A COMPARATIVE STUDY OF

ANALYSIS OF FUNCTIONAL OUTCOME BETWEEN LOCKING PLATING AND CONSERVATIVE MANAGEMENT OF MIDDLE THIRD CLAVICLE FRACTURES

Dissertation submitted to

THE TAMILNADU Dr. M.G.R MEDICAL UNIVERSITY

CHENNAI - 600 032.

In partial fulfillment of the regulations for the award of the degree of

M.S. (ORTHOPAEDIC SURGERY)

BRANCH –II

KILPAUK MEDICAL COLLEGE
CHENNAI – 600 010.

APRIL – 2015

CERTIFICATE

This is to certify that **Dr. SAJEER MUSHRAK. M. K.**, Postgraduate student,(2012-2015) in the Department of Orthopaedic Surgery, Government Kilpauk Medica lCollege Hospital has done dissertation on- **A COMPARATIVE STUDY OF FUNCTIONAL OUTCOME BETWEEN LOCKING PLATING AND CONSERVATIVE MANAGEMENT OF MIDDLE THIRD CLAVICLE FRACTURES** under my guidance and supervision in partial fulfillment of the regulations laid down by **THE TAMIL NADU DR.M.G.R.MEDICAL UNIVERSITY, CHENNAI-32** for the **MS (Orthopaedic Surgery)** degree examination to be held in April 2015.

Prof.Dr.N.Nazeer Ahmed,M.S.Ortho.,D.Ortho.,
Professor and HOD
Department of Orthopaedics
Govt.Kipauk Medical College
Chennai-10

DR. N. GUNASEKARAN, M.D.,D.T.C.D.,
The DEAN,
Govt. Kilpauk Medical College,
Chennai-60001

DECLARATION

I, Dr. SAJEER MUSHRAK. M. K., solemnly declare that this dissertation entitled **"A COMPARATIVE STUDY OF FUNCTIONAL OUTCOME BETWEEN LOCKING PLATING AND CONSERVATIVE MANAGEMENT OF MIDDLE THIRD CLAVICLE FRACTURES"** is a bonafide work done by me at Government Kilpauk Medical College And Hospital, Chennai-10 between 2012-2015 under the guidance and supervision of our respected Head Of The Department and Unit Chief Prof. Dr. N. Nazeer Ahmed, M.S.Ortho, D.Ortho.

This dissertation is submitted to **"THE TAMILNADU DR.MGR MEDICAL UNIVERSITY"** CHENNAI-32, towards partial fulfillment of regulations for the award of M.S. Degree Branch II in Orthopaedic Surgery.

Place: Chennai

Date: **Dr. SAJEER MUSHRAK. M. K.**

ACKNOWLEDGEMENT

I express my utmost gratitude to Dean, **DR. N. GUNASEKARAN, M.D., D.T.C.D.,** Government Kilpauk Medical College and Hospital for providing me an opportunity to conduct this study and for permitting to use the hospital facilities for my study to the full extent.

It is with deep sense of gratitude that I submit my humble acknowledgement to my beloved Chief, teacher, mentor and guide **Prof. N. NAZEER AHMED, M.S.(Ortho)., D.Ortho., Head Of The Department Of Orthopaedics**, for his esteemed guidance, valuable suggestions.,under whom I have the great honour to work as a graduate student.

I would like to express my gratitude and reverence to our beloved **Chief Prof. K. Raju, M.S.Ortho., D.Ortho**., whose guidance and help has elevated me to this level to conduct this study successfully. I sincerely thank his expert guidance and constant encouragement to conduct this study.

I sincerely thank **Prof. S.Anbazhagan, M.S.(Ortho)., D.Ortho.,** Professor of Orthopaedics, Govt. Royapettah Hospital, Chennai, And **Prof. R.Balachandran, M.S. (Ortho)., D.Ortho.,** Professor of

Orthopaedics, Government Royapettah Hospital , for their expert guidance and constant support.

I am using this opportunity to express my gratitude to all myAssistant Professors **Dr.Samuel Gnanam M.S.Ortho., D.Ortho., Dr.S.S.Sukumaran M.S.Ortho., D.Ortho., Dr. G.Mohan M.S.Ortho., Dip.N.B.Ortho., MNAMS., Dr. Anantharaman. C., M.S.Ortho , Dr. S. Prabhakar M.S. Ortho., D.Ortho., Dip.N.B. Ortho., Dr. Karu Shanmuga Karthikeyan M.S.Ortho.,** for theiraspiring guidance, invaluably constructive criticism and friendly advice during the course of the study.I am deeply indebted to all my teachers who have patiently imparted the benefits of their research, clinical experience and stood by me through the study, without which this study could not have been completed. I express my sincere thanks to all of them.

I thank **Dr. P. Thirunavukarasu**, Chief, Department of Physical Medicine and Rehabilitation, for his support and help in completing this study.

I wish to express my thanks to postgraduate colleagues, staff members of Department of Anaesthesia, Radiology, theatre staffs, other staff members of the hospital and my family for the help they have rendered.

I would like to thank all my patients for their full cooperation for this study without whom this study would not have been possible.

Above all it is the blessings of the Almighty that made this study a successful one and toHim I offer my sincere prayers.

TITLE: A COMPARATIVE STUDY OF ANALYSIS OF FUNCTIONAL OUTCOME BETWEEN LOCKING PLATING AND CONSERVATIVE MANAGEMENT OF MIDDLE THIRD CLAVICLE FRACTURES.

ABSTRACT:

INTRODUCTION

Clavicle fractures are of the common injuries accounting for 2.6% to 4% of all fractures with an overall incidence of 36.5 to 64 per 1,00,00 people per year. The most common site of fracture in the clavicle occurs at the middle third and which accounts for almost 80% of all clavicle fractures. Historically conservative treatment has remained the main forte of clavicle fractures for orthopaedic surgeons. Locking plating is the latest implant used in the treatment of clavicle fractures. Recent studies have highlighted a non union rate of 15% with 32% of patient dissatisfaction.

AIM OF THE STUDY

To compare and analyze the functional outcome between locking plating and conservative management of middle third clavicle fractures.

MATERIALS AND METHODS

This comparative study is conducted in Govt. Kilpauk Medical College from October 2012 to July 2014. About 46 patients with middle third clavicle fractures were randomly classified into two groups Surgical group and Conservative group

treated with anatomical precontoured locking compression plate and figure of eight bandage respectively. After radiological evaluation, fractures were classified using Robinson classification and the cases belonging to Robinson type 2B fractures were included in the study. 23 patients in surgical group and 23 patients in conservative group were treated. Out of this, 3 patients from each group missed the follow up and so we included 20 patients in each group for this study. Average follow up for surgical group was 11.65 months and conservative group was 11.85 months. We analyzed the functional outcome using Constant – Murley shoulder score and DASH questionnaire.

RESULTS

After proper analysis and statistical comparison we obtained a p-value of 0.005 in Constant score and < 0.001 in DASH score which is considered significant (significance of p-value determined as < 0.05). Individual parameters obtained in the study showed a better functional outcome in surgical group in both constant and DASH scores. Complications included 5 malunions and 2 nonunions in conservatively treated group where as, all fractures went for union in surgical group. Superficial infection in two cases and numbness in the surgical area in one case was noted in surgical group. Infection resolved in one week of intravenous antibiotics and numbness resolved 11 weeks post operatively.

CONCLUSION

Our study showed improved DASH score, better constant score, early return to work and decreased nonunion and malunion in surgically treated Robinson type 2B midshaft clavicle fractures compared to conservatively treated group. Hence, we conclude that surgical fixation using anatomical pre contoured locking compression plate in midshaft clavicle fractures (Robinson type 2B) in active adults gives better functional outcome, early return to work, decreased nonunion and malunion and saves man-hour.

KEY WORDS

Middle third clavicle fractures, Anatomical pre contoured locking compression plate, Robinson classification, DASH score, Constant- Murley score.

CONTENTS

INTRODUCTION

INTRODUCTION

Clavicle fractures are one of the common injuries accounting for 2.6% to 4% of all fracture with an overall incidence of 36.5 to 64 per 1,00,00 people per year[1,2]. The most common site of fracture in the clavicle occurs at the middle third and which accounts for almost 80%of all clavicle fractures[3].

Despite having hundreds of years of documented clinical experiences with the treatment of these injuries, controversy still exists about their optimal management. Traditionally, midshaft clavicle fractures were treated non-operatively even when it was markedly displaced.

Historically, conservative treatment has remained the main forte of treatment of clavicle fractures for orthopaedic surgeons. The culture of orthopedic surgery training has fostered a “benign neglect” approach to their management despite a paucity of validated, patient-oriented outcomes to support this position. In fact, the phrase “clavicle fracture” to orthopedic surgeons, often invokes images of simple injuries, simple treatments, and favorable outcomes[9].

Based on previous clinical studies, the nonunion rate was less than 1% [3, 4]. However, in a latest study of 52 displaced midshaftclavicular

fractures it has projected a nonunion rate of 15% that is eight patients with a 31%(sixteen) of unsatisfactory functional outcome. Another study of 68 patients reported a 32% (twenty two) dissatisfaction. These values reported are obviously much higher than previously reported rates[4,5].

But, most of these studies has been about surgical intervention which has failed to project the decreased residual function and patient oriented dissatisfaction in non surgical group[5,-8]. Furthermore, patients with malunion or nonunion are at higher risk of developing substantial residual disability of the affected limb[5-12]. Moreover, malunion of the clavicle has been found to be a definite clinical entity [13].

Numerous latest studies have been concentrating on evaluating the efficacy and safety of primary open fixation for midshaft clavicular fractures which are displaced and have come out with a high union rate and less complication rate[6-8].A varieties of surgical techniques aredescribed for the treatment of middle-third clavicle fractures,with the likes of, plating, Kirschner-wire fixation, knowles-pin fixation, and elastic intramedullary nailing[10] .

Novak and Larsson et al. in one of their studies stated that plating will be the logical choice for comminuted clavicle fractures and even for nonunion[14]. But, the plate fixation poses challenge both anatomically

and technically. Anatomically the neurovascular structures that lies beneath the clavicle has been the main concern for surgeons in carrying out the plate fixation.Technically, it is difficult because the clavicle has a very complex anatomy with an S-shaped curvatureand also has a cephalad-to-caudad bow.

Most of the outcomes in recent studies have been favouring surgical fixation of the displaced clavicular shaft fractures. It has highlighted areducedmalunion and non-union with improved functional outcome rates compared with non-operative treatment. Usually the reason for a second surgery in the operative group was for hardware removal due to the complex anatomy and its immediate subcutaneous location [(14)].

The locking property has got certain advantages for clavicular fixation. In particular, a single construct of plate and screws in locking plates enhances its ability to resist the high torque on the outer segment which is inferiorly directed leading to less plate pullout[(11,12)].

In this comparative study we have analysed and compared the functional outcome of patients with midshaft clavicle fractures, treated with locking plate and conservatively.

AIM OF THE STUDY

AIM OF THE STUDY

The aim of the study is to "***TO ANALYSE AND COMPARE THE FUNCTIONAL OUTCOME BETWEEN LOCKING PLATING AND CONSERVATIVEMANAGEMENT OF MIDDLE THIRD CLAVICLE FRACTURES***"at the Department of Orthopaedics, Government KilpaukMedical College, between October2012 and July 2014.

HISTORICAL REVIEW AND LITERATURE

HISTORICAL REVIEW AND LITERATURE

Hippocrates stated that the patient with a fractured clavicle could be treated with observation and that the treating physician would not be "sorry at the neglect of the patients," for, although deformity was universal, healing and return to normal function were equally expected[46].

The Ancient Egyptians were the first to report on the management of clavicle injuries. Reports of the non-operative treatment of clavicle fractures dates back to the Edwin Smith Papyrus, written in the 17th century BC[13].The figure of eight bandage is known to be the most common closed method of treatment of clavicular mid-shaft fractures.

Falls related with bicycling and skiing sports are usually the most common causes of clavicle fractures[14].Andersen et al. in his study series analyzed and compared seventy-nine patients with mid-shaft clavicular fractures treated with a simple sling and figure of eight bandage in a prospective study. He, observed that cosmetic and functional results in both types of treatment were identical and in healed fractures the alignment of initial displacement were unchanged . Further he went on to say that treatment of these injuries with a simple sling caused fewer complications and less discomfort in patients than it was with the figure of eight bandage [19].

Lazarides and Zafiropoulos et al. in a retrospective study reviewed 132 patients with united midshaft clavicle fractures following conservative treatment. Thirty four patients (25.8 %) among them were not satisfied with the result of their treatment. They further stated that ultimate clavicular shortening at the end of the study revealed a significant association with unsatisfactory results. Clavicular shortening with amean of 14.4 mm in male and11.2 mm in female patients were noted[20].

Mostly all of acute fractures were used to be treated conservatively. Nowadays, the treatment has become more interventional in certain patterns or types of clavicle fractures, thus involving surgery[15].

Nordqvist et al. evaluated, a clinically significant post fracture shortening of the clavicle in 85 patients and he concluded that permanent shortening of the clavicle is much more commonly seen post fracture, but keeps no clinical significance [47].

In 2007 Canadian Orthopaedic Trauma Society conducted a multicenter, randomized clinical trial in which they compared the patient oriented outcome and complication rates after plate fixation and conservative treatment of displaced mid shaft clavicular fractures. 132 patients were included in the study all with displacedmid shaft clavicular

fractures which were randomized to either surgical fixation with or conservative management. Constant shoulder score, DASH(disability of arm, shoulder and hand) questionnaire, standard clinical follow-ups and radiographs were used for the analysis of the outcome. The study showed that operative fixation of displaced clavicular fracture resulted in improved functional outcome and decreased malunion and nonunion rates compared with that of the conservative treatment outcome after 1 year follow up[(16)].

Hill et al. did a study on 52 cases of conservatively treated adults with mid-shaft clavicle fractures at a mean of 38 months after injury. Unsatisfactory results were reported by sixteen patients (31%) following non operative treatment. The fracture shortening of ≥20 mm at initial stage showed high significant association with nonunion ($p < 0.0001$) and thus increasing the chance of an unsatisfactory result. Shortening of 20 mm or more finally following fixation was associated with an unsatisfactory result, but not with nonunion. No other patient variable, fracture characteristic or treatment factor had a significant effect on final outcome[(5)].

WgCdr v kulshrastha et al., in 2008 concluded that displaced comminuted mid shaft clavicular fracture treated with internal fixation leads to predictable and early return to function and therefore preventing

unacceptably high complication rates following a non-operative procedures[17].

In 2009 L.A. Kashif Khan et al., concluded that non-displaced fractures of both the midshaft and the lateral end of the clavicle following non-operative treatment have a high union rate with good functional outcome .Though non-operative treatment of displaced clavicle middle third fractures have higher chance of more nonunion and functional deficits than previously reported, still it is not clear which of these conservatively treated patients will have these complications. Although, operative treatment of nonunion or malunion may result in better functional outcome than conservative, still there is genuine and considerable debate on about the outcome of primary operative treatment of clavicle fractures[18].

In 2011 Olivier A. van der Meijden et al., stated that surgical treatment of midshaft clavicle fractures provides better outcome, thus becoming more desirable and satisfactory over the past 2 decades. A meta-analysis of current data on nondisplaced fractures treated by plate fixation compared to intramedullary pin fixation mentions a relative risk reduction of 72% and 57% respectively for nonunion when compared with that of the non-operative treatment. Furthermore, it stated that in

case of displaced fractures, the relative risk reduction increased to 87% and 86%, respectively[19].

According to some old literatures the incidence of nonunion following midshaft clavicle fracture has been described as 1 % or less[4].Nowak et al. observed a nonunion rate of 7% in a prospective study of 208 patients treated without surgery [22].

15% nonunion rate was reported by Hill et al. in a study of 52 patients with displaced midshaft clavicle fractures treated non operatively. All clavicular fractures having an initial shortening of greater than 2 cm resulted in nonunion[22].

Zlowodzki et al. evaluated 2144 patients with midshaft clavicle fractures in a meta-analysis and reported a non-union rate of 15.1 % following conservative treatment [28].

In a literature, a nonunion rate of 2.2 % is described in midshaft clavicle fractures, treated with plate fixation. According to the above results, 86% risk reduction for non-union could be achieved with plate fixation in comparison to non-operatively treated clavicle fractures[28].

Patient dissatisfaction is highly common in case of non-union; the reason being severe symptoms frequently associated with it. The daily routine activities as well as job was affected by weakness, easy fatigue and scapular winging.

McKee et al. evaluated the functional results of corrective osteotomy of mal-united clavicular fractures in patients with chronic disorders. Fourteen among fifteen patients with the corrective osteotomy resulted in a high degree of satisfaction and improved patient-oriented upper-extremity scores, where the mean shortening of the clavicle showed improvement from 2.9 to 0.4 cm [(29)].

Narrowing of the space between the clavicle and first rib for any reason can cause compression of the subclavian vessels or brachial plexus. Stienberg, Lord and Rosati et al. noted that the fracture of the clavicle healing with inferior and posterior displacement of the distal fragment may cause such compression [(30)].

Altamimi, Mckee et al. in a recent multicenter randomized clinical trial of 132 patients with displaced midshaft clavicle fracture reported an improved functional outcome and reduced malunion and nonunion rates in surgically fixed group as compared with non-operative treatment[(24)]

Due to the three dimensional morphology, functional anatomy and multidimensional forces, the contoured two dimensional plate on the superior surface cannot completely limit displacement [(31, 32, 33)], whereas the three dimensional fixation better addresses the functional anatomy of the clavicle [(34)].

ANATOMY

SURGICAL ANATOMY

OSSIFICATION

In 1913 - **FAWCETT J** described ossification and development of clavicle.

It has two primary and one secondary center.

Clavicle is the first fetal bone to undergo primary ossification, and its medial epiphysis is the last to fuse.

Ossification of clavicle is through intramembranous ossification having no prior endochondral ossification.

There are two primary centers of the clavicle. Both of which appears between 5^{th} and 6^{th} weeks of intrauterine life.

They fuses at about 45^{th} day after birth.

The secondary center of clavicle appears at 15-17 years and fuses at 20-22years.

