**B.L.D.E. (DEEMED TO BE UNIVERSITY)**

**S.H.R.I. B M PATIL MEDICAL COLLEGE, HOSPITAL & RESEARCH CENTRE, VIJAYAPURA, KARNATAKA.**

PROFORMA FOR REGISTRATION OF SUBJECT FOR DISSERTATION

# TITLE OF THE TOPIC

# "FUNCTIONAL OUTCOME OF INTRAMEDULLARY INTERLOCKING NAIL IN THE TREATMENT OF SHAFT HUMERUS FRACTURES - A PROSPECTIVE STUDY"


BY

**DR. CHALLA VEERA NAVEEN KUMAR REDDY**

P. G. IN ORTHOPAEDICS

UNDER THE GUIDANCE OF

**DR. SANDEEP NAIK**

M.S.ORTHOPAEDICS

PROFESSOR (Additional)

DEPARTMENT OF ORTHOPAEDICS

BLDE( DEEMED TO BE UNIVERSITY)

VIJAYAPURA.

# FUNCTIONAL OUTCOME OF INTRAMEDULLARY INTERLOCKING NAIL IN THE TREATMENT OF SHAFT HUMERUS FRACTURES - A PROSPECTIVE STUDY

**By**

**DR. CHALLA VEERA NAVEEN KUMAR REDDY**

DISSERTATION SUBMITTED TO

IN PARTIAL FULFILMENT FOR THE DEGREE OF

## MASTER OF SURGERY IN ORTHOPAEDICS

UNDER THE GUIDANCE OF

**DR. SANDEEP NAIK M.S. Ortho**

PROFESSOR (Additonal)

DEPARTMENT OF ORTHOPAEDICS

B. L. D. E. UNIVERSITY'S SHRI B. M. PATIL MEDICAL COLLEGE, HOSPITAL & RESEARCH CENTRE

VIJAYAPURA 586103

2025

**B.L.D.E UNIVERSITY'S**

**SHRI B. M. PATIL MEDICAL COLLEGE, HOSPITAL & RESEARCH CENTRE, VIJAYAPURA**

## DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation/thesis entitled **"FUNCTIONAL OUTCOME OF INTRAMEDULLARY INTERLOCKING NAIL IN THE TREATMENT OF SHAFT HUMERUS FRACTURES - A PROSPECTIVE STUDY"** is a bonafide and genuine research work carried out by me under the guidance of **DR. SANDEEP NAIK** M.S.Ortho, Professor (Additional), Department of Orthopaedics, Shri B.M. Patil Medical College, Vijayapura, Karnataka.

Date:

Place: Vijayapura

**Dr. CHALLA VEERA NAVEEN KUMAR REDDY**

**B.L.D.E UNIVERSITY'S**

**SHRI B. M. PATIL MEDICAL COLLEGE, HOSPITAL & RESEARCH CENTRE, VIJAYAPURA**

## CERTIFICATE BY THE GUIDE

This is to certify that the dissertation entitled **"FUNCTIONAL OUTCOME OF INTRAMEDULLARY INTERLOCKING NAIL IN THE TREATMENT OF SHAFT HUMERUS FRACTURES - A PROSPECTIVE STUDY"** is a bonafide and genuine research work carried out by **Dr.CHALLA VEERA NAVEEN KUMAR REDDY** in partial fulfillment of the requirement for the degree of MS in Orthopaedics.

Date:

Place: Vijayapura

**Dr. SANDEEP NAIK** M.S Ortho
Professor (Additional),
Department of Orthopaedics
BLDE University's
Shri B.M Patil Medical College
Hospital and Research Centre,
Vijayapura.

**B.L.D.E UNIVERSITY'S**

**SHRI B. M. PATIL MEDICAL COLLEGE, HOSPITAL & RESEARCH CENTRE, VIJAYAPURA**

## ENDORSEMENT BY THE HOD

This is to certify that the dissertation entitled **"FUNCTIONAL OUTCOME OF INTRAMEDULLARY INTERLOCKING NAIL IN THE TREATMENT OF SHAFT HUMERUS FRACTURES - A PROSPECTIVE STUDY"** is a bonafide research work done by **Dr. CHALLA VEERA NAVEEN KUMAR REDDY** under the guidance of, **Dr. SANDEEP NAIK** MS Ortho, Professor (Additional), Department of Orthopaedics, Shri B.M Patil Medical College, Vijayapura.

