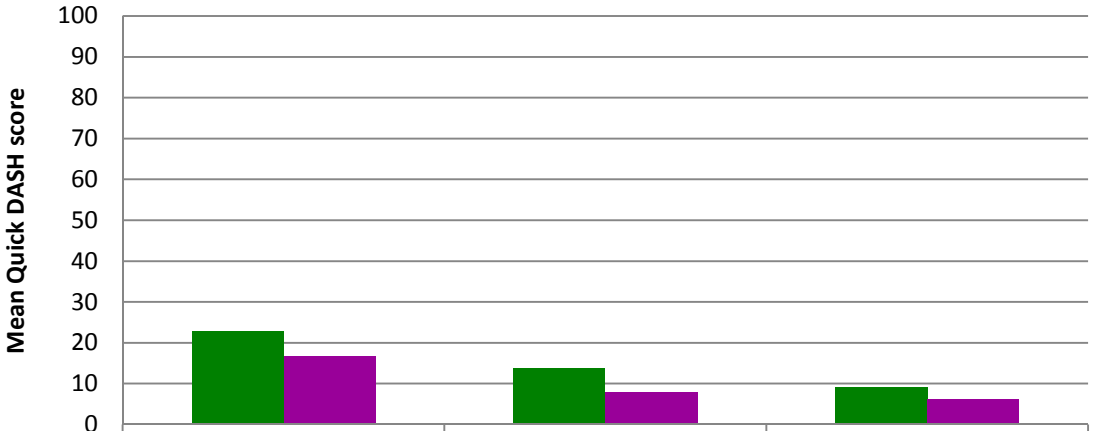


FUNCTIONAL OUTCOME:

Based on the Quick DASH scoring, the following are the outcomes.

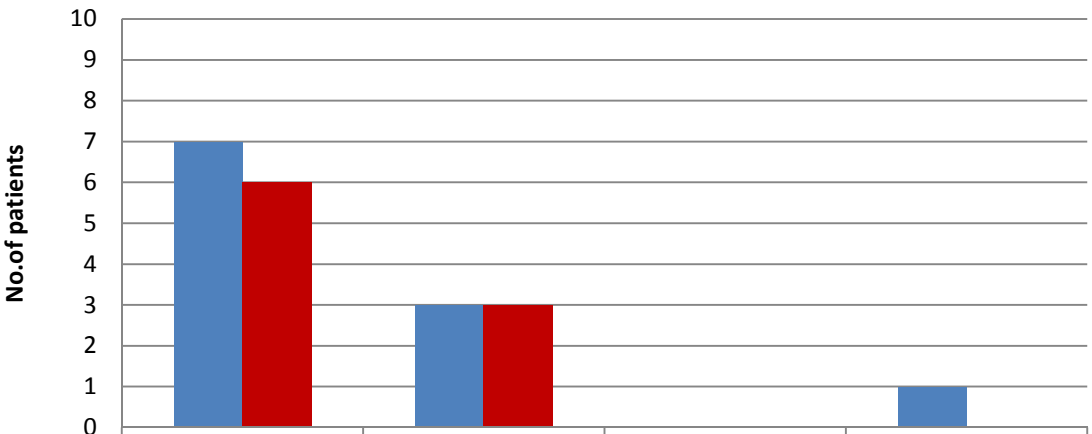
S.No	OUTCOME	PLATING	NAILING
1	EXCELLENT	7 (63.63%)	6 (66.66%)
2	GOOD	3 (27.27%)	3 (33.33%)
3	FAIR	0	0
4	POOR	1 (9.09%)	0

Chart 14:Mean Quick DASH score



	1 month	3 months	6 months
Plating	22.98	13.73	9.29
Nailing	16.89	7.95	6.2

Chart 15: Functional outcome



	EXCELLENT	GOOD	FAIR	POOR
Plating	7	3	0	1
Nailing	6	3	0	0

DISCUSSION

Clavicle fractures, one of the common fractures of adult population are often treated conservatively since the time of **Hippocrates**. Thorough understanding of the musculoskeletal anatomy and the dynamic relation between clavicle and shoulder motion is essential in management of clavicle fractures. The deforming forces, the degree of comminution and over riding causes shortening of the clavicle. Shortening more than 2 cms influences the outcome in the midshaft clavicle fractures.