ANATOMY

The clavicle connects the upper limb to the trunk. It contains two curves in horizontal plane. The medial half of clavicle is convex anteriorly, and its medial end is triangular and enlarged. It articulates with the manubrium sterni at this junction at sternoclavicular (SC) joint. Lateral half of the clavicle is concave anteriorly with flat lateral end. At acromioclavicular (AC) joint it articulates with the acromion of the scapula. Two thirds of the medial end of the clavicle has convexity anteriorly. It is concave and flattened anteriorly in the lateral one-third. All the curvatures of the clavicle increases it's resilience and it getsthe shape of an elongated capital *S.*

In the coronal view, the clavicle is visible as a slender bone. It has got parts which are wider medially at its medial end and laterally it is seen thinner. However in the axial view, the three-dimensional structure appears more evident. The clavicle takes a gentle S-shape. It shows two curvatures, with a forward directed convexity at the medial end and has concavity at the scapular end. Lateral third of clavicle from above downward is flattened while the medial two-third is in prismatic or rounded shape.

Medial and lateral flat expanses, have been noted in clavicle, between which lies a tubular middle part. And this middle part forms the weak link in the shape of clavicle. The midshaft of the clavicle is hence the most common site of fracture [2.

In sagittal view, the scale of anterior to posterior transition is seen clearly.

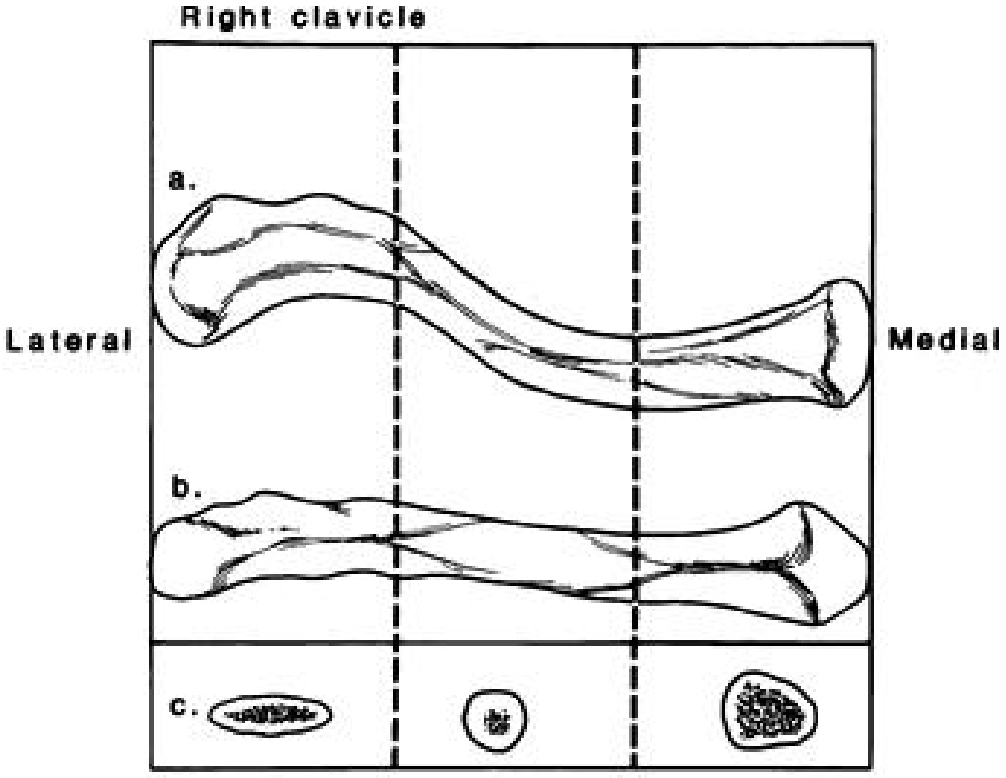


FIGURE 1, A-SUPERIOR VIEW; B-FRONTAL VIEW;

C-CROSS SECTIONS OF CLAVICLE

Lateral One-Third of clavicle:

The lateral one-third of clavicle contains:

- 2 surfaces → the surfaces are an upper and a lower.

And

- 2 borders →the borders are an anterior and a posterior .

Surfaces:

Upper surface-

It is a rough and flat surface. In front it has got markings for the attachments of the Deltoid muscle with Trapezius behind. Between these two markings a part of clavicle remains subcutaneous.

Lower surface-

The lower surface of clavicle is flat.

Coracoid tuberosity-Posterior border of clavicle has a rough eminence formed by the joining of prismatic end and flattened portion, and this forms the coracoid tuberosity (conoid tubercle), with the attachment of conoid ligament.

An oblique or trapezoid ridge is seen at posterior border which runs forward and laterally and provides attachment for the trapezoid ligament.

Borders:

It has got two borders

1) Anterior border-

It is thin with rough character and has a concavity in the shape. It provides the area for Deltoid muscle attachment.

2) Posterior border-

It is thicker compared to anterior with a similar rough character. But has a convexity in the shape. Trapezius muscle is attached to it.

Medial Two-thirds

The medial two-thirds of clavicle contains the rounded portion of the bone. It is curved in shape with convex appearance from front and concave from behind. It has got three surfaces and three borders.

Borders-

1) Anterior

2) Superior

3) Posterior

Surfaces-

1)Anterior

2)Posterior

3)Superior

Borders

Anterior border

It extends along with the anterior margin of the flat portion. It has a lateral smooth part which marks the gap between the attachments of the Pectoralis major and Deltoid.

Lower boundary of an elliptical surface is formed by its medial part and also provides the site for the attachment of the clavicular part of the Pectoralis major.

Superior border

It is moves along with the posterior margin of the flat portion. Two surfaces anterior and posterior are separated by this border. Lateral part of it is rounded and smooth but as it goes towards the medial third, becomes rough. This roughness is for the attachment of the Sternocleidomastoid. It then ends at the upper angle of the sternal extremity.

Posterior or **Subclavian border-**

It separates inferior from posterior surface. It extends from the coracoid tuberosity to the costal tuberosity. It creates the posterior boundary of the groove for the Subclavius. A layer of cervical fascia which envelops the Omohyoid has got the attachment to it.

Surfaces

Anterior surface

It is formed by the bone between the superior and anterior borders. It has a medial and lateral part. Medial part is further divided into an upper and lower surface. Lower is elliptical in shape with directing forward where Pectoralis Major muscle gets its attachment and upper provides attachment for sternocleidomastoid muscle. Lateral part looks upward, and has continuity with superior surface of the flattened portion. It is convex , smooth and almost subcutaneous with Platysma cover alone.. and an upper for the attachment of the Sternocleidomastoid.

Posterior or **Cervical surface**

This surface is smooth and glances towards back to the root of the neck. It is stopped,

Medially- by the margin of the sternal extremity

Laterally- it is limited by coracoid tuberosity.

Above- limited by the superior border;

Below- limited by the subclavian border;

It is medio-laterally concave and has a relation with the transverse scapular vessels by its lower part. This surface is also in relation with the subclavian vessels and brachial plexus of nerves. Near the sternal end, a part of the Sternohyoid is attached to it. It lies directed laterally near the middle, an oblique foramen which passes the chief nutrient artery of the bone. Sometimes posterior surface presents with two foramina and sometimes has one each on the posterior and inferior surface.

I**nferior** or **Subclavian surface**

It is surrounded by the anterior border in front and by the subclavian border behind. Medial part is narrowed with increased width in the lateral aspect. It has continuity with the under surface of the flat portion. The medial part has the attachment of costoclavicular ligament to the costal tuberosity or rhomboid impression with a length of more than 2cm which makes the surface rough and broad. The remaining part has a groove with Subclavius attached to it. Subclavius which is enclosed by coracoclavicular fascia is attached to the margins of the groove. Most of the time this groove gets divided further by a longitudinal line where the intermuscular septum of subclavius gets attached.

The Sternal Extremity

The sternal extremity of the clavicle is triangular in shape. It is directed medially, a little forward and downward. It contains an articular facet which from above downward is convex and from front to back is concave. It articulates with manubrium sterni through an articular disc intervention. The facet's lower part has articulation with the cartilage of first rib. This articulating area is a semi oval shaped continuation of lower part of facet on to inferior surface. The rough articular surface has numerous ligamentous attachment with upper angle having the attachment to articular disc.

The Acromial Extremity

The acromial extremity has articulation with acromion of scapula.It has a small oval and flat surface with an oblique downward direction. The articular facet is rough with the attachment of acromioclavicular ligaments.

The medial clavicular end forms the lateral part of the sternoclavicular joint. Several layers of ligaments support this articulation of which some are extremely important in terms of fracture anatomy and displacement. Recent studies has determined that the

posterior capsule serves as the most important structure in resisting both anterior and posterior translation at the sternoclavicular joint.

The interclavicular ligament extends from the medial aspect of one clavicle to the superior part of the sternum to the opposite clavicle. The shoulder elevation results in the loosening of the ligament but prevents downward displacement of the lateral end of the clavicle by providing with adequate support.

Costoclavicular Ligament runs from the upper part of the first rib and adjacent part of the sternum to the inferior aspect of the clavicle. The medial clavicle is stabilized by costoclavicular ligament. Its anterior fibers prevents upward rotation while the posterior surface prevents downward rotation.

The trapezoid and conoid ligaments are very two important ligaments which are very strong and thick with one end attached to the coracoid process and the other one to inferior part of lateral clavicle. Trapezoid is attached laterally on clavicle on a ridge while conoid attaches to clavicle medially onto conoid tubercle. Both ligaments are very important in suspension of the shoulder girdle from the clavicle.

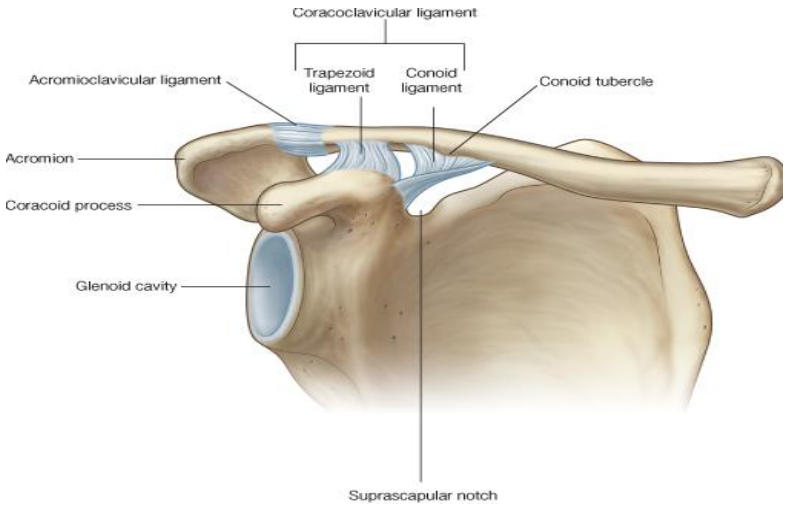


FIGURE 2, TRAPEZOID, CONOID AND ACROMIOCLAVICULAR LIGAMENTS

Acromioclavicular ligaments, one of the main ligaments of shoulder is formed by the capsule of acromioclavicular joint. Anteroposterior (AP) displacement of the distal clavicle is prevented by this ligament[(48)]. Recently a biomechanical study proved that the anterior-posterior translation is prevented by acromioclavicular capsule[(49)]. Moreover, disruption of acromioclavicular ligaments resulted in the differential loading on the coracoclavicular ligaments. Posterior loading was prevented by trapezoid ligament. Conoid ligament prevents anterior and superior loading.

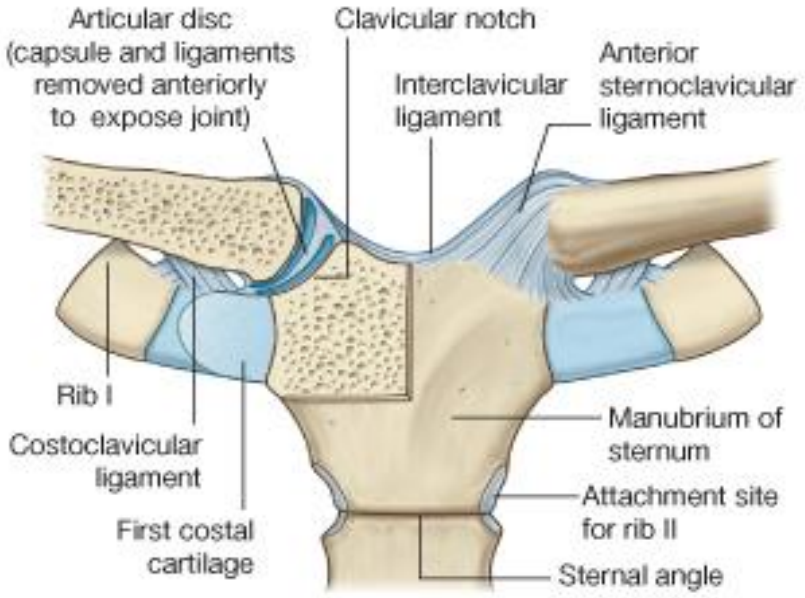
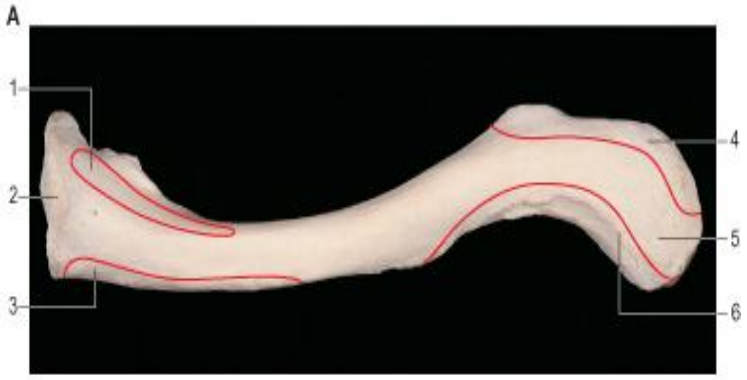


FIGURE 3, STERNOCLAVICULAR JOINT

Pectoralis major and sternohyoidmuscles are attached to medial part of the clavicle. The superomedial clavicle has attachment of sternocleidomastoid (Figure 4). In a middle third clavicle fracture, clavicle is elevated medially by the sternocleidomastoid. Subclavius muscle attaches to middle part of the clavicle at its undersurface. Clavipectoral fascia is attached to the edges of the groove, the posterior edge of the groove runs to the conoid tubercle where fascia and conoid ligament merge. Lateral to the groove there is a laterally inclined nutrient foramen, running in a lateral direction. The nutrient artery is derived from the suprascapular artery.

Laterally, the anterior deltoid muscle is attached to the anterior aspect of clavicle. Trapezius is attached to posterosuperior aspect of clavicle. Platysma originates over pectoralis major and deltoid and inserts on mandible, muscles of mouth and skin. On the course of this patysma crosses clavicle's superficial anterior surface. Midshaft clavicle is approached in case of open fixation by incising of platysma.

The female clavicle compared to male is shorter and thinner. It is also less harder and curved. Sternal end is at a higher level than acromial end. But in case of males, the dependent position of the arm shows acromial end on be on level with, or slightly at higher level. Manual workers have more thicker clavicle with more curves and better marked ridges[50].



1. Sternocleidomastoid (clavicular head). 2. Sternal end. 3. Pectoralis major. 4. Trapezius. 5. Acromial end. 6. Deltoid.

FIGURE 2, SUPERIOR SURFACE WITH ITS MUSCLE ATTACHMENTS

1. Pectoralis major. 2. For costoclavicular ligament. 3. For first costal cartilage. 4. For sternum. 5. Sternohyoid. 6. Subclavius. 7. Deltoid. 8. For acromion. 9. Trapezoid line. 10. Trapezius. 11. Conoid tubercle.

Figure 3. INFERIOR SURFACE WITH ITS MUSCLE ATTACHMENTS

NEUROVASCULAR ANATOMY

Supraclavicular nerves are one of the main structure on the anterior surface of clavicle. These are branches of cervical plexus. Origin is as a common trunk at the level of posterior border of sternocleidomastoid. Jupiter and Ring et al. reported that it is important to locateand preserve spraclavicular nerves during surgical approach to the midclavicle[51]. Superficial surface of clavicle gets anterior, middle and posterior nerves lying over it deep under platysma.

The clavicle as a bone protects subclavian vesels, jugular vessels and brachial plexus from getting injured. Inferior border of posterior triangle of the neck is formed by the superior surface of clavicle at its

middle two third. The triangle contains subclavian artery and brachial plexus. Hence the midshaft clavicle fractures can cause neurovascular injuries as the proximity of these structures are clearly stated.