Date:

Place: Vijayapura

**Dr. S. S. NANDI**
Professor and HOD,
Department of Orthopaedics,
B.L.D.E. University's
Shri. B. M. Patil Medical College
Hospital & Research Centre, Vijayapura.

**B.L.D.E UNIVERSITY'S**

**SHRI B. M. PATIL MEDICAL COLLEGE, HOSPITAL & RESEARCH CENTRE, VIJAYAPURA**

## ENDORSEMENT BY THE PRINCIPAL

This is to certify that the dissertation entitled **"FUNCTIONAL OUTCOME OF INTRAMEDULLARY INTERLOCKING NAIL IN THE TREATMENT OF SHAFT HUMERUS FRACTURES - A PROSPECTIVE STUDY"** is a bonafide research work done by **Dr. CHALLA VEERA NAVEEN KUMAR REDDY** under the guidance of, Dr. SANDEEP NAIK MS Ortho, Professor (Additional), Department of Orthopaedics, Shri B.M Patil Medical College, Vijayapura.

Date:

Place: Vijayapura

**DR. ARAVIND PATIL**

Pricipal,

B.L.D.E University's Shri B. M. Patil

Medical College & Research Centre

Vijayapura.

**B.L.D.E UNIVERSITY'S**

**SHRI B. M. PATIL MEDICAL COLLEGE, HOSPITAL & RESEARCH CENTRE, VIJAYAPURA**

## COPYRIGHT

## DECLARATION BY THE CANDIDATE

I hereby declare that the BLDE (Deemed to be University), Karnataka shall have the rights to preserve, use and disseminate this dissertation / thesis in print or electronic format for academic / research purpose.

Date:
Place: Vijayapura

**Dr. CHALLA VEERA NAVEEN KUMAR REDDY**

# ACKNOWLEDGEMENT

On completion of my post graduation journey and this scientific document, I would like to acknowledge the immense help received from my mentors in the department of orthopaedics.

With privilege and respect I like to express my gratitude and indebtedness to my Guide, Dr. Sandeep Naik, for his constant inspiration, extensive encouragement and loving support, which he rendered in pursuit of my post-graduate studies and in preparing this dissertation.

I am forever grateful to Dr. S. S. Nandi, HOD of department of orthopaedics for his guidance and encouragement provided to me, to achieve new heights professionally over my course period.

I am grateful to Prof's. Dr. Ashok Nayak and Dr. Ravi kumar biradar for their guidance, encouragement and inspiration.

I am thankful to Asso. Prof's Dr. Dayanand B.B. , Dr. Shreepad Kulkarni, Dr.Rajkumar Bagewadi, Dr. Gireesh Khodnapur and Dr. Anil Bulagond for their guidance, encouragement and inspiration.

I am thankful to, Dr. Shrikant Kulkarni, Dr. Prashant Kenganal, Dr. Vijay Kumar Patil , Dr. Sahebagouda Patil, Dr. Vijay Vittal Mundewadi, Dr. Bhimanagouda Biradar, Dr. Wadiraj Kulkarni, Dr. Vivekanand Nidoni and Dr. Shivaraj Sajjan for their great help.

I am extremely thankful to Prof. Dr. Aravind Patil , Principal, of B.L.D.E.U'S Shri. B.M. Patil Medical College, Hospital and Research Centre, Vijayapura, for permitting me to utilize resources in completion of my work.

My thanks to one and all staff of Library, Orthopaedics Department and Hospital for their co-operation in my study.

I am thankful to my colleagues Dr. Anant, Dr. Charan, Dr. Kyathi, Dr. Harish, Dr. Manish, Dr. Ajay, Dr. Pranav, Dr. Rahul, Dr. Pranav teja, Dr. Anand and Dr. Sudev for their advice, suggestions and co-operation in my journey.

Last but not the least; I convey my heartfelt gratitude to all my patients, without whose co-operation, this study would be incomplete.