In clavicle fractures, the major determining factor for restoration of function of upper limb is the restoration of clavicular length. As early as 1790, **Therselben** described that the chief function of clavicle is to keep the shoulder blade away from the axial skeleton which helps in proper functioning of the shoulder.[50]His postulates were confirmed by our study with the restoration of clavicular length after surgery resulted in better functional outcome.

For a long period of time clavicle fractures were traditionally managed conservatively.There was unanimous thought to leave these fracture conservatively with a simple sling or figure of 8 bandage.

Based on review of various recent studies on the management of clavicle fractures by conservative methods, the effectiveness of non operative management is found to be deficient in providing optimal outcome particularly in young population and had unsatisfactory results.

Recent studies suggest that the operative management of middle third clavicle fractures resulted in lower non union rates, improved functional outcome, faster mobilization, better cosmesis and increased patient satisfaction.[9-22]

Operatively,clavicle fractures are commonly managed either with plate osteosynthesis or intramedullary elastic nailing.It becomes imperative for a surgeon to know the various aspects of plating and nailing and also their advantages and disadvantages to make a proper choice of surgery.

Theoretically, both plate osteosynthesis and titanium nailing have their own advantages. A biomechanical study suggest that plate fixation results in more rigid fixation when compared to nailing and this helps in having an early rehabilitation.[51] Plate fixation is technically easy to perform and provides rotational control.Disadvantages include large wound size and implant prominence.

On the other hand, Titanium elastic nailing is less invasive, has lesser rate of implant prominence and after union implant removal can be done as an outpatient procedure with minimal dissection.[52]Further,in nailing if closed reduction is achieved this has an advantage of preserving the fracture hematoma which speeds up fracture healing.Disadvantages are that it does not provide rotational control. TEN protrusion leading to implant irritation is also of concern.

There are very limited literature comparing the outcomes with plating and nailing for middle third clavicle fractures.

Ferran et al.(2006) analysed 17 patients operated with plate osteosynthesis with LC-DCP and 15 patients operated with ROCKWOOD pin and found that there is no significant difference in functional outcome after 12 months between plate fixation and intramedullary fixation .20% patients had infection and 40% patients had implant failure requiring removal in plating group.Whereas in nailing 6% patients had implant failure requiring removal,6% patients had implant irritation and 6% patients had re-osteosynthesis.[26]

Liu et al.,(2006) did a retrospective comparative analysis of 110 patients (aged 16-65 years) with clavicle fractures of which 59 patients are operated with plating (RECONSTRUCTION plate) and 51 patients were operated TEN and demonstrated no significant differences in functional outcome between the two groups.They also observed no significant difference in complication rate between the two groups.[27]

Bohme et al.(2010) reported in an observational cohort study comparing the outcome of clavicle fractures treated by RECON plate, LC-DCP with that treated with ESIN.They observed that 4% patients had infection,11% patients had implant failure requiring removal and 11% patients had re-osteosynthesis in plating group. Whereas 5% patients had implant failure requiring removal,5% patients had implant irritation and 5% patients had re-osteosynthesis in nailing group.[53]

Thyagarajanet al. (2011) did a retrospective comparative analysis of 51 patients of mid shaft clavicle fractures treated with plating (LC-DCP),nailing (ROCKWOOD pin) or conservatively (17 patients in each group). They reported a constant score of 98 for the intramedullary fixation group and of 94 for the plate fixation group after six months. In plating group 12% patients had infection,6% had non union,12% patients had implant failure requiring removal and 35% had implant irritation.In

nailing group 12% patients had infection.None of the other patients in nailing group had complications.[54]

We evaluated 20 cases of displaced middle third clavicle fractures of which 11 patients are treated with plate osteosynthesis and another 9 patients with intramedullary TEN nailing.