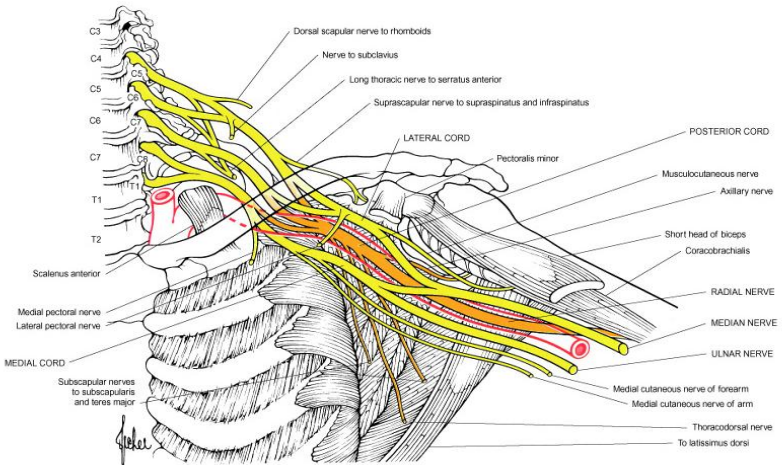
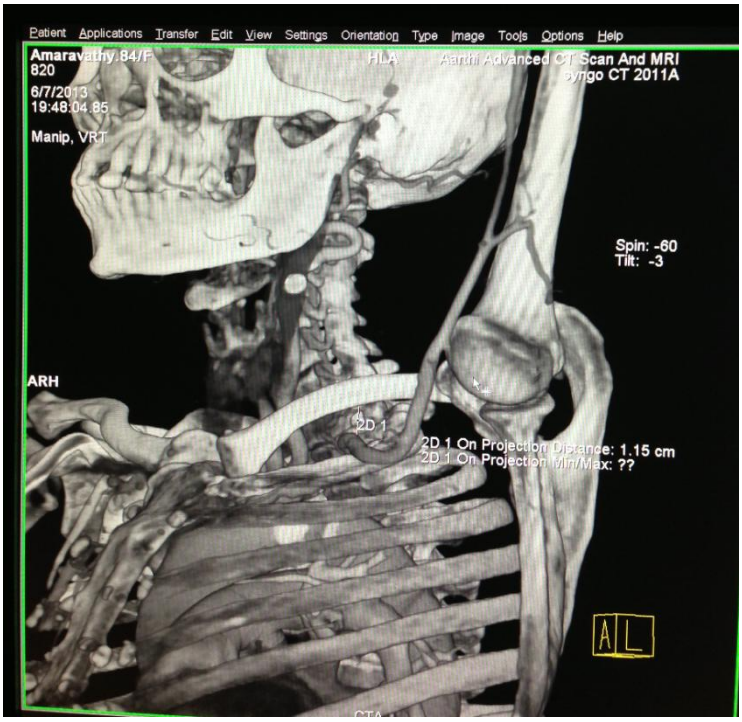
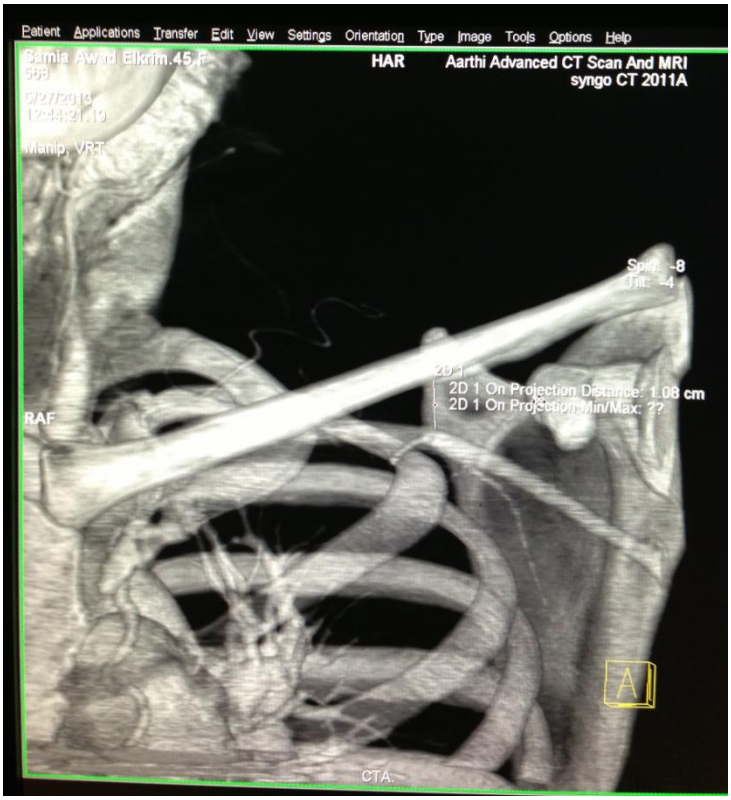


FIGURE 4, NEUROVASCULAR ANATOMY BELOW THE CLAVICLE

Robinson and Federico et al. did a study on cadavers to analyze relation of subclavian vessels from clavicle and concluded that subclavian artery lies within 2cms from midshaftclavicle[(66)]**.**This study is really helpful and useful in keeping the surgeons alert of the subclavian vessels passing beneath clavicle during clavicle surgery. Especially at middle third as it is much closer here than it is with the rest of the clavicle.





RELATION OF SUBCLAVIAN VESSELS TO CLAVICLE.

FUNCTIONS OF CLAVICLE

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

It serves as a moveable, crane-like (rigid support) from which the scapula and free limbs are hanging down providing them with maximum freedom of motion by keeping scapula and limbs away from the trunk. Having this grandstand allows the shoulder to move and touch cross-body, provides internal rotation positions without creating any medial collapse.

This function of the clavicle allows the thoraco humeral muscles to maintain their optimal working distance in a way similar to that of wrist extension which permits optimal muscle-tendon unit length for power grip. Hence, the clavicle increases the strength of shoulder girdle movements [(52)].

Transmits shocks (traumatic impacts) from the upper limb to the axial skeleton. Study done by Robinson and Federico et al. on relationship of neurovascular structures to clavicle has made surgeons to be more aware of the neurovascular bundles passing beneath to perform surgery of clavicle better while passing drill, depth gauges and clamps.

They stated that the neurovascular structures are more closer at the middle third of clavicle with < 2cm and distance increases at lateral and medial ends.

MECHANISM OF INJURY

Stanley et al. in his study of 122 patients found that in 94% among them, had direct blow resulting in the clavicle fracture rather than a fall on the outstretched hand. Falling on outstretched hand is believed to be the most common mechanism of injury [53].

Jeray et al. and Kotelnicki et al. published that , clavicle injury due to falling on outstretched hand represents only 2% to 5% of all clavicle injuries. Although it was previously believed to be the most common cause of injury[20,21].

- **Direct Trauma**

The direct trauma, either blunt or penetrating, is not dependent of any muscular forces or arm position. Clavicle is vulnerable through out.

Bicycling and skiing are the most common sporting items which may result in direct trauma to the clavicle. Falls as a result of such sports causes most of the clavicle fractures[22].

Cummings et al.in his research confirmed that clavicle fractures resulting from a fall on an outstretched hand was not so common [36].

Radial neck dissection in cases of carcinoma results in stress fractures of clavicle[36 - 39]. Medial third is the most common site for athletic-related stress fractures[40,41].

- **Indirect Trauma**

Initial description by Allman for clavicle classification stated that a fall on to point of shoulder or fall on outstretched hands were the common mechanism causing the injury of clavicle.[42].

Latest data suggests that predominant cause of clavicle fracture is direct trauma unlike which was believed earlier. Stanley et al. in his study confirmed the claims made by other authors that main reason for clavicle fracture is direct trauma[43 - 45].

FRACTURE BIOMECHANICS

For lateral fractures, the displacing forces are as follows (Figure 7):

- Medial on the distal segment through the pull of the pectoralis major, pectoralis minor and latissimus dorsi.
- Inferior on the distal segment through the weight of the arm.
- Superior on the medial segment through the sternocleidomastoid and trapezius.

For a midshaft clavicle fracture, the displacing forces are as follows (Figure 8):

- Superior on the medial segment through the sternocleidomastoid.

  Inferior and medial on the lateral segment through the pectoralis major.
- Stabilizing on the medial segment by the sternoclavicular ligaments.
- Inferior on the lateral segment through the weight of the arm pulling through the coracoclavicular ligaments.

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

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 scapulothoracic joint and the clavicle rotates, relatively lengthens, and moves through an arc of 60^0.

The middle third lateral third junction is the thinnest part of the bone and the only area not protected by or reinforced by the muscles and ligamentous attachments. It is also the area subjected to the greatest bending and torsional stresses. These anatomical features make it prone to fracture, particularly with fall on the point of the shoulder, resulting in an axial load to the clavicle.

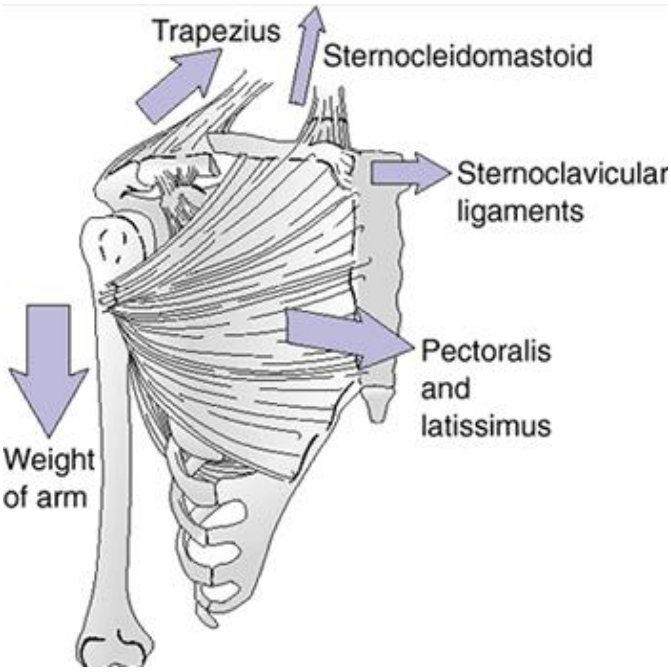


FIGURE 7, DISPLACING FORCES FOR LATERAL THIRD FRACTURE

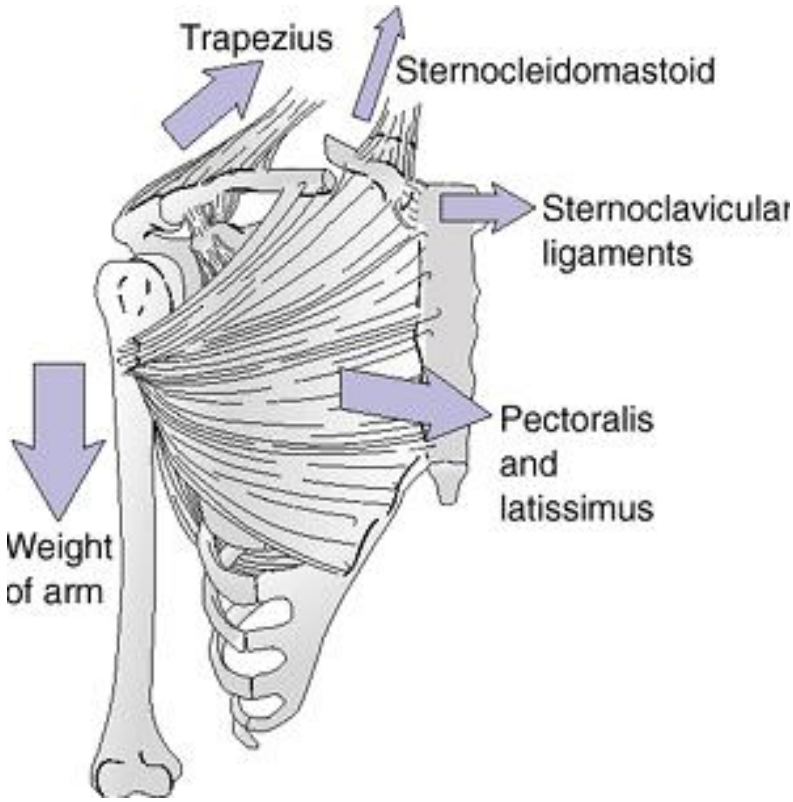


FIGURE 8, DISPLACING FORCES FOR MIDSHAFT FRACTURE

CLASSIFICATION OF CLAVICLE FRACTURES

ROBINSON CLASSIFICATION OF CLAVICULAR FRACTURES (Figure 9)

TYPE 1 – MEDIAL CLAVICE

A- fracture is nondisplaced

A1-extraarticular

A2-intraarticular

B-fracture isdisplaced

B1-extraarticular

B2-intraarticular

TYPE 2 – MIDDLE CLAVICLE

A-cortical alignment

A1-nondisplaced

A2-angulated

B-displaced fracture

B1- consists of simple or single butterfly fragment

B2- is a comminuted or segmental fracture.

TYPE 3-DISTAL CLAVICLE

A-nondisplaced fracture

A1-extraarticular fracture

A2-intraarticular fracture

B-displaced fracture

B1-extraarticular fracture

B2-intraarticular fracture.

Advantages:

- Traditionally followed practice of dividing in thirds is maintained.
- It contains prognostically relevant variables such as degree of comminution, intra articular extension and degree of displacement .
- It is formulated in a number scheme which is very easy to recall.

Disadvantages:

- Unusual fracture types not included

The number scheme is different from that used by Allman, Craig and Neer.

ALLMAN CLASSIFICATION [(42)]

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 DIVIDING ALLMAN'S GROUP II INTO THREE DISTINCT TYPES[(54,55)].

1968 - **NEER** described fractures of distal third clavicle fractures.

TYPE I : Contains intact Coracoclavicular ligaments.

TYPE II : Trapezoid is intact .Coracoclavicular ligaments rupture from the medial segment.

TYPE III : Intra-articular extension present. Extending into the acromioclavicular joint.

ROCKWOOD DIVIDED NEER'S TYPE II FRACTURE OF THE DISTAL CLAVICLE [56]

TYPE IIA

Both the conoid and trapezoid remain attached to the distal segment.

TYPE IIB

Torn conoid making medial segment unstable.

Advantages

- Combines the Allman and Neer classes
- More descriptive and functional
- Including more unusual injuries.

Disadvantages

- No subclassification for middle third fracture

NORDQVIST AND PETERSSON CLASSIFICATION [57]

- Allman Types I to III are maintained.
- Each type is then further divided based on fracture displacement as displaced and non displaced.
- Type I group (middle), a final subgroup of comminution is given.

Advantages

Midshaft fracture group which is most common and important is described further.

CRAIG CLASSIFICATION (Figure 10)

GROUP I : Middle third fracture.

GROUP II : Distal third fracture.

TYPE I - minimal displacement (interligamentous)

TYPE II - displaced occurs secondary to fracture with fracture medial to the coracoclavicular ligaments.

(A) Conoid and trapezoid remains intact.

(B) Conoid is torn but trapezoid remains intact.

TYPE III - Intra articular fractures.

TYPE IV - periosteal sleeve fracture as seen in children.

TYPE V - comminuted fracture with ligaments attached to the comminuted fragment.

GROUP III : Fractures of the proximal third

TYPE I - minimal displacement

TYPE II - displaced (ligaments ruptured)

TYPE III - intra-articular

TYPE IV - epiphyseal separation (children and young adults)

TYPE V - comminuted

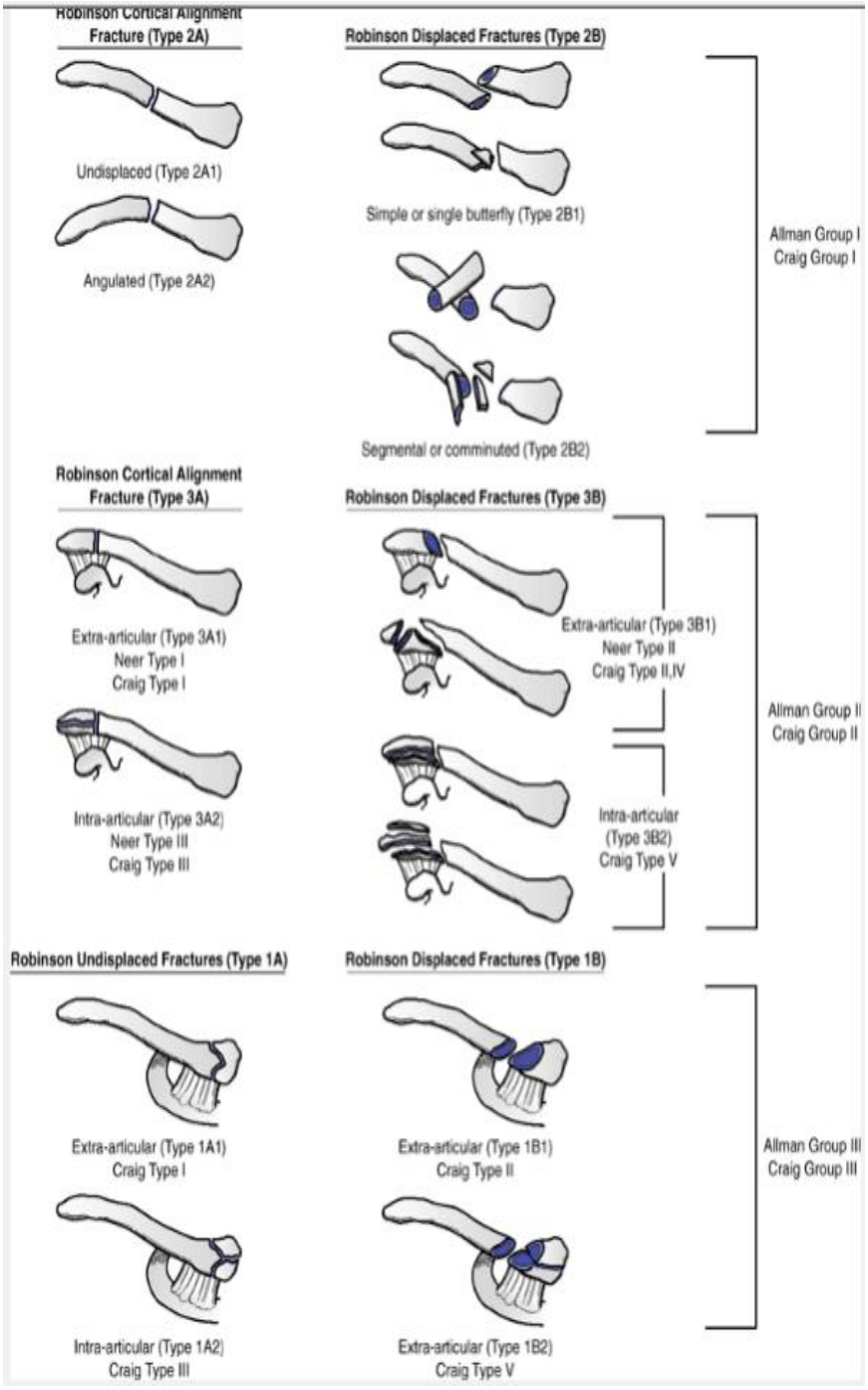


Figure 9, ROBINSON, CRAIG AND ALLMAN CLASSIFICATIONS

CLINICO-RADIOLOGICAL EVALUATION

Examination for associated injuries is a must. It is very important to rule out the ipsilateral scapula injuries, upper ribs injuries, brachial plexus and vascular injuries.

RADIOGRAPHS

- 1926 - **QUENSA** described special x-ray views.
- AP view.
- Serendipity view: to evaluate medial third fractures when it extends into the sternoclavicular joint.
- An axillary radiograph: to evaluate intra-articular Type III fractures.
- An apical oblique: a bump or roll is placed under the contralateral scapula, which places the involved scapula flat against the radiographic cassette. The beam is then angled 20 degrees cephalad, which brings the clavicular image away from the thoracic cage.
- CT scan: for evaluating medial and lateral third fractures.