**DR. CHALLA VEERA**
**NAVEEN KUMAR REDDY**

# ABSTRACT


**INTRODUCTION :**

Humerus shaft fractures are common orthopedic injuries, often resulting from trauma and the choice of treatment remains a topic of debate. Intramedullary interlocking nailing is a minimally invasive surgical technique that provides excellent bio-mechanical stability, particularly in diaphyseal fractures and facilitates early mobilization. This prospective study evaluates the functional outcomes of intramedullary interlocking nailing in the treatment of Shaft humerus fractures.

**OBJECTIVES :**

- To examine the functional results of intramedullary interlocking nails used to treat closed shaft humerus fractures.

- To study the common complications associated with humerus nailing, such as non-union rate, infection, rotator cuff dysfunction and need for secondary procedures.

**MATERIALS AND METHODS :**

The present study involved 40 cases with shaft humerus fractures treated with Intramedullary Interlocking nails. Patient were followed up for minimum of 6 months. Inclusion criteria were patients of age above 18 years and below 70 years with closed and segmental fractures. Functional outcome evaluation was done using DASH score. Radio logical union, intra-operative data, and complications were documented.

**RESULTS :**

The study observed fracture union in 95% of cases, with an average time to union of 10-16weeks.At the final follow-up, the average mean DASH score was 16.51, indicating adequate elbow, arm, and shoulder function. Out of 40 patients, 6(15%) patients had excellent functional outcomes,26(65%) patients had good results, 6(15%) patients had fair outcome and with 5% having poor outcome which needed secondary procedures for union.

**CONCLUSION :**

Intramedullary interlocking nailing is an effective and reliable method for managing shaft humerus fractures, providing excellent functional outcomes and high rates of fracture union and acceptable complications. Early mobilization and minimal surgical morbidity make it a good option. Intamedullary interlocking nailing for humerus shaft fractures results in significant functional recovery, as evidenced by improved DASH scores at 6 months. This highlights its efficacy as a minimally invasive treatment option with favorable long-term outcomes.

**KEYWORDS :**

Humerus shaft fractures, intramedullary interlocking nails, Functional outcomes, DASH score.

# LIST OF ABBREVATIONS

| | |
|---|---|
| AO | ARBEITSGEMEINSCHAFT FUR OSTEOSYNTHESEFRAGEN |
| CM | CENTIMETER |
| DASH | DISABILITIES OF ARM, SHOULDER AND HAND |
| IMILN | INTRAMEDULLARY INTERLOCKING NAILING |
| OTA | ORTHOPAEDICS TRAUMA ASSOCIATION |
| IMN | INTRAMEDULLARY NAILING |
| ROM | RANGE OF MOVEMENTS |
| RNP | RADIAL NERVE PALSY |
| POP | PLASTER OF PARIS |
| HSF | HUMERUS SHAFT FRACTURES |
| ORIF | OPEN REDUCTION AND INTERNAL FIXATION |
| SD | STANDARD DEVIATION |
| VAS | VISUAL ANALOGUE SCORE |
| IRNI | IATROGENIC RADIAL NERVE INJURY |
| ASES | AMERICAN SHOULDER AND ELBOW SURGEONS |
| LCP | LOCKING COMPRESSION PLATE |
| UCLA | THE UNIVERSITY OF CALIFORNIA, LOS ANGELES |
| DCP | DYNAMIC COMPRESSION PLATE |
| RTA | ROAD TRAFFIC ACCIDENT |

# TABLE OF CONTENTS

# LIST OF FIGURES

# LIST OF TABLES

# LIST OF GRAPHS

# INTRODUCTION

Humerus Shaft Fractures are one of the most commonly seen fractures in upper limb, which accounts for 14% of all humeral fractures and 1-2%[1] of all fractures in the body and 2% to 5% are open fractures of all diaphyseal humerus fractures. The annual incidence is increased with age, ranging from 13 to 20 per 100,000 people[36].

The age distribution of humerus shaft fractures is bimodal, with the first peak occurring in men between the ages of 21 and 30 after high-energy trauma. Comminuted fractures and related soft tissue injuries are the most common outcome. The second peak usually occurs after low energy trauma and is observed in women between the ages of 60 and 80[66].