TEN Nailing resulted in decreased blood loss ($p<0.05$),decreased operative time ($p=0.005$),decreased wound size ($p<0.05$) and decreased hospital stay ($p=0.41$) when compared to plating.Moreover,the mean Quick DASH score of nailing patients at 30 days after surgery is16.89when compared to Quick DASH score of 22.98 for plating at 30 days after surgery. This suggests better patient acceptability and satisfaction in the nailing group.However,the mean Quick DASH score at 6 months after surgery in nailing and plating are 6.2 and 9.29 respectively indicating that there is no significant difference in shouder function and disability on a long term follow up.

There was no difference between two groups in terms of rate of union. All cases had 100% union. There was a slight difference in union time .The mean time period for clinical and radiological union in plating group was 7.90 weeks and 14 weeks whereas the mean time period for

union in nailing group was 7.55 weeks and 13 weeks.Both these were statistically not significant.($p>0.05$).

Based on the functional outcome at 6 months, In plating group,we had 7 patients with excellent outcome,3 patients with good outcome and 1 patient with poor outcome.In nailing group,6 patients with excellent outcome, 3 patients with good outcome.

Complications like superficial infection is noted in 2patients (18.18%) in plating when compared to 1patient (11.11%) in nailing group. Moreover minor complications like implant irritation occurred in 2 patients(18.18%) in plating and 1(11.11%) patient in nailing group. There were 1 case of medial TEN protrusion and 2 cases of lateral TEN protrusion.The lateral TEN protrusion in our study can be attributed to the inadvertent piercing of the cancellous lateral margin of clavicle intra operatively. This problem arises when TEN nailing is performed without image control. We therefore suggest that all TEN nailing of the clavicle whether open or closed to be done under image control to know the lateral extent of the nail.

Shortening do occurs in both plating and nailing.

LazaridesS, Zafiropoulos[14] reviewed 272 patients with middle third clavicle fractures and found that patients with shortening of more

than 18 mm had residual shoulder pain and unsatisfactory results mainly due to altered biomechanics of the shoulder joint that occurs with clavicular shortening.

In our study, the mean shortening in plating group was 4.5 mm and in nailing group was 4.8mm.However these amount of shortening did not have any effect on the functional outcome of the patients in our study.

Our study has limitations.Our study is not a randomised control study.Further our study involves limited number of subjects.Therefore statistical significance of our study can be questioned.However our study shows some basic information comparing plating and nailing for clavicle fractures. Our study supports further randomised control trials and with a large number of samples to arrive at a definite conclusion.

S. no	Results	Ferran et al. [26], 2010		Liu et al. [27], 2010		Thyagarajan et al.[54],2009		Bohme et al.[53], 2010		Our Study,2013	
		Plating(LC-DCP)	Nailing (Rockwood pin)	Plating(RECON plate)	Nailing(TEN)	Plating(LC-DCP)	Nailing(Rockwood pin)	Plating(DCP,LC-DCP,RECON plate)	Nailing(ESIN)	PlatingRECONplatepreco ntoured	TENS
	No.of cases	15	17	59	51	17	17	53	20	11	9
1	Blood loss(ml)	NR	NR	128±49	67±37	NR	NR	NR	NR	97.27	62.22
2	Operative time(min)	NR	NR	76±23	73±26	NR	NR	61(20––133)	43 (10–95)	77.27	61.67
3	Infection	3(20%)	0	6 (10%)	3 (6%)	2 (12%)	2 (12%)	2 (4%)	0	2(18.18%)	1(11.11 %)
4	Malunion	0	0	2 (3%)	4 (8%)	0	0	0	0	0	0
5	Non union	0	0	6 (10%)	5 (10%)	1 (6%)	0	0	0	0	0
6	Implant failure	6(40%)	1(6%)	12 (20%)	4 (8%)	2 (12%)	0	6 (11%)	1 (5%)	0	0
7	Implant irritation	0	1(6%)	NR	NR	6 (35%)	0	0	1 (5%)	2(18.18%)	1(11.11 %)
8	Re-osteosyn thesis	0	1(6%)	NR	NR	0	0	6 (11%	1 (5%)	0	0

CONCLUSION

Hence we conclude that though nailing has advantage over plating during surgery and postoperative period, on long term follow up there is no significant functional difference between plating and nailing for displaced middle third clavicle fractures.