VARIOUS MODALITIES OF TREATMENT

1. **Non operative treatment**
2. **Operative treatment**

NON OPERATIVE TREATMENT

The Ancient Egyptians were the first to report on the management of these injuries. Reports of the non-operative treatment of clavicle fractures dates back to the Edwin Smith Papyrus, written in the 17th century BC.[13]. Here it is recorded that the patient with a clavicle fracture should be placed “prostrate on his back with something folded between his shoulder blades . . . with his two shoulders to stretch apart his collar bone until the break falls in its place. Place two splints of linen, one on the inside and the other on the underside of his arm. Thou shouldst bind it with yarn, (and) treat it afterward with honey every day, until he recovers.” With the exception of treating these fractures with “honey” this description of a “figure-of-eight” brace (Figure 1) has not evolved much in almost four millennia despite advancements in surgical and medical management of other maladies.

1. Traditionally the majority of clavicular fractures are treated effectively with nonoperative means, but the functional and cosmetic results falls short of expectations.

2. About 10-35% loss of shoulder strength functions were noted.

3. High prevalence of symptomatic malunion and nonunion after non-operative treatment of displaced midshaft clavicular fractures.

Modes of non-operative treatment:

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

OPERATIVE TREATMENT

Operative fixation is usually indicated in adults with any of the following (Indications):

- A completely displaced midshaft fractures.
- Skin tenting caused by superior displacement and/or an impending open fracture.
- Fracture neurovascular injury needs intervention.
- A compound clavicular fracture.

- A floating shoulder consisting of completely displaced clavicle fracture.
- Clinical deformity which seems very obvious accompanied by any shoulder asymmetry caused usually by a combination of shortening, rotation and displacement.
- Fracture of lateral end near acromio-clavicular joint.
- Associated lower extremity trauma.
- Underlying neuromuscular conditions like parkinsonism, seizure disorder.

Recent clinical studies conducted by different orthopaedicianshas highlighted better functional outcome for patients in case of operative fixation of displaced midshaft clavicle fractures than that with conservative management. These studies also reports of less malunion and nonunion rates in surgically fixed clavicles than in conservatively treated ones.

Mode 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

Depending on the surface of the placement, various plates can be used for the midshaft clavicle fractures.

Superior surface:

1. Reconstruction plate
2. Locking Reconstruction plate
3. Precontoured superior locking compression plate

Anterior surface:

1. Reconstruction plate
2. Locking Reconstruction plate
3. Locking anterior plate

Superior and anterior surface:

1. Reconstruction plate
2. Locking Reconstruction plate
3. Anatomical precontoured anterior-superior locking compression plate.

Since midshaft clavicle fractures displace three dimensionally we wanted to choose a plate which can be used to fix all the fragments anatomically. For this to be achieved we chose precontoured superior anterior locking compression plate which has 3 dimensional fixation.

OPEN REDUCTION AND INTRAMEDULLARY FIXATION

Advantages

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

Disadvantages

- Infection.
- Hardware prominence and migration.
- Does not provide rotational control
- Nonunion.

Implants used

- ‘K’ wire
- Titanium elastic nail
- Hagie pin
- 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.

We in our study chose pre-contoured locking compression plate as implant of choice in surgical group, as it is the latest of all plate options available in treating clavicle fractures with

- Angular stable fixation of fragments regardless of bone quality.
- Minimized risk of primary and secondary loss of reduction, even under high dynamic loading
- Reduced impairment of periosteal blood supply due to the limited plate contact
- Good purchase even in osteoporotic bone and in multifragment fractures
- Valuable anatomical template when reconstructing a malunion, nonunion or highly comminuted fracture
- They can reduce valuable operative time and thereby reducing the risk of infection.

ANATOMICAL PRECONTOURED LOCKING COMPRESSION PLATE (PRECONTOURED LCP - ANTERIOR SUPERIOR PLATE)

In our study we have used anatomical pre contoured locking compression plate as the implant in fixation of clavicle in surgical group.

- Angular stable fixation of fragments regardless of bone quality.
- Reduced impairment of periosteal blood supply due to the limited plate contact
- Minimized risk of primary and secondary loss of reduction, even under high dynamic loading
- Very useful anatomical template when reconstructing a malunion, nonunion or highly comminuted fracture
- Good purchase even in osteoporotic bone and in multifragment fractures
- They can reduce precious operative time and thereby reducing the risk of infection.
- Plate is used for bridging osteosynthesis.

DESCRIPTION OF THE PLATE

Lateral superior placement

Medial anterior placement

Tapered plate tip

LCP combi-hole for 3.5 mm locking or 3.5 mm cortical screws.

Plate is side specific.(Figure 13).

SCREWS(Figure 13)

Locking Screw 3.5 mm, self-tapping, length 12–30 mm

Cortex Screw 3.5 mm, length 12–30 mm (self tapping also available)

The locking of the screws into the plate prevents the loss of reduction. The frictional force between the plate and the screw are avoided.

AO PRINCIPLES AS APPLIED TO THE ANATOMICAL PRECONTOURED LOCKING COMPRESSION PLATE:

Anatomical reduction

It maintains the anatomical reduction.

Stable fixation

Locking screws create a fixed-angle construct providing angular stability.

Preservation of blood supply

Tapered end for submuscular plate insertion and limited contact preserves tissue viability.

Early active mobilization

Early mobilization, as per standard AO technique creates an environment for bone healing and return to optimal function.

DISADVANTAGES WITH ANATOMICAL PRECONTOURED LOCKING COMPRESSION PLATE

1. If the fracture is fixed in distraction or fracture fragments resorbs during healing, the rigidity of locked screw plate construct prevents bone to bone contact and may result in nonunion. So reduction should be achieved before fixation with locking screws.
2. It is not a load sharing device.
3. Locking plate contouring may distort the screw hole and canaffect the screw locking. To avoid such damage to the LCP threads due to

extensive bending, insert a LCP drill sleeve into the threaded hole for protection while contouring the plate[58].

5. Sometimes implant exit can get difficult if locked screws become cold welded to the plate. (**Cold** or **contact welding** is a solid-state welding process in which joining takes place without fusion/heating at the interface of the two parts when two clean and flat surfaces of similar metal are brought into contact under vacuum. Unlike in the fusion-welding processes, no liquid or molten phase is present in the joint.)

PLATE PLACEMENT ILLUSTRATION OF ANATOMICAL PRECONTOURED LOCKING COMPRESSION PLATE

FIGURE 10, SHOWS BOTH RIGHT AND LEFT PLATES, LOCKING SCREWS, CORTICAL SCREWS, DRILL BIT AND DRILL SLEEVE

MATERIALS AND METHODS

This comparative study was conducted in the “Department of Orthopedic Surgery” Govt. Kilpauk Medical College Hospital from October 2012 to July 2014. Ethical committee approval was obtained. Patients with midshaft clavicle fractures were randomly selected and divided into two groups, one group who were treated with locking plates using anatomical pre-contoured locking compression plate and the other group treated conservatively. We chose to compare between these two modalities of treatment as one was the latest advancement in orthopedics and the other one being the most followed and preferred treatment by many orthopedic surgeons until recently and historically.

INCLUSION CRITERIA

- Patients in the age group of above 18 years.

- ROBINSON Type 2B Fractures.

    - Closed fractures.

    - Fractures reported within 9 days of injury.

EXCLUSION CRITERIA

- Other simultaneous upper limb fractures.

- Former surgery of the shoulder.

- Former chronic illness of the shoulder.
- Associated nerve or vessel damage of the affected arm.
- Compound fractures.

PRE-OPERATIVE EVALUATION AND CARE

About 46 patients with midshaft clavicle fractures were treated either surgically with Anatomically pre contoured LCP or conservatively with figure of 8 bandage, among which 6 patients lost follow up and hence, 20 patients were included in the study.

The patients included in the study presented with pain, swelling and difficulty in using the involved limb following injury. Detailed clinical examination was done to rule out other associated injuries and documented. The associated injuries were also treated simultaneously (Table 5).

Antero-posterior radiograph of the shoulder joint with clavicle was taken with other relevant x-rays if needed, were ordered accordingly.

Initially patients were supplemented with analgesics and the limb was immobilized with figure of 8 bandage .

It was continued for patients who were not willing for surgery. They were included in conservatively treated group.

The fractures were classified according to Robinson Classification (Table 6).

After completing the routine blood investigations, ECG, chest x-ray and other relevant investigations and anaesthetic fitness, the patients were taken up for surgery.

Fracture fixation was done using locking plate. In our study we chose anatomical pre-contoured locking compression plate for all patients with antero -superior plate placement.

The time interval between the injury and the surgery / treatment was 1 to 9 days with average of 3.15 days in surgical group and 3.35 days incase of conservative group (Table 7).

SURGICAL TECHNIQUE FOR FIXING MIDSHAFT CLAVICLE FRACTURES USING ANATOMICAL PRECONTOURED LCP.

Preoperative planning

The preoperative radiographs were taken in all cases to determine the length of the plate and the position of the screws.

Anaesthesia

General anaesthesia.

Position and preparation

Patient was kept in supine position on a radiolucent operating table with enough area provided for the movement of c-arm at 45° in both directions to view the clavicle in two planes.

Operative site including the arm was prepared and draped so that it can be mobilized intra-operatively and could be used as a reduction aid.

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

Surgical approach

Skin incision -a gentle curvilinear incision was made parallel to the skin cleavage lines.

The supraclavicular nerve branches were identified during the subcutaneous dissection and protected, which is usually difficult.

The platysma was divided to expose the clavicle periosteum at the deltotrapezial fascia.

The periosteum was then minimally dissected to expose the fracture site.

Bone fragments were not detached from the periosteum.

Fracture reduction with temporary fixation

Normal length of the bone should be corrected.

Rotational mal-alignment should be corrected along with restoration of axis angulation.

After exposure of the fracture site, the main two fragments should be distracted and the length of the clavicle is restored.

In cases where the fracture ends are angled or oblique, a pointed or serrated reduction forceps is used for its reduction.

In cases where large comminuted fragments are found it should also be reduced. Small pointed bone clamps or K-wires are used for temporary fixation of clavicle fractures.

In certain cases with butterfly fragments as an additional options for maintaining the reduction, lag screws were used. It was applied independently or through the plate.

Plate length

Appropriate plates were selected for each fracture.

Temporary fixation of the plate

Plate was then kept in position (antero-superiorly) on the reduced bone and temporarily fixed with plate holding forceps.

Screw Insertion

The screw to be used for fixation were determined.

In cases with plan of using a combination of locking and cortical screws, the cortical screws were inserted first, to pull the bone to the plate.

Fixation with 3.5 mm cortex screws

Using a 2.5 mm drill bit with a 3.5mm universal drill guide the bone was pre-drilled through both cortices.

With depth gauge the length of the cortical screw required was measured.

Then, the appropriate 3.5 mm cortical screws were inserted using the hexagonal screwdriver.

Fixation with 3.5 mm locking screws

In cases where locking screw was used as the first screw, then it was made sure that the fracture was reduced properly and the plate was held securely to the bone to prevent any rotation of the plate as the screws were locked to the plate.

The drilling was done in the locking hole till both cortices were drilled.

After measuring the length of the screws required, the locking screws were inserted using hexagonal screwdriver and tightened until it was locked.

The alignment and screw placement were checked with image intensifier.

After satisfactory reduction and complete haemostasis, thorough irrigation was done and the myofascial layer was closed with interrupted absorbable sutures covering the hardware.

After applying drain subcutaneous layer was closed with interrupted absorbable sutures.

Skin was then closed with interrupted non absorbable sutures.

Sterile dressing was applied.

Arm sling was applied for protection and to reduce the operative site pain.

POSTOPERATIVE CARE AND REHABILITATION

- The arm was maintained in a sling on a full-time basis for two weeks.
- Pendulum movements of shoulder was started within two days with limb rested in arm sling.
- Drain was removed after 48 hours.
- Suture removal was done on the 12thpost operative day.
- After two weeks, the wound status was assessed and use of the sling was discontinued and active assisted range-of-motion exercises of the shoulder in the scapular plane were started.
- After four weeks, full active motion was initiated.
- When there were clinical and radiographic signs of union noted (usually at six to eight weeks), strengthening and resistive exercises of the rotator cuff, deltoid and trapezius were started.
- 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, 6th week, 8th week and then every month for the next three months and

thereafter once in 7three months. In our study, the follow up period ranged from 6 to 18 months with average of 10 months.

- At three months and 6 months follow up, patients functional outcome were assessed using DASH questionnaire.
- Radiological evaluation of the union was done by taking serial x-rays. Radiological union was assumed to be achieved when there were bridging trabeculations across the fracture site on three of four cortices at the fracture line.
- Any changes in the alignment, screw pullout or implant failure were also noted.
- Functional outcome was based on the Constant and Murley scoring system [59] which includes both subjective and objective variables and DASH score.

CONSERVATIVE MANAGEMENT

- Patients not willing for surgery were invariably included in this group.
- All patients were applied with figure of 8 bandage.
- It was continued for 4 weeks with reinforcing of bandage at 2 weeks.

- At the end of 4 weeks bandage was removed and was started on with pendulum exercises.

- When radiological signs of union was noted , strengthening and resistive exercises of the rotator cuff, deltoid and trapezius were started.

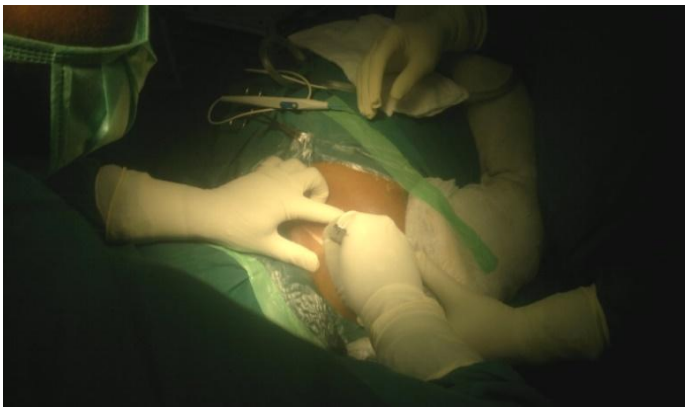
- Union was assessed radiologically at every follow up at 2 weeks, 4 weeks, 6 weeks, 8 weeks. then at one month interval for next three months and every three months from there on.

- We had follow up period range of 6 to 18 months with average of 8 months.

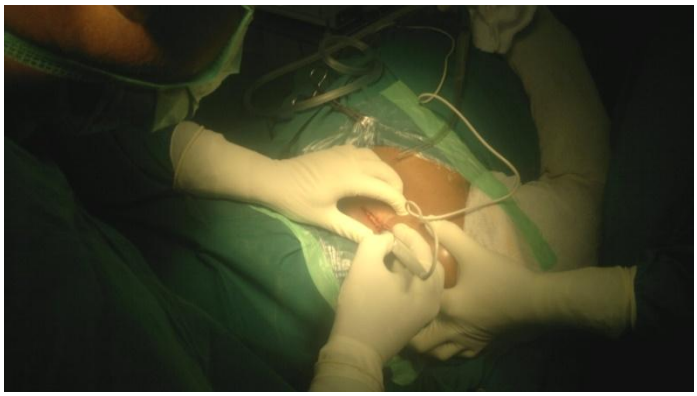
SURGICAL APPROACH AND PLATE FIXATION

PATIENT POSITIONING

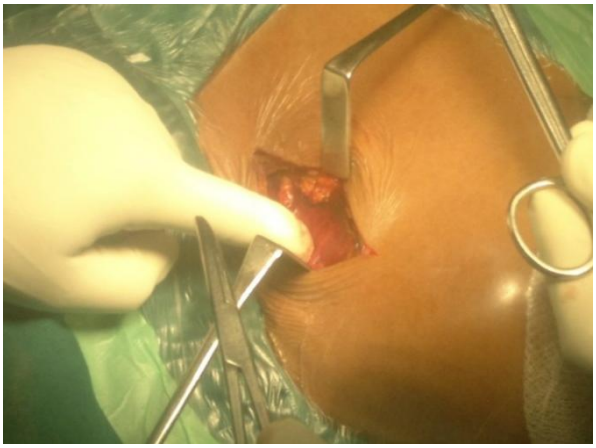
SKIN INCISION



SUBCUTANEOUS INCISION



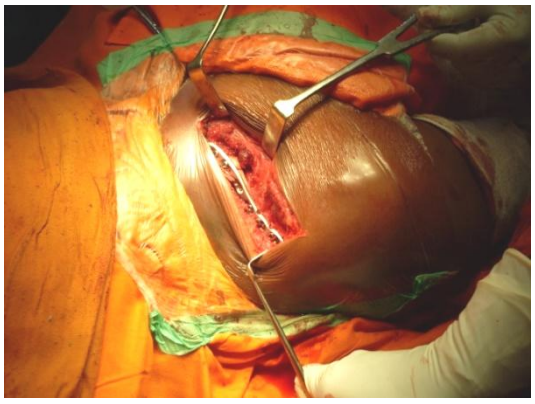
IDENTIFYING SUPRACLAVICULAR NERVE



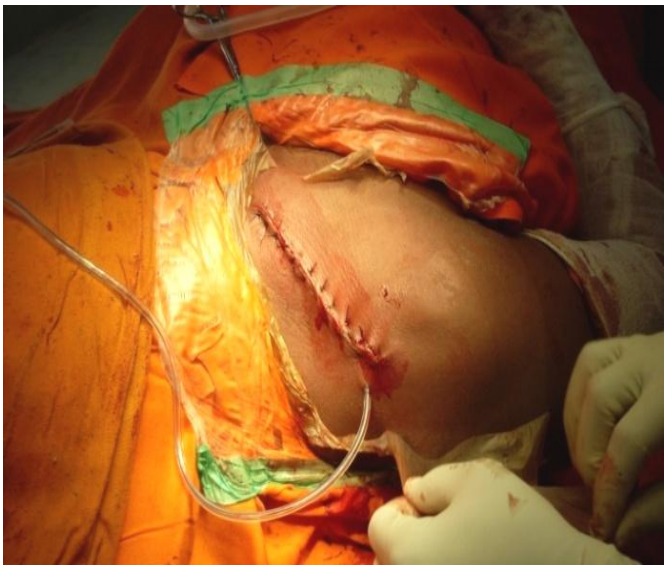
BONE EXPOSED AND REDUCED

PLATE FIXED TEMPORARILY

AFTER FIXATION



WOUND CLOSED



STERILEDRESSING DONE

OBSERVATIONS AND ANALYSIS

OBSERVATION AND ANALYSIS

TABLE 1

AGE DISTRIBUTION

S. No.	Age group	No. of patients		Percentage		Males		Females	
		Surgical	Con servative	Surgical	Con servative	Surgical	Con servative	Surgical	Conser vative
1	20-29	8	5	40%	25%	5	3	3	2
2	30-39	5	8	25%	40%	3	4	2	4
3	40-49	5	4	25%	20%	5	3	0	1
4	50-59	1	2	5%	10%	1	1	0	1
5	60-69	1	1	5%	5%	0	1	1	

In our study of 40 patients, Surgical group had an average age of 36.5 ranging from 20 – 64 years and Conservative group had an average of 37 ranging from 25 – 64 years. Maximum number of patients in Surgical group belonged to 20 to 29 years whereas in conservative group it was between 30 to 39 years.