Historically, closed shaft humerus fractures have been considered benign, with a high primary healing rate when treated conservatively with a functional brace or a hanging arm cast. Malunion is always the result of the plaster cast's lack of reduction[2].

Operative management of humerus shaft fractures are commonly done by open reduction with plates and screws or with intramedullary nails. However, operative management with plates and screws is associated with complications like excessive soft tissue stripping, radial nerve injury, blood loss and a higher infection rate[3].

Intramedullary Interlocking Nailing is an alternative that does not have the above complications and also is a better option in osteoporosis, where plate fixation may have increased chances of implant failure. Intramedullary interlocking nailing however, are linked to a higher prevalence of shoulder pain and a higher rate of non-union[4]. Due to the complications, intramedullary interlocking nailing was reserved for treating segmental, pathological, and fractures with extensive comminution.

In the last decades, humeral nails design have had many technical developments, operative techniques and the usage of intramedullary interlocking nailing techniques have created interest in considering it an option in the primary treatment of shaft humerus fractures.

We conducted this prospective study to assess the functional results of intramedullary interlocking nailing in humerus shaft fractures and its associated problems to support the recent and existing literature.

# AIM AND OBJECTIVS OF THE STUDY

- To examine the functional results of intramedullary interlocking nails used to treat closed humerus shaft fractures.

- To study the complications associated with humerus nailings, such as non-union rate, infection and rotator cuff dysfunction.

# ANATOMY OF HUMERUS AND ARM

The proximal humerus articulates into shoulder and distal into elbow.

It has 3 parts.

1. The upper end
2. Body or the Shaft
3. The lower end

The rounded Head, the slender Neck, and the two tubercles, also known as the Tuberosities, make up the uppermost part of the humerus bone. The Humerus body or Shaft is in the form of a cylinder in the proximal portion. Moving on distally, the shape of a cylinder gradually becomes triangular in shape.

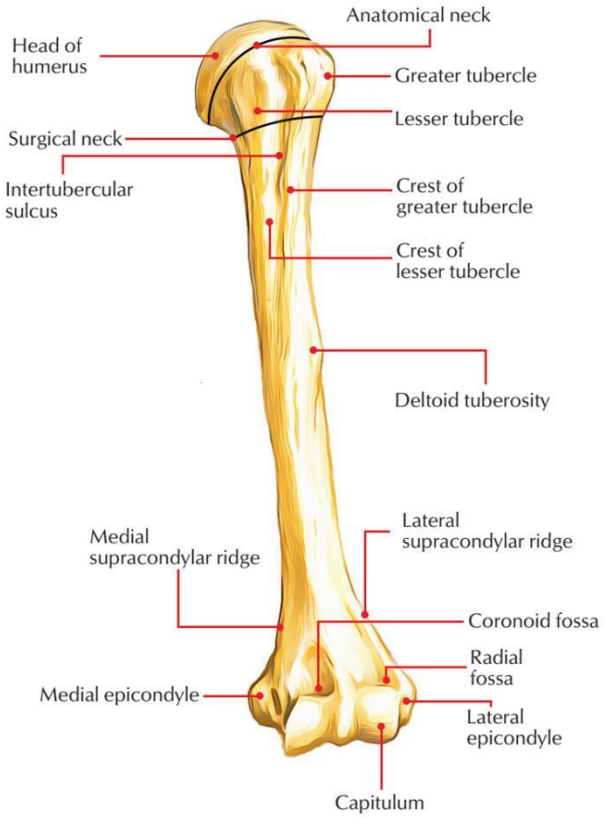



Fig 1 : Anatomy of humerus

The shape of the cylinder in the proximal offers the needed strength and also the resistance when encountering torsional forces or bending forces or a combination of both. Two epicondyles, three fossae, and Two Processes – Capitulum, Trochlea contribute the lower extremity of the Humerus.

Besides the anatomical neck, there is a construction, which is present below the greater and lesser tubercles also called greater and lesser tuberosities of humerus, is known as the Surgical Neck of the Humerus, because of its tendency to get fractured easily.

The Humerus bone is encased in a covering of muscles and soft tissues. Hence in case of fractures, which are uncomplicated, the outcome is favorable as the sheath of muscles and soft tissues promote healing.