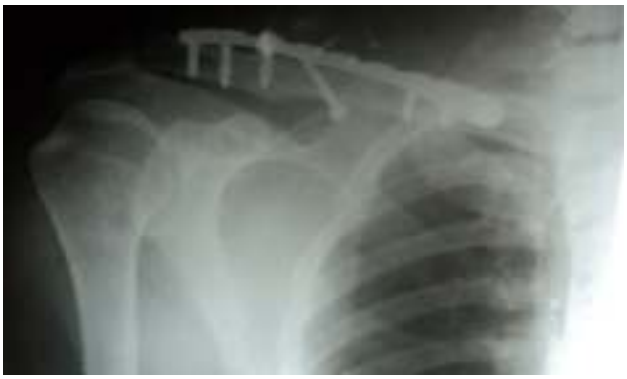
CASE ILLUSTRATIONS

PLATING

CASE 1

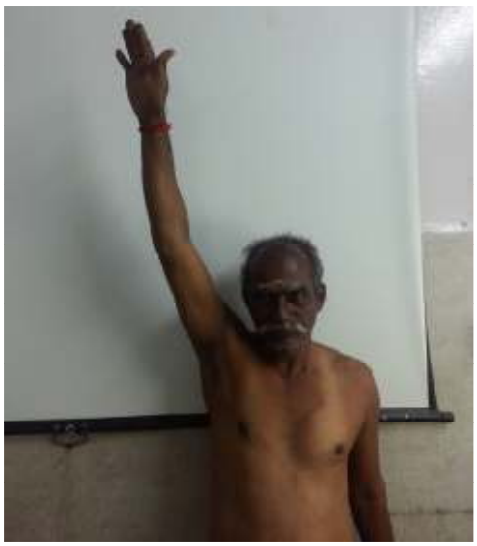
PRE OP X RAY

POST OP X RAY



FOLLOW UP –UNION AT 12 WEEKS

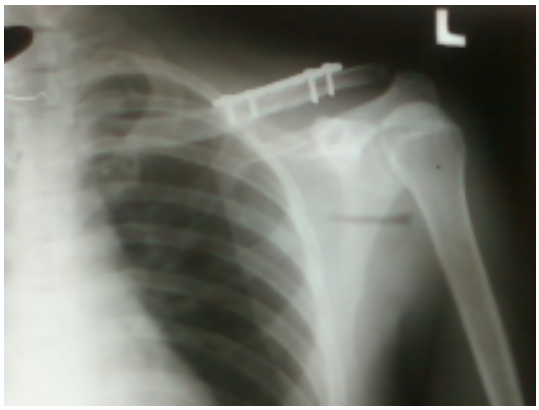
FUNCTIONAL OUTCOME



CASE 2

PRE OP X RAY

POST OP X RAY



FOLLOW UP- UNION AT 13 WEEKS

FUNCTIONAL OUTCOME

CASE 3

PRE OP

POST OP

FOLLOW UP- UNION AT 13 WEEKS

FUNCTIONAL OUTCOME

PROMINENCE

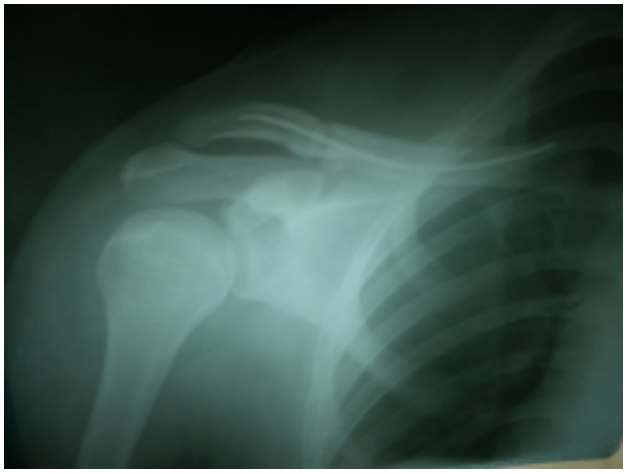
HARDWARE

NAILING

CASE 1

PRE OP

POST OP



FOLLOW UP- UNION AT 15 WEEKS

FUNCTIONAL OUTCOME

CASE 2

PRE OP

POST OP

FOLLOW UP- UNION AT 14 WEEKS

FUNCTIONAL OUTCOME

CASE 3

PRE OP

POST OP

FOLLOW UP- UNION AT 12 WEEKS

FUNCTIONAL OUTCOME

BIBLIOGRAPHY

1.Nordqvist A, Petersson C. The incidence of fractures of the clavicle.ClinorthopRelat Res. 1994;300:127–132.

2. Postacchini F, Gumina S, De Santis P, et al. Epidemiology of clavicle fractures. J Shoulder Elbow Surg. 2002;11:452–456.

3. Robinson CM : Fractures of the clavicle in the adult. Epidemiology and classification. JBJS Br. 1998 : 80 : 476-89

4.Schiffer G, Faymonville C, Skouras E, Andermahr J, Jubel A : Midclavicular fracture: Not just a trivial injury – *current treatment options* .DtschArzteblInt 2010;107(41);711-7

5.Adams F. The genuine works of Hippocrates. New York, NY: William Wood and Co., 1886.

6.Neer CS 2nd. Nonunion of the clavicle. J Am Med Assoc 1960;172: 1006-11.

7. Rowe CR. An atlas of anatomy and treatment of midclavicular fractures.ClinOrthopRelat Res. 1968;58:29–42.

8.Nordqvist A, Redlund-Johnell I, von Scheele A, Petersson CJ: Shortening of clavicle after fracture. Incidence and clinical significance, a 5-year follow-up of 85 patients.ActaOrthop Scand. 1997;68:349-351.