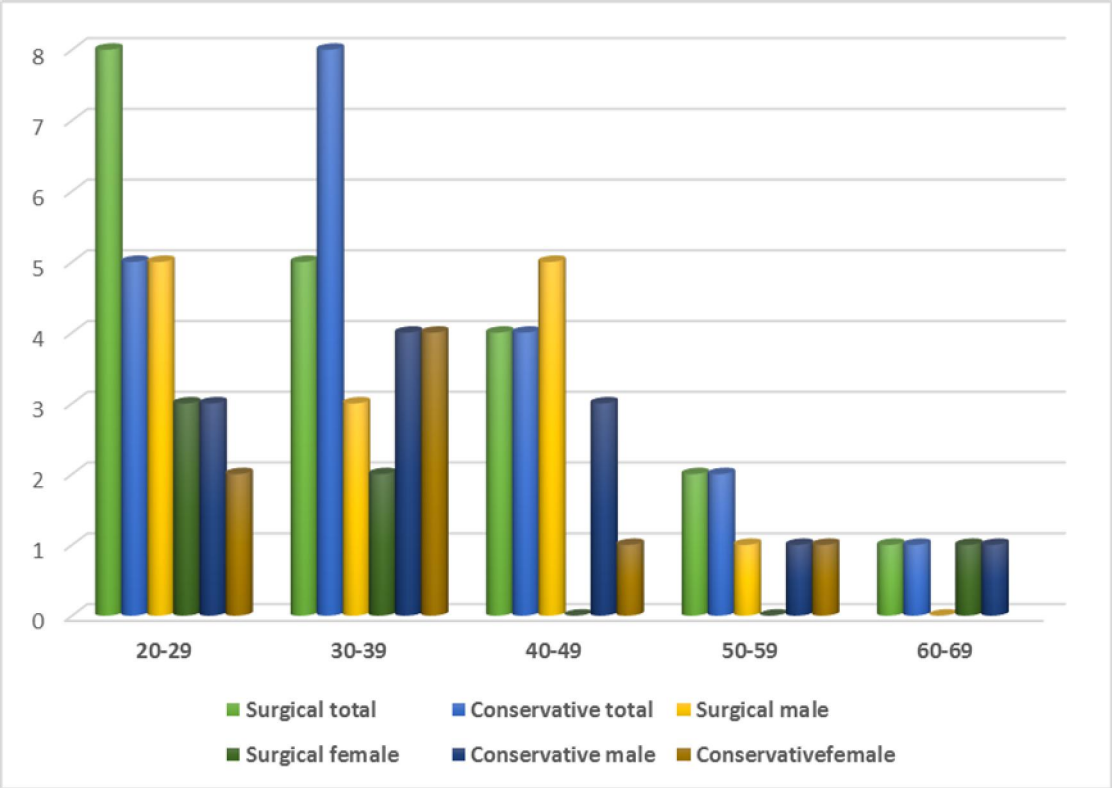
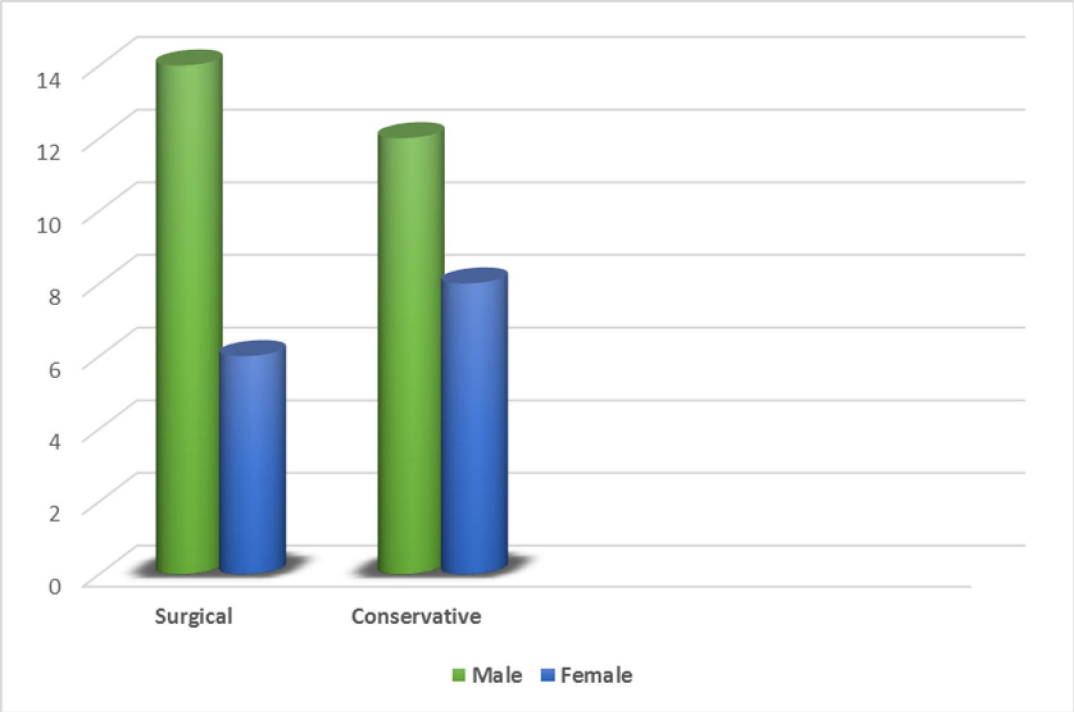


TABLE 2

SEX DISTRIBUTION

S. No.	Sex	No. of Patients		Percentage	
		Surgical	Conservative	Surgical	Conservative
1.	Males	14	12	70%	60%
2.	Females	6	8	30%	40%

Total number of males in Surgical group were 14 and Conservative group were 12.Total number of females in Surgical group were 6 and Conservative group were 8.



			Group		
			Surgical Fixation with Locking	Conservative Treatment	Total
Sex	Male	Count	14	12	26
		% within Sex	53.8%	46.2%	100.0%
		% within Group	70.0%	60.0%	65.0%
	Female	Count	6	8	14
		% within Sex	42.9%	57.1%	100.0%
		% within Group	30.0%	40.0%	35.0%
Total		Count	20	20	40
		% within Sex	50.0%	50.0%	100.0%
		% within Group	100.0%	100.0%	100.0%

TABLE 3

MODE OF INJURY

S. No.	Mode of injury	No. of patients		Percentage	
		Surgical	Conservative	Surgical	Conservative
1.	Road traffic accidents	10	8	50%	40%
2.	Self fall	6	5	30%	25%
3.	Assault	4	7	20%	35%

Maximum number of cases in both groups were due to Road Traffic Accidents.50% in Surgical group and 40% in conservative group.

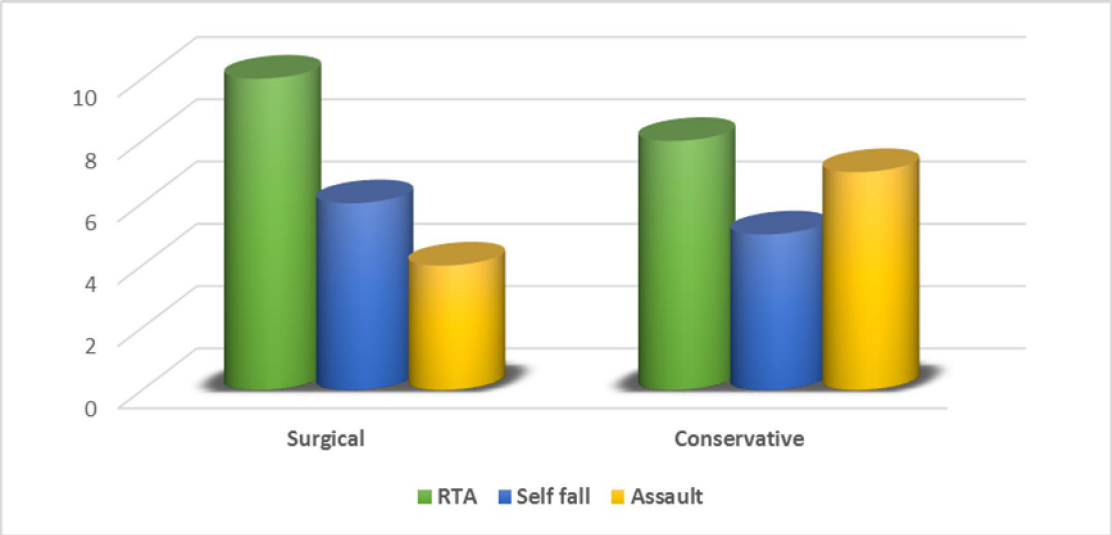


TABLE 4

INVOLVED SIDE

S. No.	Side	No. of patients		Percentage	
		Surgical	Conservative	Surgical	Conservative
1.	Right	12	11	60%	55%
2.	Left	8	9	40%	45%

In surgical group we had 12 (60%) patients with right side injury and in conservative group it was 11 (55%) patients with injured right side. In total maximum number of cases in our study had right sided injury. All patients in the study are right hand dominant.

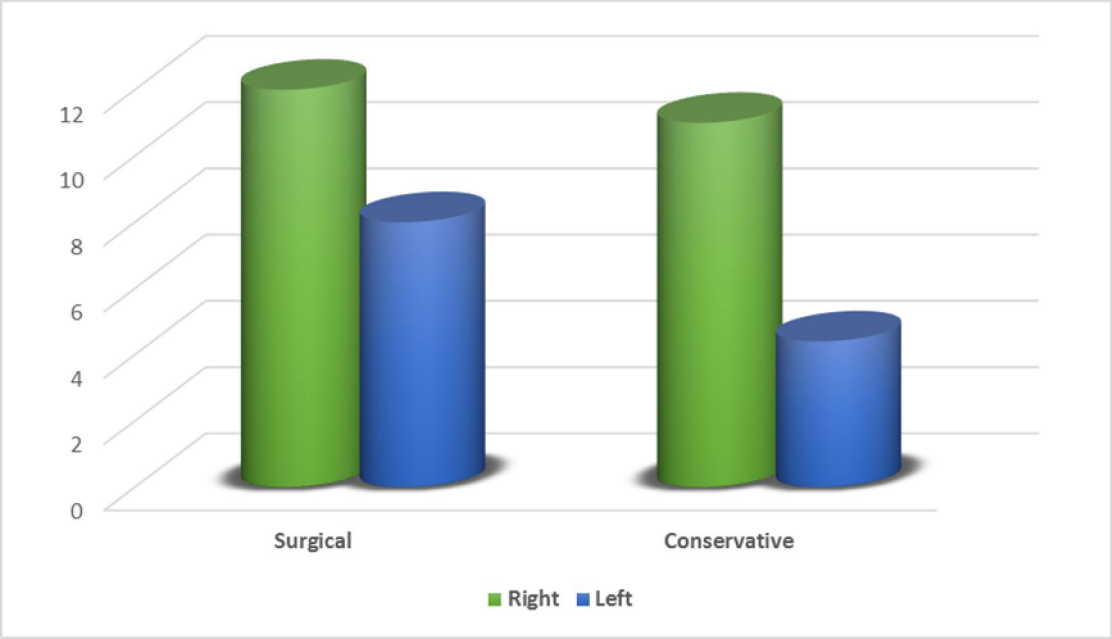


TABLE 5

ASSOCIATED INJURIES

a) SURGICAL GROUP

S. No.	Associated injury	No. of patients
1.	Fracture both bones leg	1
2.	Fracture shaft of femur	2
3.	Bimalleolar fracture	1
4.	Fracture metatarsal	1

In Surgical group we had total of 5 cases with associated injuries, which included 2 cases of fracture shaft of femur, 1 bimalleolar fracture, 1 metacarpal fracture and 1 both bones leg fracture. All of them were addressed simultaneously.

b) CONSERVATIVE GROUP

S.No.	Associated injury	No. of patients
1.	Fracture lateral malleoli	1
2.	Fracture Shaft of femur	1

In conservative group we had a fracture lateral malleoli and a fracture shaft of femur for which appropriate treatment was taken**.**

TABLE 6

FRACTURE CLASSIFICATION

All the fractures were classified according to Robinson classification. Only type 2B fractures were included in the study, which were further classified into 2B1 and 2B2 fractures within the group.

a) SURGICAL GROUP

S. No.	Robinson's type	No. of patients	Percentage	No. of males	No. of females
1.	Type 2B1	12	60%	9	3
2.	Type 2B2	8	40%	5	3

Study consisted of 12 (60%) type 2B1 fractures with 9 males and 3 females and type 2B2 fractures included 8 (40%) patients with 5 males and 3females.

S. No.	Robinson's type	No. of patients	Percentage	No. of males	No.of females
1.	Type 2B1	14	70%	8	6
2.	Type 2B2	6	30%	4	2

b) CONSERVATIVE GROUP

Conservative group consisted of 14 (70%) type 2B1 fractures with 8 males and 6 females and type 2B2 fractures had 6 (30%) patients with 4 males and 2 females.

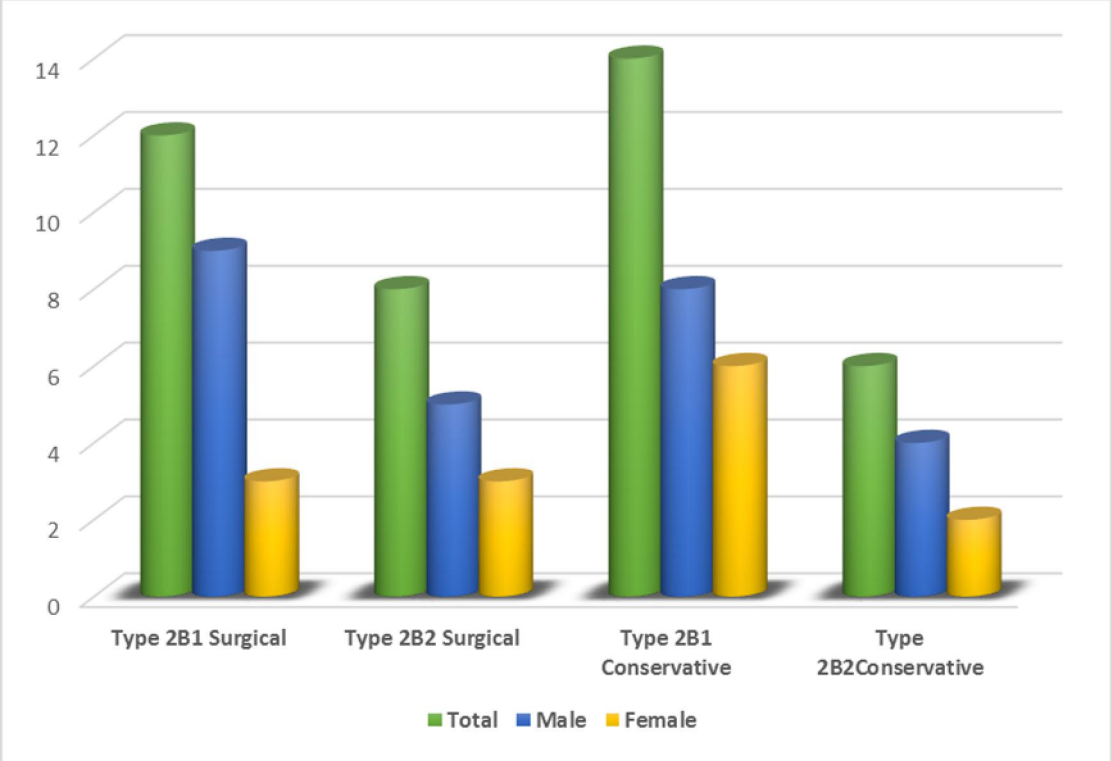


TABLE 7

TIME INTERVAL BETWEEN INJURY AND SURGERY

a) SURGICAL GROUP

S. No.	Days	No. of patients	Percentage
1.	0 – 3	10	50%
2.	4 – 6	9	45%
3.	7 – 9	1	5%

Average time taken from the time of injury till surgery was 3.35 days in surgical group.

b) CONSERVATIVE GROUP

S. No.	Days	No. of patients	Percentage
1.	0 – 3	8	40%
2.	4 – 6	11	55%
3.	7 – 9	1	5%

Average time taken from the time of injury till treatment was 3.65 days in conservative group.