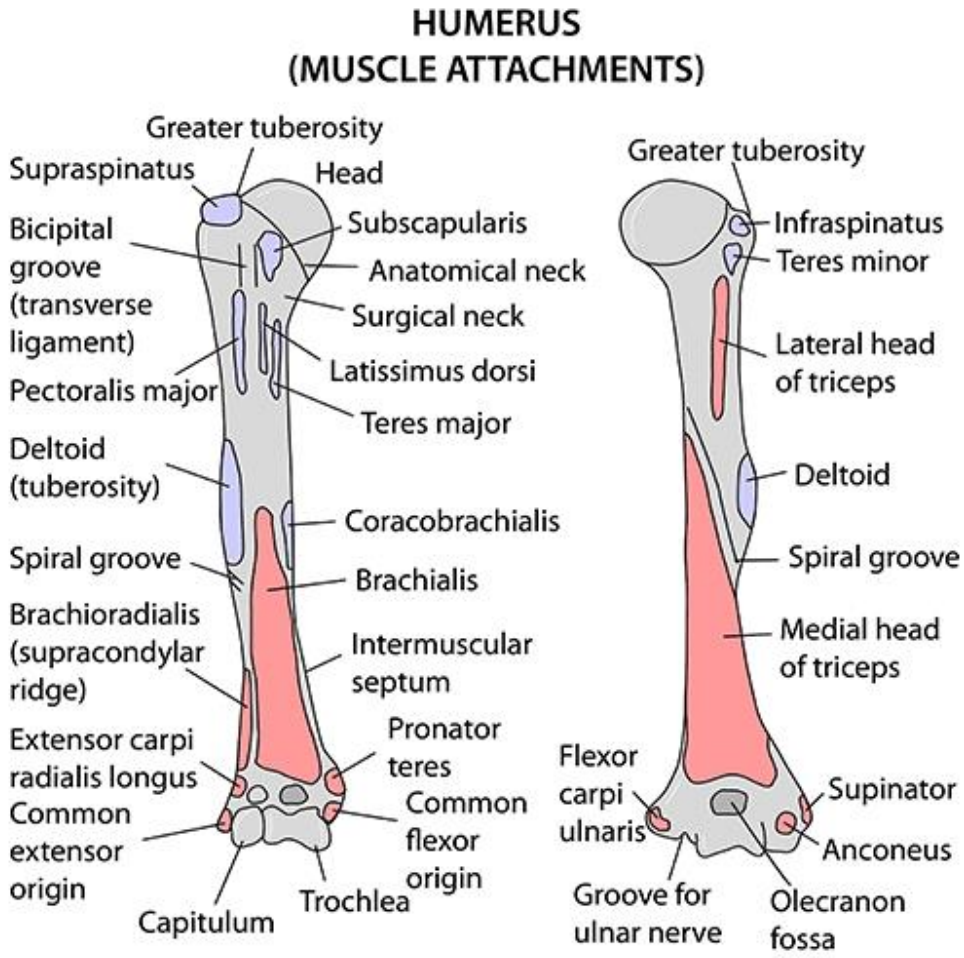
The Muscles which have its origin from the shaft of humerus are