9.Hill JM, McGuire MH, Crosby LA. Closed treatment of displaced middle third fractures of the clavicle gives poor results. J Bone and Joint Surg Br.1997;79:537–539

10.Matis N, Kwasny O, Gaebler C. Effects of clavicular shortening after clavicular fracture. HefteUnfallchirurg1999 ; 275 : 314-315.

11.McKee MD, Pedersen EM, Jones C, et al. Deficits following nonoperative treatment of displaced midshaftclavicular fractures. J Bone and Joint Surg Am. 2006;88:35–40.

12.Nowak J, Holgersson M, Larsson S. Can we predict long-term sequelae after fractures of the clavicle based on initial findings? A prospective study with nine to ten years of follow-up. J Shoulder Elbow Surg. 2004;13:479–486.

13.Nowak J, Holgersson M, Larsson S. Sequelae from clavicular fractures are common: a prospective study of 222 patients. ActaOrthop.2005;76:496–502

14.Lazarides S, Zafiropoulos G: Conservative treatment of fractures at the middle third of the clavicle: the relevance of shortening and clinical outcome. J Shoulder Elbow Surg. 2006;15:191-194.

15. Zlowodzki M, Zelle BA, Cole PA, Jeray K, McKee MD; Evidence-Based Orthopaedic Trauma Working Group. Treatment of acute midshaft clavicle fractures: systematic review of 2144 fractures: on behalf of the Evidence-Based Orthopaedic Trauma Working Group. J Orthop Trauma. 2005; 19(7):504-507

16.Stienberg, Israel: Subclavian vein thrombosis associated with fracture of the clavicle. Report of two cases. New England J Med., 264:686-688, 1961

17. Canadian Orthopaedic Trauma Society. Nonoperative treatment compared with plate fixation of displaced midshaftclavicular fractures. A multicenter, randomized clinical trial.J Bone Joint Surg Am. 2007;89(1):1-10

18. Robinson CM, Court-Brown CM, McQueen MM, et al. Estimating the risk of nonunion following nonoperative treatment of a clavicularfracture.J Bone Joint Surg Am. 2004;86:1359–1365.