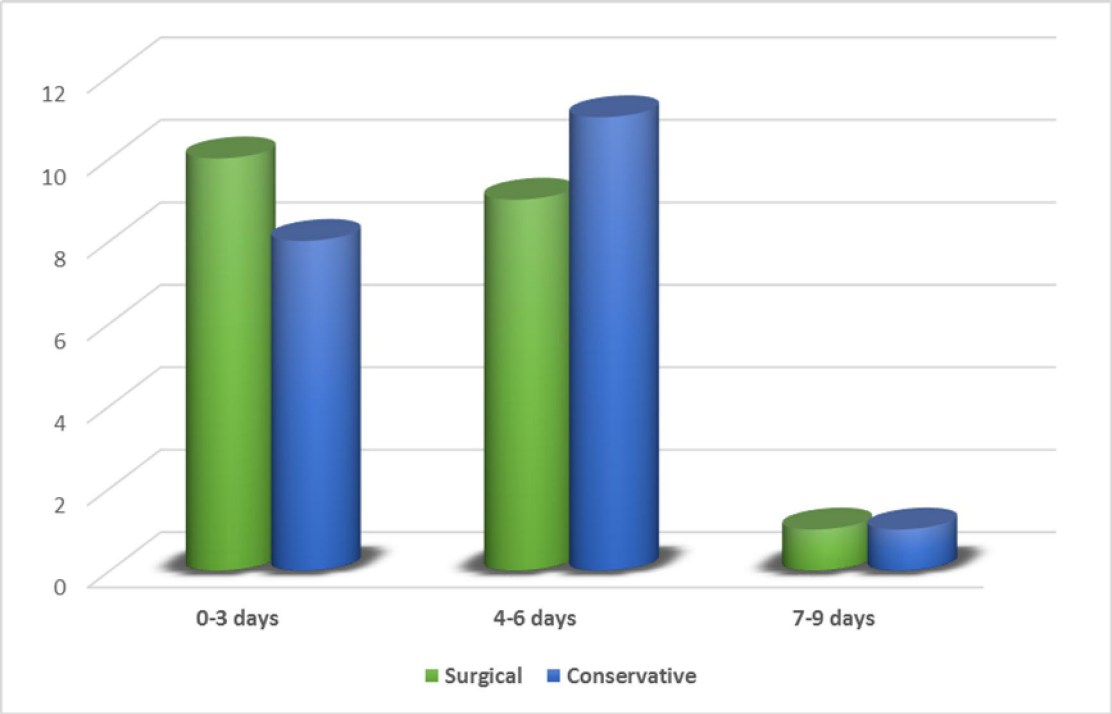


TABLE 8

COMPLICATIONS

a) SURGICAL

S. No.	Complication	No. of patients
1.	Hardware irritation	2(10%)
2.	Superficial infection	2(10%)
3.	Laterally unseated plate	1(5%)
4.	Numbne7ss	1(5%)

b) CONSERVATIVE

S.No.	Complication	No. of patients
1.	Malunion	5
2.	Nonunion	2

Complications were encountered in 6 patients in surgical group.2 patients had hardware irritation, 2 patients developed superficial infection which settled with intravenous antibiotics within 7 days, 1 patient developed numbness over the clavicular region, which resolved spontaneously after 11 weeks. Postoperatively we found that the plate was not fully seated in one patient on the lateral side of the clavicle, but ultimately it went for union with good functional outcome.

In conservative group we observed 5 malunions and 2 nonunions. Patients with nonunions proceeded with further appropriate treatment.

TABLE 9

EVALUATION OF PAIN

Post operative pain was recorded on a scale of 0-5points.At six months follow up 19(95%) patients had no pain and 1(5%) patients had mild pain in Surgical group and in Conservative group, 14(70%) patients had pain, 3(15%) patients had mild pain and 3 patients (15%) had pain after unusual activities.

Pain scale	**Points**	**No. of patients**			
		At 3 months		**At 6 months**	
		Surgical	**Conservative**	**Surgical**	**Conservative**
No pain	5	14 (70%)	10(50%)	19 (95%)	14(70%)
Mild pain	4	4 (20%)	6(30%)	1 (5%)	3(15%)
Pain after unusual activities	3	2 (10%)	4(20%)	-	3(15%)
Pain at rest	2	-		-	
Marked pain	1	-		-	
Complete disability	0	-		-	

TABLE 10

RANGE OF MOVEMENTS

S. No.	Shoulder movements	Average (mean ± standard deviation)	
		Surgical	**Conservative**
1.	Flexion	170.25 ± 10.69	156.75±20.21
2.	Abduction	170.25 ± 10.93	156.25±21.99
3.	External rotation	76 ± 7.88	69±9.79
4.	Internal rotation	76 ± 7.36	70±8.58

The range of motion with flexion, abduction, external and internal rotation were measured in both groups after 6 months of follow up using goniometer and was recorded.The average range of motion in the surgical group was found to be better than the conservative group.

TABLE 11

MUSCLE STRENGTH

S. No.	Muscle strength	No. of Patients			
		At 3 months		At 6 months	
		Surgical	Conservative	Surgical	Conservative
1.	Normal	**13(65%)**	**11(55%)**	**19(95%)**	**16(80%)**
2.	Against resistance	**7(35%)**	**9(45%)**	**1(5%)**	**2(10%)**
3.	Against gravity		-		**2(10%)**
4.	With elimination of gravity		-		-
5.	Flicker		-		-
6.	Paralysis		-		-

TABLE 12

OCCUPATION LIMITATION

S. No.	Occupation status	No. of patients			
		At 3 months		At 6 months	
		Surgical	Conservative	Surgical	Conservative
1.	Regular work	13(65%)	12(60%)	19(95%)	14(70%)
2.	Restricted work	7(35%)	8(40%)	1(5%)	6(30%)
3.	Unable to work		-		-

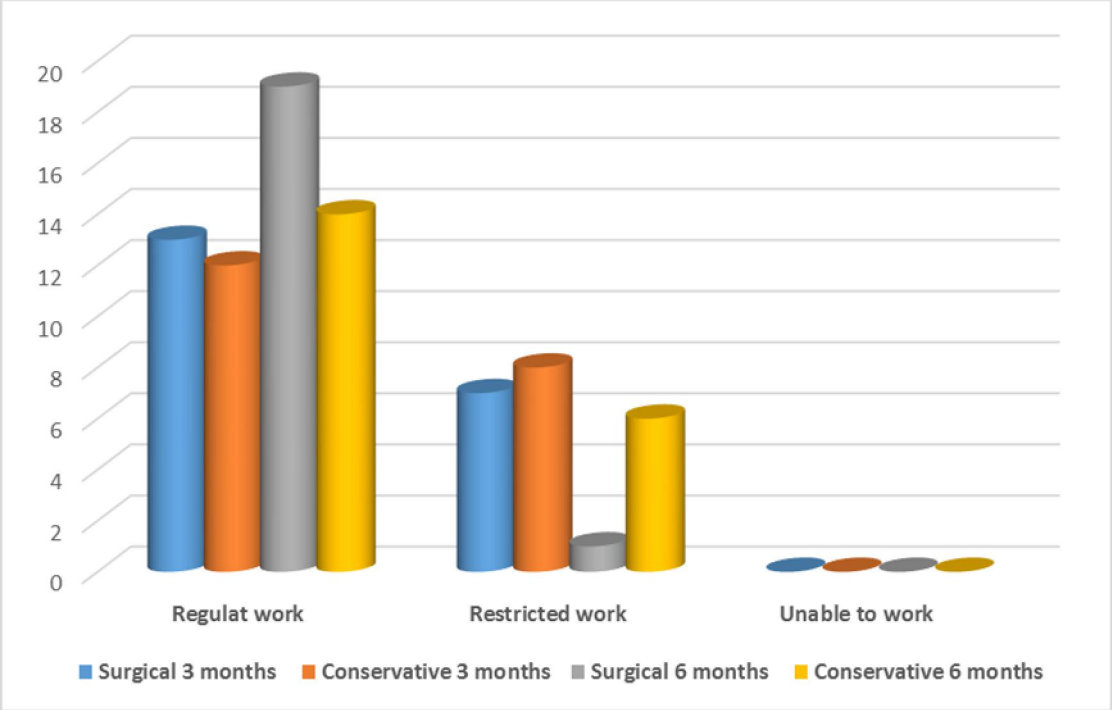


TABLE 13

FRACTURE UNION

Fracture type	**Average time for union (weeks)**	
	Surgical	**Conservative**
Type 2b1	6.07	7.07
Type 2b2	6.85	8
Combined	6.33	7.33

Average time for union in Surgical group was 6.07 and 6.85 weeks for type 2B1 and 2B2 fractures respectively whereas, in Conservative group it was 7.07 and 8 weeks for type 2B1 and 2B2 fractures after excluding the two nonunions which were observed. Overall average Radiological union time in Surgical group was **6.35 weeks**, range being **6 – 8 weeks** and in Conservative group it was 7.33 weeks ranging from 6 – 10 weeks.

TABLE 14

FUNCTIONAL EVALUATION USING CONSTANT SCORE

We evaluated functional outcome using Constant Score in both groups. Surgical group showed 85% Excellent and 15% Good outcome whereas Conservative showed 30% and 55% of Excellent and good outcome along with 5% fair and 10% of poor outcome. All were evaluated at the end of 6 months of follow up.

S. No.	Result	Constant score	No. of patients		Percentage	
			Surgical	Conservative	Surgical	Conservative
1.	Excellent	86-100	17	6	85%	30%
2.	Good	71-85	3	11	15%	55%
3.	Fair	56-70	0	1	0%	5%
4.	Poor	1-55	0	2	0%	10%

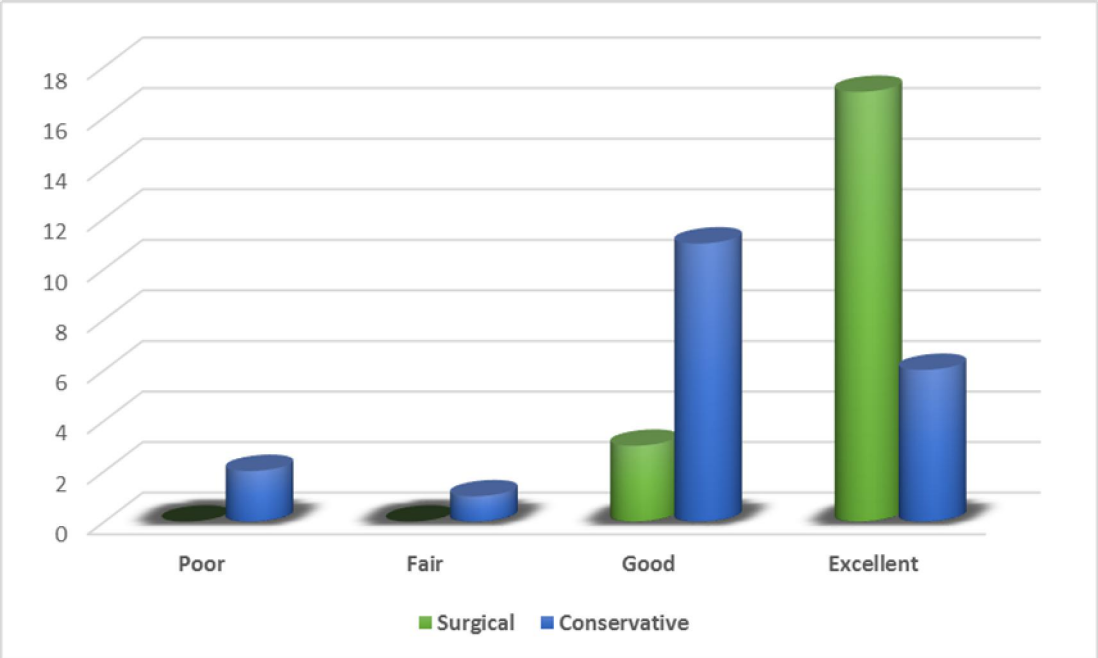


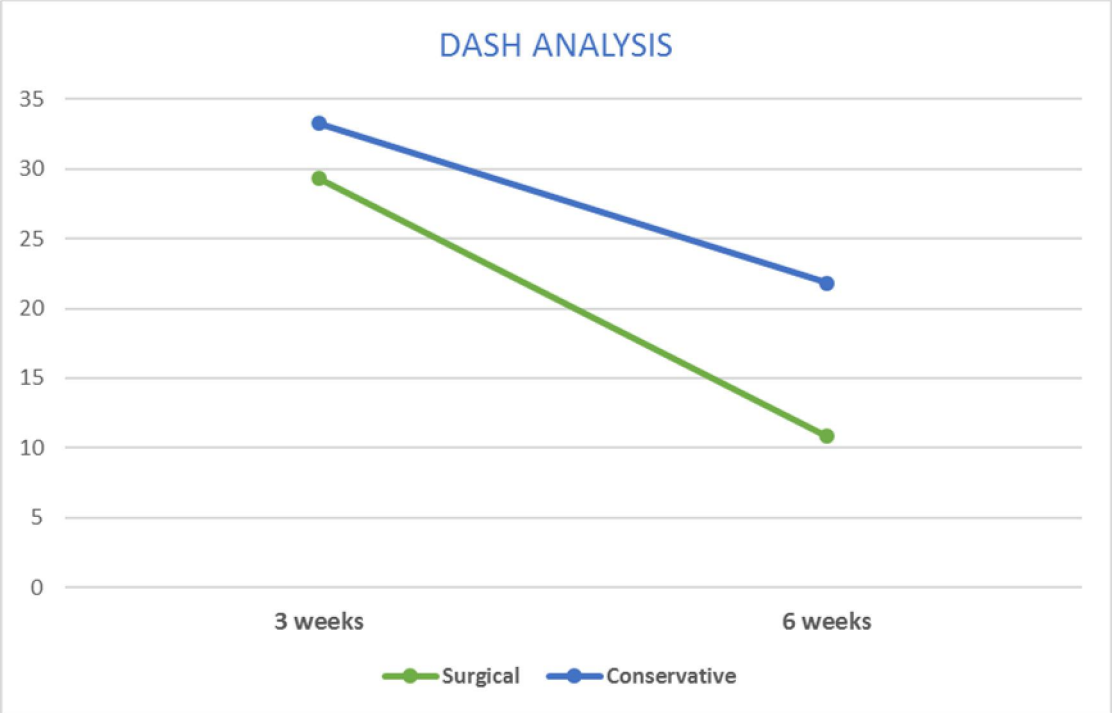
TABLE 15

FUNCTIONAL OUTCOME USING CONSTANT-MURLEY SCORING SYSTEM

			Group		Total	p-value
			Surgical Fixation with Locking	Conservative Treatment		
Result	Poor	Count	0	2	2	0.005
		% within Result	.0%	100.0%	100.0%	
		% within Group	.0%	10.0%	5.0%	
	Fair	Count	0	1	1	
		% within Result	.0%	100.0%	100.0%	
		% within Group	.0%	5.0%	2.5%	
	Good	Count	3	11	14	
		% within Result	21.4%	78.6%	100.0%	
		% within Group	15.0%	55.0%	35.0%	
	Excellent	Count	17	6	23	
		% within Result	73.9%	26.1%	100.0%	
		% within Group	85.0%	30.0%	57.5%	
Total		Count	20	20	40	
		% within Result	50.0%	50.0%	100.0%	
		% within Group	100.0%	100.0%	100.0%	

FUNCTIONAL OUTCOME USING DASH SCORE

	Group	N	Mean	Std. Deviation	Std. Error Mean	p-value
Dash score - 3 months	Surgical Fixation with Locking	20	29.30	3.213	.719	0.004
	Conservative Treatment	20	33.25	4.700	1.051	
Dash score - 6 months	Surgical Fixation with Locking	20	10.85	3.329	.744	0.000
	Conservative Treatment	20	21.80	5.444	1.217	
Dash score - Difference	Surgical Fixation with Locking	20	18.45	4.979	1.113	
	Conservative Treatment	20	11.45	3.517	.786	



RESULTS

RESULTS

We treated a total of 46 midshaft clavicle fractures which falls under Robinson type 2B classification using two different modalities of treatment and divided it into two groups accordingly. One group was treated Surgically using Anatomically pre-contoured LCP and the other group treated conservatively using figure of 8 bandage.As, 3 patients from each group missed the follow up, we included 20 patients in each group for the study.

Average follow up for Surgical group was 11.65 months and conservative group was 11.85 months, with a minimum follow up of 6 months and maximum follow up of 18 months in both groups.

We evaluated the functional outcome of the patients using Constant – Murley Shoulder score at 6 months follow up and DASH score twice at 3 months and 6 months follow up period.

We did the statistical comparison between the outcomes of surgical fixation and conservative management and level of significance is determined by $p<0.05$. Value was determined using Pearson chi square and Independent sample T test.Constant score done at the end of 6 months showed a p-value of 0.005 which is considered significant.The Surgical group had significantly superior(lower) DASH score at both 3 months and 6 months follow up. The p-value obtained was <0.001 which is considered significant**.**

DISCUSSION

DISCUSSION

In our comparative study we have compared the functional outcome of midshaft clavicle fractures treated surgically using anatomical pre-contoured LCP and Conservative management. We divided the patients into two groups randomly and some those who were not willing for surgical treatment were included directly into conservative group and analyzed the result.

Most of the orthopedic surgeons prefer to opt for non-operative treatment for non-displaced middle-third fractures of the clavicle, using a sling or a figure 8 support. Still the ideal treatment modality for acute displaced middle-third fractures of the clavicle remains controversial[22].

Although most of the middle-third clavicle fractures treated conservatively seems to unite uneventfully, studies now shows to have higher rates of non union and patient dissatisfaction to be associated with it in the final result[23].

A prospective randomized controlled trial by the Canadian Orthopaedic Trauma Society compared plate and screw fixation with nonoperative treatment for displaced middle-third clavicle fractures[24].The functional outcome was assessed using Constant shoulder scores and DASH scores, which were significantly improved in

the operative fixation group at all time-points ($p = 0.001$ and $p < 0.01$, respectively). Similar to COTS study, our study also revealed a significant p-value when the functional outcome were measured using Constant and DASH scores favouring surgical fixation.

Hill et al. in his study noted unsatisfactory patient orientated functional outcomes in 16 out of 52 adult patients (31%) for the conservative treatment of displaced mid-shaft clavicle fractures.

Vanbeek et al. reported 32.1% of plate prominence (9 out of 28 patients) on using precontoured plate fixation. In our study we noticed 1 patient with plate prominence which is better than the published studies.

Vanbeek et al. reported 10.7% of reoperation rate[64] in pre-contoured plate fixed patients. But in our study we never had to re-operate on a patient as all of them went for union.

Chandrasenan et al reported 0% of reoperation rate in his study[65]. Our study is comparable to Chandrasenan et al. study of 0% reoperation rate.

In our study, hardware irritation was reported in 2 of twenty patients (10%), which seem to be lower than the previously published literature by Chandrasenan et al.[63]. One of them developed irritation

probably due to unseating of the implant on the lateral aspect of the clavicle which we found postoperatively.

Robinson et al.[27] in his study compared plate fixation with conservative management of midshaft clavicle fractures concluded to have less non-union rate and better functional outcome in patients treated with plate fixation. Overall DASH score and Constant score were significantly better in operative group with p-value of 0.04 and 0.01 respectively. Our study also revealed similar outcome with DASH and Constant score revealing p value of <0.001 and 0.005 respectively. As it was significant in the study revealed by Robinson et al. our study also showed a significant p-value showing Surgical treatment to be superior.

Dannilidis K et al. in their study of comparison of midshaft clavicle fractures treated with locking compression plate and intramedullary fixation against conservative management reported superior DASH and Constant score in surgical group. Our study also falls in line with this study with superior DASH and Constant score for surgical treatment.

Despite the gaining popularity of plating for displaced midshaft clavicle fractures, optimal plate position is still being debated.