19.McKee MD, Wild lm, Schemitsch EH. Mid-shaft malunions of the clavicle. J Bone Joint Surg Am.2003;85:790-7.

20. Shen, W. J., T. J. Liu, et al. Plate fixation of fresh displaced midshaft clavicle fractures Injury 30(7): 497-500. 1999

21. McKeeClavicle fractures in 2010: sling/swathe or open reduction and internal fixation?OrthopClin North Am. 2010 Apr;41(2):225-31. doi: 10.1016/j.ocl.2009.12.005.

22.WgCdr V Kulshrestha, Primary Plating Of Displaced Mid-Shaft Clavicular Fractures. *MJAFI* 2008; 64: 208-211.

23. Jonas Andermahr, Axel Jubel, Andreas Elsner. Anatomy of clavicle and the intramedullary nailing of midclavicular fractures. Clinical Anatomy 20.2007:48-56.

24. Jubel A, Andemahr J, Schiffer G, Rehm KE 2003 - Elastic stable intramedullary nailing of mid clavicular fractures in atheletes. Br J Sports Med 37: 480-4844.

25. Jubel A, Andermahr J, Prokop A, Isenberg J, Rehm K 2002. Minimal invasive biologicalosteosynthesis of the clavicle fractures with Titanium nail. 119:485-490

26. Ferran NA, Hodgson P, Vannet N, Williams R, Evans RO (2010)Locked intramedullary fixation vs plating for displaced and shortened mid-shaft clavicle fractures: a randomized clinical trial.J Shoulder Elbow Surg 19:783–789

27.Liu HH, Chang CH, Chia WT, Chen CH, Tarng YW, Wong CY(2010) Comparison of plates versus intramedullary nails forfixation of displaced midshaftclavicular fractures. J Trauma 69(6):E82–E87

28.Jupiter JB, Ring D. Fractures of the clavicle. In: Iannotti JP, Williams GR, eds. Disorders of the shoulder: diagnosis and management. Philadelphia: Lippincott Williams & Wilkins, 1999

29.GRAY'S anatomy, the anatomical basis of clinical practice. Thirty ninth edition

30.Moseley HF. Shoulder lesions. Edinburgh: Churchill Livingstone, 1972.

31.Rockwood and Green fractures in Adults,7th edition

32.Campbell's Operative Orthopaedics, 11th edition

33.Allman FL Jr. Fractures and ligamentous injuries of the clavicle and its articulation. J Bone Joint Surg [Am] 1967;49:774-784.

34.Stanley D, Trowbridge EA, Norris SH. The mechanism of claviculartfracture.A clinical and biomechanical analysis. J Bone Joint Surg Br 1988;70:461-464.

35.Fowler AW. Treatment of fractured clavicle. Lancet 1968;1:46-47.

36.Sankarankutty M, Turner BW. Fractures of the clavicle. Injury 1975;7:101-106.

37.Jan Nowak,Hans Mallmin,Sune LarssonThe aetiology and epidemiology of claviculartfractures.**Injury**Volume 31, Issue 5 , Pages 353-358, 1 June 2000

38.Cummings CW, First R. Stress fracture of the clavicle after a radical neck dissection; case report. PlastReconstrSurg 1975;55:366-367.

39.Fini-Storchi O, Lo Russo D, Agostini V. Pseudotumors of the clavicle subsequent to radical neck dissection. J LaryngolOtol 1985;99:73-83.

40.Ord RA, Langdon JD. Stress fracture of the clavicle.A rare late complication of radical neck dissection. J MaxillofacSurg 1986;14:281-284.

41.Seo GS, Aoki J, Karakida O, et al. Case report: nonunion of a medial clavicular fracture following radical neck dissection: MRI diagnosis. Orthopedics 1999;22(10):985-986.

42.Fallon KE, Fricker PA. Stress fracture of the clavicle in a young female gymnast. Br J Sports Med 2001;35(6):448-449.

43.Roset-Llobet J, Sala-Orfila JM. Sports-related stress fracture of the clavicle: a case report. IntOrthop 1998;22(4):266-268.

44. Neer CS. Fractures of the distal clavicle with detachment of the coracoclavicular ligaments in adults. J Trauma 1963;3:99-110.

45.Neer CS. Fractures of the distal third of the clavicle. ClinOrthop 1968;58:43-50.

46.Rockwood CA. Fractures of the outer clavicle in children and adults. J Bone Joint Surg Br 1982;64:642.

47.Nordqvist A, Petersson, C. The incidence of fractures of the clavicle.ClinOrthop 1994;127-132.

48. Robinson. Fractures of the clavicle in the adult Epidemiology and classification J Bone Joint Surg Br May 1998 vol. 80-B no. 3 476-484

49. Andersen K, Jensen PO, Lauritzen J: Treatment of clavicular fractures. Figure-of-eight bandage versus a simple sling. ActaOrthop Scand. 987;58:71-74

50.Martin R, Saller K.1959.Lehrbuch der Antropologie.2nd Ed. Stuttgart: Gustav fisher.

51. Golish SR, Oliviero JA, Francke EI, Miller MD: A biomechanical study of plate versus intramedullary devices for midshaft clavicle fixation.JOrthopSurg Res 2008, 16:3-28

52. McKee M Elastic stable intramedullary nailing was effective in displaced midshaftclavicular fractures. The Journal Of Bone And Joint Surgery. American Volume [J Bone Joint Surg Am] 2009 Nov; Vol. 91 (11), pp. 2746

53. Böhme J, Bonk A, Bacher GO, Wilharm A, Hoffmann R, JostenC(2010) Current treatment concepts for mid-shaft fractures of theclavicle - results of a prospective multicentre study. Z OrthopUnfall 149(1):68–76

54. Thyagarajan DS, Day M, Dent C, Williams R, Evans R (2009) Treatment of mid-shaft clavicle fractures: a comparative study. IntJ Shoulder Surg 3(2):23–27

PROFORMA

1. **Name :**
2. **Age/Sex:**
3. **Occupation:**
4. **Address:**
5. **Ip no:**
6. **Date of admission:**
7. **Date of surgery:**
8. **Date of discharge:**
9. **History of presenting illness**

   Chief complaints:
10. **Mode of injury :**
11. **Pre-injury status:**

    Ambulatory/ non ambulatory

    Obese / non obese

    Diabetic / non diabetic

    Congestive heart failure/Coronary Artey Disease

    Chronic obstructive pulmonary disease

    Psychiatric illness

12. Associated injuries:

Head injury

Chest injury

Other fractures if any

13. Local examination:

Shoulder region:

Open / closed injury

Skin condition

Deformity

14. Other joint examination

Acromioclavicular joint :

Deformity

Elbow joint:

Deformity

Range of movements

15. Investigation

Radiograph

x-ray chest – PA view
x-ray shoulder –AP view

16. Diagnosis:

Plan

17. Anaesthesia:

Type

Risk grade

18. Operative technique:

Approach

Position

19. Duration of surgery :

20. Amount of blood loss:

21. Wound size :

22. Duration of hospital stay:

23. Post operative protocol:

a. **Duration of I.V.Antibiotics**

b. **Rehabilitation**

24. Advise on discharge

a) **Avoid weight lifting on the operated limb**
b) **Avoid driving four wheeler for 3 weeks**

23.Follow up:

Duration after surgery	Range of movements	Quick Dash score	Complications if any
1 month			
3 months			
6 months			