Jupiter and Leffert[25] in their study published that superior plating is to be biomechanically stable than inferior plating. He further went on

to explain that the load-bearing side of clavicle is superior surface. However, in superior plating, the lateral fragment which is usually osteopenic faces the risk of screw pull out because of the downward force of the arm challenging the holding power of screws.

Kloen et al.[26]in his study recommended plating to be done on the anterior-inferior side. He stated that antero-inferior plating serves as an inferior buttress, especially at the lateral end of clavicle where the bone is osteopenic. This reduces the risk of screw pullout from the lateral fragmentby giving a better medial fixation inturn giving an excellent support to the construct.

Due to complex morphology of the clavicle almost all plates have to be contoured for placement on any surface. This paved the way for the evolution of precontoured plates for clavicle. The latest of which is anatomical precontoured locking compression plate, which incorporates three dimensional morphology by involving superior and anterior surface.

In fractures of clavicle, the weight of the arm creates a cantilever force that increases screw pull-out, especially on the lateral aspect. Hence the use of locking plates provides better screw pull-out strength[60, 61].

An anatomical pre-contoured locking compression plate provides rigid fixation withoutcompromising plate stiffness and fatigue strength [62]

and also serves as an anatomical template when reconstructing highly comminuted fracture.

Zlowodzki M et al. in his study reported 2.2 % non union in midshaft clavicle fractures, treated with plate fixation [28]. But our study showed a better result than the previously published studies for clavicle fractures as we had no case of nonunion or delayed union surgical group, whereas 2 cases of non union was reported in conservative group.

STUDY LIMITATIONS

Our study had some of the limitations

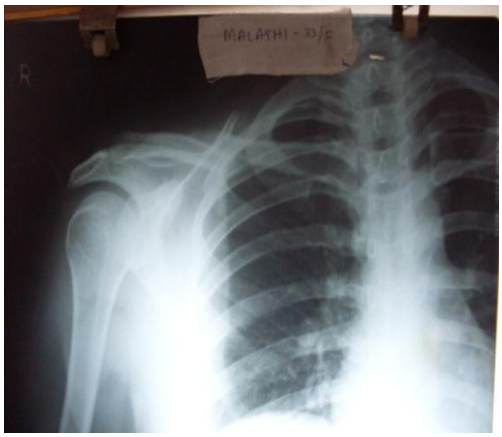
- We had limited number of cases in the stipulated period of time.
- Minimum follow up of the patients.
- Included only Robinson type 2B fractures as lot of other patterns of clavicle fractures being left out.
- Did only plating in surgical group as intramedullary fixations are also available.

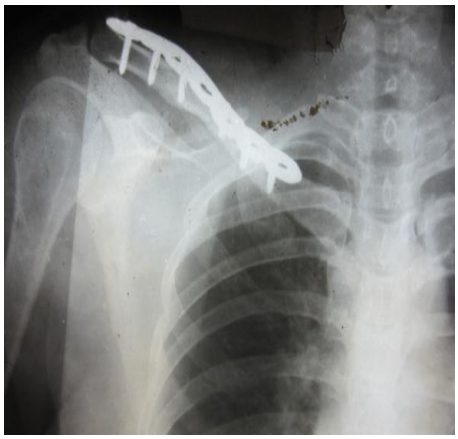
Hence, we recommend a multicenter randomized study comparing various modalities of surgical fixation for midshaft clavicle fractures with long term follow up and adequate number of patients.

CASE REPORTS

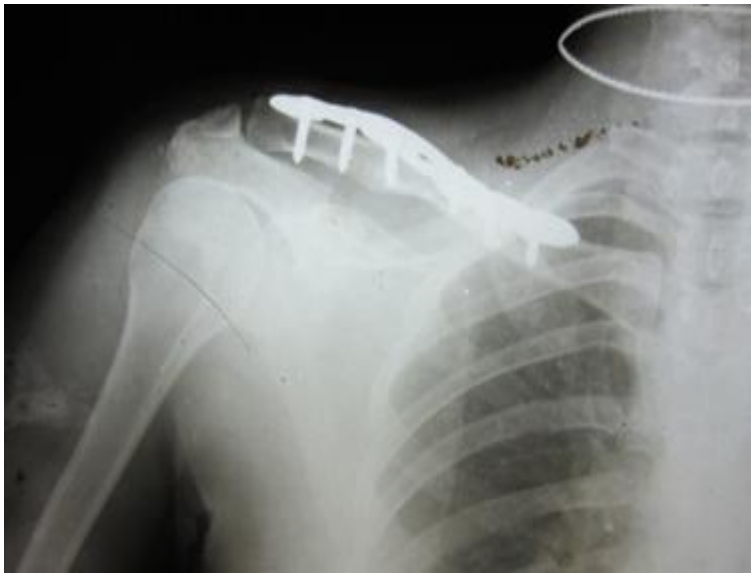
SURGICAL GROUP

CASE-1





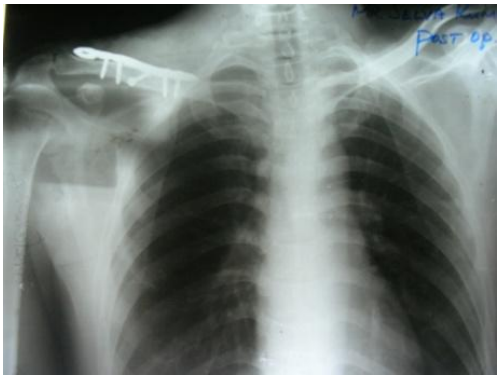
PRE OPERATIVE X-RAY **POST OPERATIVEX-RAY**



13 MONTHS FOLLOW UP

CASE- 2

PRE OPERATIVE X-RAY



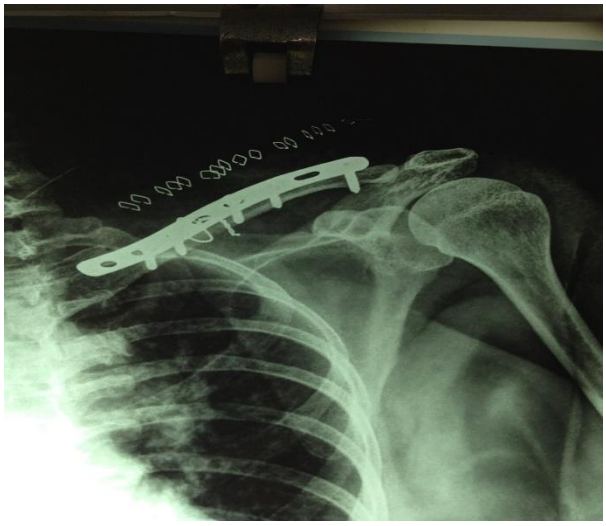
POST OPERATIVE X-RAY

14 MONTHS FOLLOW UP

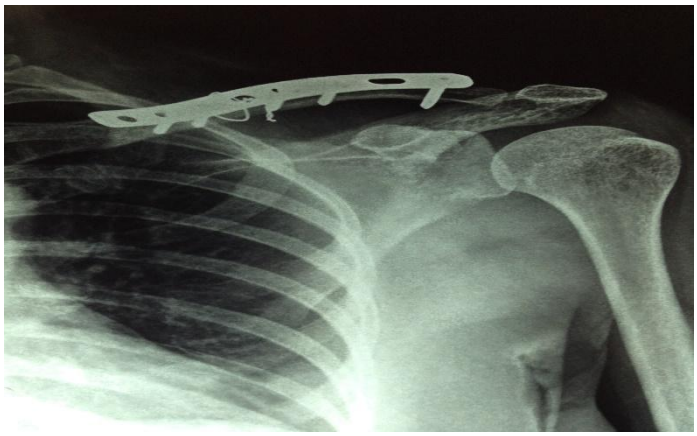

ORTHO WARD

CASE-3

PRE OPERATIVE X-RAY



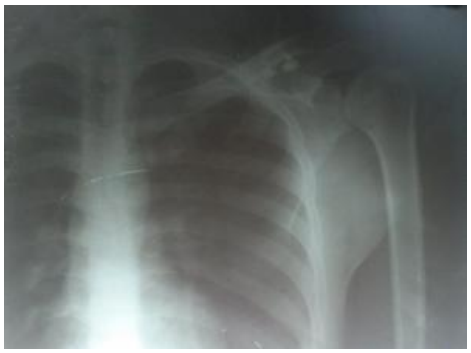
POST OPERATIVE X-RAY



8 MONTHS FOLLOW UP

CONSERVATIVE GROUP

CASE- 1

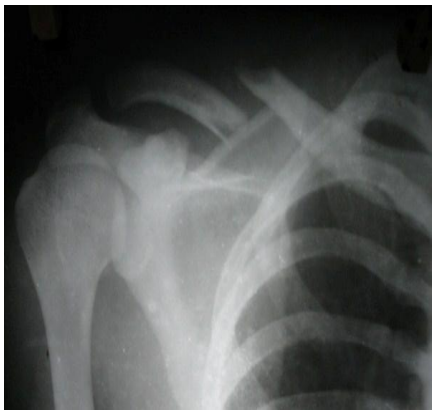


CASE-2

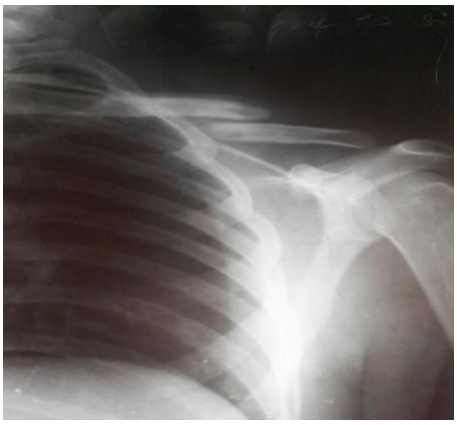
PRE TREATMENTX-RAY **6 MONTHS FOLLOW UP**

CASE-3

COMPLICATIONS



MALUNION **NONUNION**



NONUNION

HARDWARE IRRITATION **SUPERFICIAL INFECTION**

SUMMARY

SUMMARY

Clavicle fracture is one of the common injury of shoulder girdle with midshaft being the commonest site. In our study we compared two modalities of treatment practiced in Orthopedics for the treatment of midshaft clavicle fractures. Surgical fixation using the latest developed implant, anatomically pre-contoured LCP and the other one being Conservative which is historically used for the management of midshaft clavicle fractures by most of the Orthopedic surgeons.

Functional outcome was compared using Constant – Murley Score and DASH score. Radiographic union was noted with regular follow up x-rays. 2 cases of nonunion and 5 cases of malunion were noticed in conservatively treated patients whereas all patients in surgical group went for union.

95% of patients in Surgical group continued with regular work compared to 70% in conservative group. There was no pain in 95% of patients in Surgical group compared to 70% in Conservaive group after 6 months of follow up.

CONCLUSION

CONCLUSION

In this study, we observed better functional outcome in Surgically treated patients compared to Conservatively managed patients.

We achieved excellent functional outcome and did not encounter either delayed union or nonunion in surgical group.

While we stress that our findings such as improved DASH score, better constant score, early return to work, no nonunion, no malunion, decreased pain in surgical fixation with significant p-value of 0.005 in constant score and <0.001 in DASH scoreare applicable to certain subset (Robinson type 2B) of clavicle injuries but our data supports surgical fixation using anatomical precontoured locking compression plate in displaced midshaft clavicle fractures for better functional outcome, early return to work, saving man-hour, decreased non union and decreased mal union.

Hence we conclude that primary surgical fixation of midshaft clavicle fractures using anatomical precontoured locking compression plate in active adults gives better functional outcome, early return to work, decreased rates of nonunion and malunion and saves man-hour.

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67. Clavicular Caution: An Anatomic Study Of Neurovascular Structures Luke Robinson[a,], Federico Persico[b,], Eric Lorenz[c,], David Seligson.

PROFORMA

NAME :

AGE/SEX :

ADDRESS :

OCCUPATION :

DATE OF ADMISSION :

DATE OF SURGERY :

DATE OF DISCHARGE :

DIAGNOSIS :

INVOLVED SIDE :

MODE OF INJURY :

TIME OF ARRIVAL TO HOSPITAL AFTER INJURY:

INITIAL MANAGEMENT :

CLINICAL EXAMINATION :

ASSOCIATED INJURY :

CLASSIFICATION OF CLAVICLE FRACTURE :

TIME INTERVAL BETWEEN INJURY AND SURGERY :

PROCEDURE :

DIFFICULTY DURING SURGERY :

RADIOLOGICAL FINDINGS (PRE OPERATIVE) :

POST OPERATIVE X RAYS :

DRAIN REMOVED ON :

SUTURE REMOVAL DONE ON:

MOBILISATION STARTED ON :

COMPLICATIONS :

FOLLOW UP PERIOD :

RADIOLOGICAL UNION :

CONSTANT SCORE :

DASH SCORE :

FUNCTIONAL OUTCOME :

CONSENT FORM
நோயாளிஒப்புதல்படிவம்

ஆராய்ச்சியின் விவரம்:கீழ்கழுத்துபகுதியில் உள்ள எலும்பு முறிவிற்கு உலோக தகட்டை சிறு கீறலின் மூலம் பொருத்தும் அறுவை சிகிச்சையின் பயன்களை அறியும் ஆய்வரிக்கை

ஆராய்ச்சி மையம்: அரசு கீழ்பாக்கம் மருத்துவக் கல்லூரி மருத்துவமனை
நோயாளியின் பெயர்: நோயாளியின் வயது:

பதிவு எண்:

நோயாளி கீழ்கண்டவற்றுள் கட்டங்களை (✓) செய்யவும்

1. மேற்குறிப்பிட்டுள்ள ஆராய்ச்சியின் நோக்கத்தையும் பயனையும் முழுவதுமாக புரிந்துகொண்டேன். மேலும் எனது அனைத்து சந்தேகங்களையும் கேட்டு அதற்கான விளக்கங்களையும் தெளிவுபடுத்திக் கொண்டேன்.
2. மேலும் இந்த ஆராய்ச்சிக்கு எனது சொந்த விருப்பத்தின் பேரில் பங்கேற்கிறேன் என்றும், மேலும் எந்த நேரத்திலும் எவ்வித முன்னறிவிப்புமின்றி இந்த ஆராய்ச்சியிலிருந்து விலக முழுமையான உரிமை உள்ளதையும், இதற்கு எவ்வித சட்ட பிணைப்பும் இல்லை என்பதையும் அறிவேன்.
3. ஆராய்ச்சியாளரோ, ஆராய்ச்சி உதவியாளரோ, ஆராய்ச்சி உபயத்தாரோ, ஆராய்ச்சி பேராசிரியரோ, ஒழுங்குநெறி செயற்குழு உறுப்பினர்களோ எப்போது வேண்டுமானாலும் எனது அனுமதியின்றி எனது உள்நோயாளி பதிவுகளை இந்த ஆராய்ச்சிக்காகவோ அல்லது எதிர்கால பிற ஆராய்ச்சிகளுக்காகவோ பயன்படுத்திக்கொள்ளலாம் என்றும், மேலும் இந்த நிபந்தனை நான் இவ்வாரய்ச்சியிலிருந்து விலகினாலும் தகும் என்றும் ஒப்புக்கொள்கிறேன். ஆயினும் எனது அடையாளம் சம்பந்தப்பட்ட எந்த பதிவுகளும் (சட்டபூர்வமான தேவைகள் தவிர) வெளியிடப்படமாட்டாது என்ற உறுதிமொழியின் பெயரில் இந்த ஆராய்ச்சியிலிருந்து கிடைக்கப்பெறும் முடிவுகளை வெளியிட மறுப்பு தெறிவிக்கமாட்டேன் என்று உறுதியளிக்கின்றேன்.
4. இந்த ஆராய்ச்சிக்கு நான் முழுமனதுடன் சம்மதிக்கின்றேன் என்றும் மேலும் ஆராய்ச்சிக் குழுவினர் எனக்கு அளிக்கும் அறிவுரைகளை தவறாது பின்பற்றுவேன் என்றும் இந்த ஆராய்ச்சி காலம் முழுவதும் எனது உடல் நிலையில் ஏதேனும் மாற்றமோ அல்லது எதிர்பாராத பாதகமான விளைவோ எற்படுமாயின் உடனடியாக ஆராய்ச்சி குழுவினரை அணுகுவேன் என்றும் உறுதியளிக்கின்றேன்.
5. இந்த ஆராய்ச்சிக்குத் தேவைப்படும் அனைத்து மருத்துவப் பரிசோதனைகளுக்கும் ஒத்துழைப்பு தருவேன் என்று உறுதியளிக்கின்றேன்.
6. இந்த ஆராய்ச்சிக்கு யாருடைய வற்புருத்தலுமின்றி எனது சொந்த விருப்பத்தின் பேரிலும் சுயஅறிவுடனும் முழுமனதுடனும் சம்மத்திக்கின்றேன் என்று இதன் மூலம் ஒப்புக்கொள்கிறேன்.

நோயாளியின் கையொப்பம் / பெருவிரல் கைரேகை ஆராய்ச்சியாளரின்
கையொப்பம்இடம்: தேதி:

CONSTANT SCORE TECHNIQUE

This scoring system consists of four variables that are used to assess the function of the shoulder. The right and left shoulders are assessed separately.

The subjective variables are pain and ADL (sleep, work, recreation / sport) which give a total of 35 points. The objective variables are range of motion and strength which give a total of 65 points.

SUBJECTIVE

Pain	15
ADL (sleep, work, recreation/sport)	20

OBJECTIVE

Range of motion	40
Strength	25

RANGE OF MOTION

Active range of motion should always be measured as part of the Constant Score.

There is specific way recommended by ESSES (European Society for Shoulder and Elbow Surgery) for measuring range of motion. Patient should be sitting on a chair or bed, with weight evenly distributed between the ischialtuberosities. No rotation of the upper body should take place during the examination.

In case of active motion, the patient lifts his arm to a pain free level. The range of motion is determined by the number of degrees at which the pain starts. If one measures the active range of motion with pain, this should be stated. The Constant score cannot be applied beyond the initiation of pain.

In the Constant score system there is precise information given about how the points should be calculated. Keep in mind that 150 degrees of flexion give 8 points, while 151 degrees give 10 points.