MASTER CHART - PLATING

S.no	Age	Sex	I.p No.	Side	Classification	Closed/	Delay in days	Plate	Blood loss (ml)	Operative time(mins)	Wound size (cms)	Mobilisation	Duration of Hospital stay(days)	Clinical union (wks)	Radiological union(wks)	Complications	Shortening (cms)	Quick DASH			Outcome
					Robinson Type	open fracture		Precontoured/				Started on day						1 month	3 months	6 months	
								Recon													
1	58	M	16204	R	2BI	Closed	4	Precontoured	90	90	6	2	4	8	12	Nil	0.5	22.7	5	0	Excellent
2	28	M	12682	R	2BI	Closed	9	Recon	100	80	7	2	9	7	14	Superficial infection	0.3	20.5	10	0	Excellent
3	29	M	13684	L	2BI	Closed	10	Recon	100	80	8	2	9	8	13	Nil	0.5	13.6	4.5	0	Excellent
4	38	M	23162	L	2BI	Closed	9	Recon	120	80	8	2	7	7	15	Nil	0.5	32.5	6.8	2.3	Excellent
5	23	M	33504	L	2BI	Closed	9	Precontoured	85	70	7	2	8	8	13	Implant irritation	0.6	36.4	20.5	13.6	Good
6	21	M	78910	L	2BI	Closed	8	Recon	100	75	8	2	5	7	13	Nil	0.5	9.1	2.3	0	Excellent
7	33	M	46322	L	2B2	Closed	2	Precontoured	90	75	5	2	5	8	14	Nil	0.75	27.2	20.5	17.5	Good
8	56	F	47581	R	2BI	Closed	3	Recon	75	65	8	2	3	10	16	Superficial infection	0.1	54.5	52.7	52.3	Poor
9	35	M	47587	R	2BI	Closed	4	Recon	100	70	8	2	3	9	15	Nil	0.5	13.6	12.5	11.7	Good
10	45	M	68660	L	2B2	Closed	6	Precontoured	100	75	6.5	2	9	7	14	Nil	0.3	9.09	7.2	2.5	Excellent
11	29	F	65680	L	2BI	Closed	5	Precontoured	110	90	8	2	6	8	15	Implant irritation	0.1	13.6	9.1	2.3	Excellent

MASTER CHART-NAILING

S.no	Age	Sex	I.p No.	Side	Classification	Closed/	Delay in days	TEN nail size(mm)	Blood loss (ml)	Operative time (mins)	Wound size (cms)	Mobilisation	Duration of Hospital stay (days)	Clinical union (wks)	Radiological union (wks)	Complications	Shortening (cms)	Quick DASH			Outcome
					Robinson Type	open fracture						Started on day						1 month	3 months	6 months	
1	42	M	3581	L	2BI	Closed	4	2.5	60	70	3	2	2	8	13	Nil	0.5	12.5	2.27	2.27	Excellent
2	22	M	30989	R	2BI	Closed	10	2	50	70	5	2	9	7	12	Nil	0.25	0	0	0	Excellent
3	32	M	35903	L	2BI	Closed	8	2.5	75	70	5	2	4	7	12	Implant irritation (medial)	0.5	2.5	2.5	0	Excellent
4	31	M	48084	R	2BI	Closed	10	2.5	70	70	6	2	6	6	14	Lateral TEN protrusion	0.75	47.7	27.3	25	Good
5	22	M	49424	R	2BI	Closed	4	2	80	50	4	2	10	9	15	Superficial infection	0.4	34.1	17.5	13.6	Good
6	36	F	58024	L	2BI	Closed	5	2	75	45	4	2	5	8	12	Lateral TEN protrusion	0.75	18.2	17.5	12.5	Good
7	40	M	47026	L	2BI	Closed	2	2.5	80	80	5	2	5	7	12	Nil	0.5	2.27	0	0	Excellent
8	27	M	59725	L	2BI	Closed	4	2.5	45	60	6	2	4	8	14	Nil	0.5	2.27	0	0	Excellent
9	40	M	76606	L	2BI	Closed	2	3	25	40	3	2.5	2	8	13	Nil	0.25	32.5	4.5	2.5	Excellent