Forward flexion 10 points

0-30	0
31-60	2
61-90	4
91-120	6
121-150	8
151-180	10

Abduction 10 points

0-30	0
31-60	2

61-90	4
91-120	6
121-150	8
151-180	10

External rotation 10 points (hand is not allowed to touch the head)

Not reaching the head	0
Hand behind head with elbow forward	2
Hand behind head with elbow back	2
Hand on top of head with elbow forward	2
Hand on top of head with elbow back	2
Full elevation from on top of head	2

Internal rotation 10 points

End of the thumb to lateral thigh	0
End of the thumb to buttock	2
End of the thumb to lumbosacral junction	4
End of the thumb to L3 (waist)	6
End of the thumb to T 12	8
End of the thumb to T 7(interscapular)	10

STRENGTH

Strength is given a maximum of 25 points in the Constant Score. The significance and technique of strength measurement has been, and continues to be, the subject of much discussion.

The European Society for Shoulder and Elbow Surgery measures strength according to the following method:

- A spring balance is attached distal on the forearm.
- Strength is measured by keeping the arm in 90 degrees of elevation in the plane of the scapula (30 degrees in front of the coronal plane) and elbow should be straight.
- Palm of the hand should be facing the floor (pronation).
- The patient should be asked to maintain this resisted elevation for 5 seconds.
- It should be repeated 3 times immediately one after another.
- The average in pound should be (lb) is noted.
- The measurement should be pain free. If pain is involved the patient gets 0 points.
- If patient is unable to achieve 90 degrees of elevation in the scapula plane the patient gets 0 points.

0 = Less than 1 kg
3 = 1 kg - 2 kg
5 = 2 kg - 3 kg
7 = 3 kg - 4 kg
9 = 4 kg - 5 kg
11 = 5 kg - 6 kg
13 = 6 kg - 7 kg
15 = 7 kg - 8 kg
17 = 8 kg - 9 kg
19 = 9 kg - 10 kg
21 = 10 kg - 11 kg

23 = 11 kg - 12 kg

25 = 12 kg or above

SCORING

0-55 - POOR

56-70 - MODERATE

71-85 - GOOD

>85 - EXCELLENT

DASH QUESTIONNAIRE

Patients are requested to answer all sections and respond based on their ability to perform activities over the past week. Only one answer per question is allowed.At least 27 of the 30 items **must** be completed for scoring.

The score is calculated as; the assigned values are summed and divided by the number of questions answered. This value is transformed to a score out of 100 by subtracting 1 and multiplying by 25.

DASH = { (sum of *n* responses) - 1} x 25 *n* = total number of questions answered

1.	Open a tight or new jar	**No difficulty**	**Mild difficulty**	**Moderate difficulty**	**Severe difficulty**	**Unable**
2.	Write	**No difficulty**	**Mild difficulty**	**Moderate difficulty**	**Severe difficulty**	**Unable**
3.	Turn a key	**No difficulty**	**Mild difficulty**	**Moderate difficulty**	**Severe difficulty**	**Unable**
4.	Prepare a meal	**No difficulty**	**Mild difficulty**	**Moderate difficulty**	**Severe difficulty**	**Unable**
5.	Push open a heavy door	**No difficulty**	**Mild difficulty**	**Moderate difficulty**	**Severe difficulty**	**Unable**
6.	Place an object on a shelf above your head	**No difficulty**	**Mild difficulty**	**Moderate difficulty**	**Severe difficulty**	**Unable**
7.	Do heavy household chores (eg wash walls, wash floors)	**No difficulty**	**Mild difficulty**	**Moderate difficulty**	**Severe difficulty**	**Unable**
8.	Garden or do yard work	**No difficulty**	**Mild difficulty**	**Moderate difficulty**	**Severe difficulty**	**Unable**
9.	Make a bed	**No difficulty**	**Mild difficulty**	**Moderate difficulty**	**Severe difficulty**	**Unable**
10.	Carry a shopping bag or briefcase	**No difficulty**	**Mild difficulty**	**Moderate difficulty**	**Severe difficulty**	**Unable**

11.	Carry a heavy object (over 10 lbs)	**No difficulty**	**Mild difficulty**	**Moderate difficulty**	**Severe difficulty**	**Unable**
12.	Change a lightbulb overhead	**No difficulty**	**Mild difficulty**	**Moderate difficulty**	**Severe difficulty**	**Unable**
13.	Wash or blow dry your hair	**No difficulty**	**Mild difficulty**	**Moderate difficulty**	**Severe difficulty**	**Unable**
14.	Wash your back	**No difficulty**	**Mild difficulty**	**Moderate difficulty**	**Severe difficulty**	**Unable**
15.	Put on a pullover sweater	**No difficulty**	**Mild difficulty**	**Moderate difficulty**	**Severe difficulty**	**Unable**
16.	Use a knife to cut food	**No difficulty**	**Mild difficulty**	**Moderate difficulty**	**Severe difficulty**	**Unable**
17.	Recreational activities which require little effort (egcardplaying, knitting, etc)	**No difficulty**	**Mild difficulty**	**Moderate difficulty**	**Severe difficulty**	**Unable**
18.	Recreational activities in which you take some force or impact through your arm, shoulder or hand (eg golf, hammering, tennis, etc)	**No difficulty**	**Mild difficulty**	**Moderate difficulty**	**Severe difficulty**	**Unable**
19.	Recreational activities in which you move your arm freely (eg playing frisbee, badminton, etc)	**No difficulty**	**Mild difficulty**	**Moderate difficulty**	**Severe difficulty**	**Unable**
20.	Manage transportation needs (getting from one place to another)	**No difficulty**	**Mild difficulty**	**Moderate difficulty**	**Severe difficulty**	**Unable**
21.	Sexual activities	**No difficulty**	**Mild difficulty**	**Moderate difficulty**	**Severe difficulty**	**Unable**

22.	During the past week, *to what extent* has your arm, shoulder or hand problem interfered with your normal social activities with family, friends, neighbours or groups?	**Not at all**	**Slightly**	**Moderately**	**Quite a bit**	**Extremely**
23.	During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder or hand problem?	**Not limited at all**	**Slightly limited**	**Moderately limited**	**Very limited**	**Unable**
24.	Arm, shoulder or hand pain	**None**	**Mild**	**Moderate**	**Severe**	**Extreme**
25.	Arm, shoulder or hand pain when you performed any specific activity	**None**	**Mild**	**Moderate**	**Severe**	**Extreme**
26.	Tingling (pins and needles) in your arm, shoulder or hand	**None**	**Mild**	**Moderate**	**Severe**	**Extreme**
27.	Weakness in your arm, shoulder or hand	**None**	**Mild**	**Moderate**	**Severe**	**Extreme**
28.	Stiffness in your arm, shoulder or hand	**None**	**Mild**	**Moderate**	**Severe**	**Extreme**
29.	During the past week, how much difficulty have you had	**No difficulty**	**Mild difficulty**	**Moderate difficulty**	**Severe difficulty**	**So much I can't sleep**

	sleeping because of the pain in your arm, shoulder or hand?					
30.	I feel less capable, less confident or less useful because of my arm, shoulder or hand problem	**Strongly disagree**	**Disagree**	**Neither agree nor disagree**	**Agree**	**Strongly agree**

KEYS TO MASTER CHART

SEX

M= MALE

F= FEMALE

MODE OF INJURY

SOF= SHAFT OF FEMUR

AST= ASSAULT

SF= SELF FALL

RTA= ROAD TRAFFIC ACCIDENT

SHOULDER MOVEMENTS

ER= EXTERNAL ROTATION

IR= INTERNAL ROTATION

TIME BETWEEN INJURY AND SURGERY/TREATMENT

bet= BETWEEN

inj= INJURY

surg= surgery

trmt= TREATMENT

ASSOCIATED INJURY

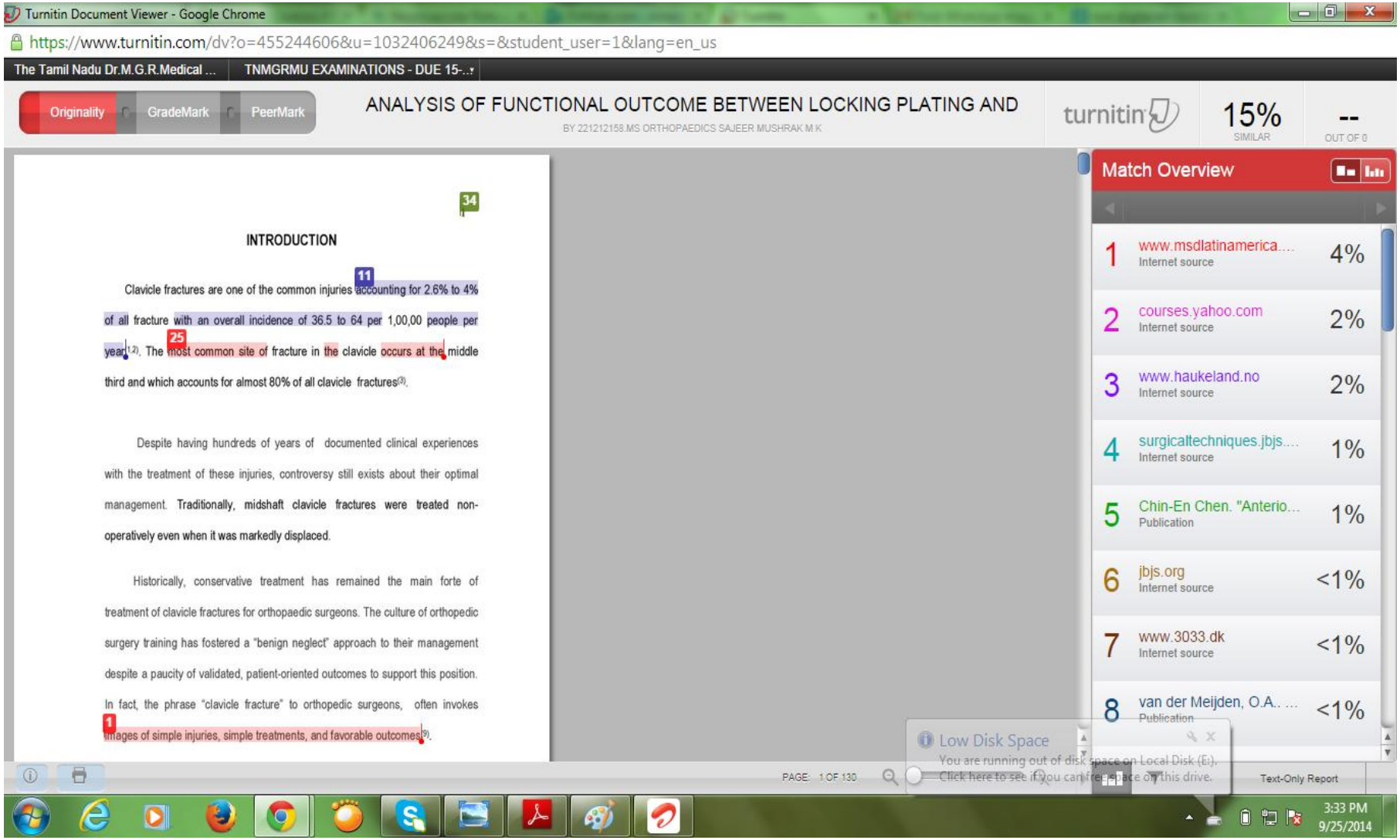
Lat.= LATERAL

MASTER CHART 1- SURGICAL FIXATION WITH LOCKING PLATE

S. No	Name	Age	Sex	Mode of Injury	Limb involved	Robinson Classification	Associated Injury	Time bet. Inj & Surg in days	Follow-up in months	Time for union in weeks	ROM in degrees				Complications	Constant Score	Result	DASH SCORE	
											Flexion	Abduction	ER	IR				3 months	6 months
1	AJZ	32	M	RTA	R	2B1		6	16	6	180	180	90	85		96	Excellent	24	10
2	MTO	48	M	RTA	L	2B1		2	8	6	170	170	70	70		96	Excellent	32	8
3	PQN	32	M	AST	R	2B1	Both bones leg	1	13	6	170	165	70	70		92	Excellent	35	10
4	NSV	48	M	AST	R	2B1		4	7	6	180	180	80	70		94	Excellent	30	9
5	KNM	33	M	RTA	R	2B1	#SOF	5	8	7	170	170	70	75		94	Excellent	26	9
6	FAS	34	F	SF	R	2B1		2	11	6	180	180	85	90		96	Excellent	32	11
7	TRE	25	M	RTA	L	2B1	#SOF	4	18	6	175	175	80	80	Superficial infection	98	Excellent	32	7
8	LSM	20	M	RTA	R	2B1		2	6	6	180	180	90	85		98	Excellent	30	9
9	KIG	28	F	SF	L	2B1	Bimalleolar#	1	8	7	170	170	70	70	Superficial infection	92	Excellent	28	8
10	MIS	27	M	SF	R	2B1		5	6	6	170	175	70	80		94	Excellent	28	12
11	BQT	64	F	AST	L	2B1		8	14	8	145	145	65	65	Hardware irritation	72	Good	33	10
12	XVR	56	M	RTA	R	2B2		4	20	6	180	180	80	80		98	Excellent	27	10
13	KKR	44	M	RTA	L	2B2	# Metatarsal	1	16	7	150	150	70	70	Hardware irritation	85	Good	26	18
14	DSA	32	F	SF	R	2B2		3	4	6	170	175	70	70		92	Excellent	24	9
15	VKN	40	M	RTA	R	2B2		2	14	7	170	165	80	80	Numbness clavicular region	96	Excellent	30	11
16	AHD	29	M	RTA	L	2B2		4	18	6	165	165	70	70		92	Excellent	31	15
17	AKS	28	F	AST	R	2B2		2	8	6	180	180	85	85		98	Excellent	32	18
18	SKO	25	M	SF	L	2B1		4	10	6	180	180	85	85		98	Excellent	33	6
19	PPB	27	F	SF	R	2B2		3	12	7	150	150	70	70	laterally unseated plate	85	Good	27	15
20	GEP	40	M	RTA	L	2B2		4	16	6	170	170	70	70		92	Excellent	26	12

MASTER CHART 2 - CONSERVATIVE TREATMENT

S. No	Name	Age	Sex	Mode of Injury	Limb involved	Robinson Classification	Associated Injury	Time bet. Inj & Tmt. in days	Follow-up in months	Time for union in weeks	ROM in degrees				Complications	Constant Score	Result	DASH SCORE	
											Flexion	Abduction	ER	IR				3 months	6 months
1	MTH	32	M	RTA	R	2B2		6	16	10	150	150	70	65		74	Good	32	27
2	KML	48	M	RTA	L	2B1		4	7	6	170	170	70	70		96	Excellent	28	15
3	VRL	33	F	AST	R	2B1		1	13	7	160	155	65	65		70	Fair	35	26
4	LNS	48	M	AST	R	2B1		4	7	6	180	180	80	70		94	Good	30	22
5	GTV	33	M	RTA	R	2B1		5	8	9	160	160	65	65		80	Good	34	23
6	HVM	34	F	SF	R	2B1		2	11	6	160	160	70	70		80	Good	32	20
7	ALE	25	M	RTA	L	2B1	sof #	4	18	8	160	160	60	70		84	Good	36	26
8	DIN	31	M	RTA	R	2B1		2	6	8	180	180	90	85		98	Excellent	30	14
9	VSN	28	F	AST	L	2B1	Lat. malleoli#	1	9	7	170	170	70	70		92	Excellent	28	15
10	RRV	27	M	AST	R	2B1		5	6	6	170	175	70	80		94	Excellent	29	14
11	KTR	64	M	AST	L	2B1		8	14	8	145	145	65	65		72	Good	33	23
12	NEP	56	F	RTA	R	2B1		4	20	on unio	110	110	50	55	Non union	55	Poor	40	30
13	YRS	44	M	RTA	L	2B2		1	16	7	150	150	70	70		85	Good	34	24
14	RIN	32	F	SF	R	2B1		4	6	7	170	175	70	70		92	Excellent	24	18
15	TEP	55	M	RTA	R	2B2		2	13	7	170	165	80	80		96	Excellent	30	16
16	LIM	32	M	SF	L	2B1		4	18	6	165	165	70	70		85	Good	34	15
17	BOM	33	F	AST	R	2B1		2	8	8	160	160	75	75		82	Good	36	28
18	MIV	25	M	SF	L	2B2		4	12	9	155	155	85	85		84	Good	38	27
19	FKN	27	F	SF	L	2B2		3	11	7	150	150	70	70		85	Good	38	25
20	SMY	40	F	AST	L	2B2		7	16	on unio	100	90	50	50	Non union	54	Poor	44	28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INTRODUCTION
Clavicle fractures are one of the common injuries accounting for 2.6% to 4% of all fracture with an overall incidence of 36.5 to 64 per 1,00,00 people per year[1,2]. The most common site of fracture in the clavicle occurs at the middle third and which accounts for almost 80% of all clavicle fractures[3].
Despite having hundreds of years of documented clinical experiences with the treatment of these injuries, controversy still exists about their optimal management. Traditionally, midshaft clavicle fractures were treated non-operatively even when it was markedly displaced.
Historically, conservative treatment has remained the main forte of treatment of clavicle fractures for orthopaedic surgeons. The culture of orthopedic surgery training has fostered a "benign neglect" approach to their management despite a paucity of validated, patient-oriented outcomes to support this position. In fact, the phrase "clavicle fracture" to orthopedic surgeons, often invokes images of simple injuries, simple treatments, and favorable outcomes[3].
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GOVT.KILPAUK MEDICAL COLLEGE,
CHENNAI-10
Ref.No.5098/ME-1/Ethics/2014 Dt:10.07.2014.
CERTIFICATE OF APPROVAL

The Institutional Ethical Committee of Govt. Kilpauk Medical College, Chennai reviewed and discussed the application for approval "A Comparative Study of functional outcome between locking plating and conservative management of middle third clavicle fractures at Kilpauk Medical College Hospital, Chennai " – For Project Work submitted by Dr.Sajeer Mushrak.M.K, MS (Ortho), PG Student, KMC, Chennai-10.

The Proposal is APPROVED.

The Institutional Ethical Committee expects to be informed about the progress of the study any Adverse Drug Reaction Occurring in the Course of the study any change in the protocol and patient information /informed consent and asks to be provided a copy of the final report.

8/8/14

GOVT. KILPAUK MEDICAL COLLEGE
8 AUG 2014
Kilpauk, Chennai-10.

CHAIRMAN,
Ethical Committee
Govt.Kilpauk Medical College,Chennai

8/8/2014.