1. The Brachialis,
2. The Brachioradialis and
3. The Triceps brachii with two heads – Medial and Lateral heads.

The Muscles which are inserted in the shaft of humerus are

1. The Pectoralis major,
2. The Deltoid,
3. The Teres major,
4. The Coracobrachialis, and
5. The Latissimus dorsi.

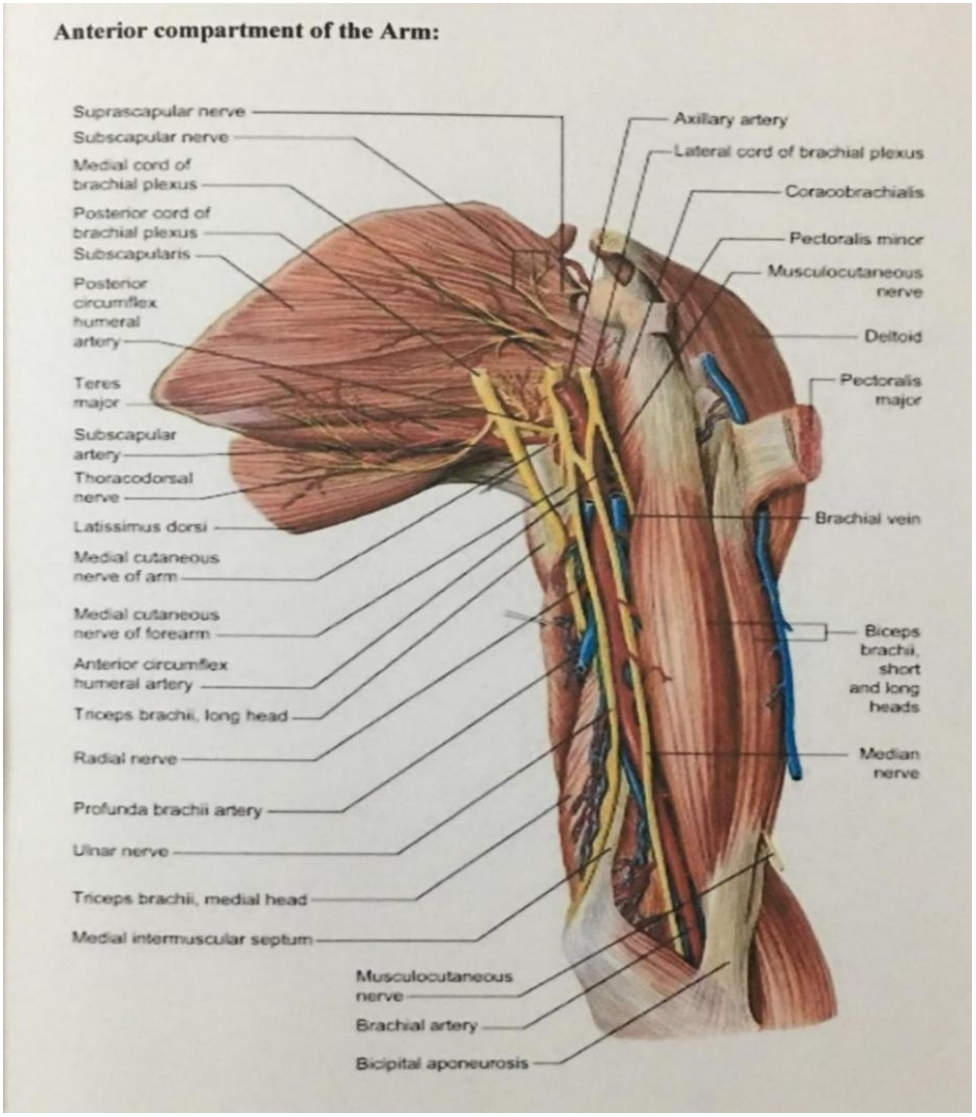
Fig 2 : Muscle attachments of Humerus




Depending on their site of insertion in the shaft of the humerus and also on the site of the fracture, these muscles exert specific types of forces on the fracture fragments which may be deforming. The humerus shaft is supplied principally by the nutrient artery and during the surgical management of fractures, caution should be maintained in preserving the artery[70].

The arm has two compartments : the anterior and the posterior, these two are separated by two thick fibrous bands that are known as the medial inter-muscular septa and the lateral inter-muscular septa.

Fig 3 : Anterior compartment of Arm




The structures of the anterior compartment are the brachial artery, median nerve, and musculocutaneous nerve. On their whole journey, they are present in the anterior compartment. Because they are located in the anterior compartment of the humerus, these structures are seen after the surgical exposure of the bone. The lateral cord and the medial cord both provide contributions to the median nerve, which is formed when the brachial plexus is formed. The median nerve passes medial to the brachial artery with close proximity to substance of the coracobrachialis and runs laterally along medial intermuscular septum which forms the anterior surface of the nerve. However, the median nerve does not supply the muscles that are located proximal to the elbow with any kind of innervation[100].

The anterior compartment is where the ulnar nerve first begins its journey after originating from the medial chord of the brachial plexus. From the Brachial plexus - posterior cord, from its terminal branch, arises the Radial nerve. The radial nerve starts its journey in the posterior compartment but after that, it goes via the anterior compartment[100].

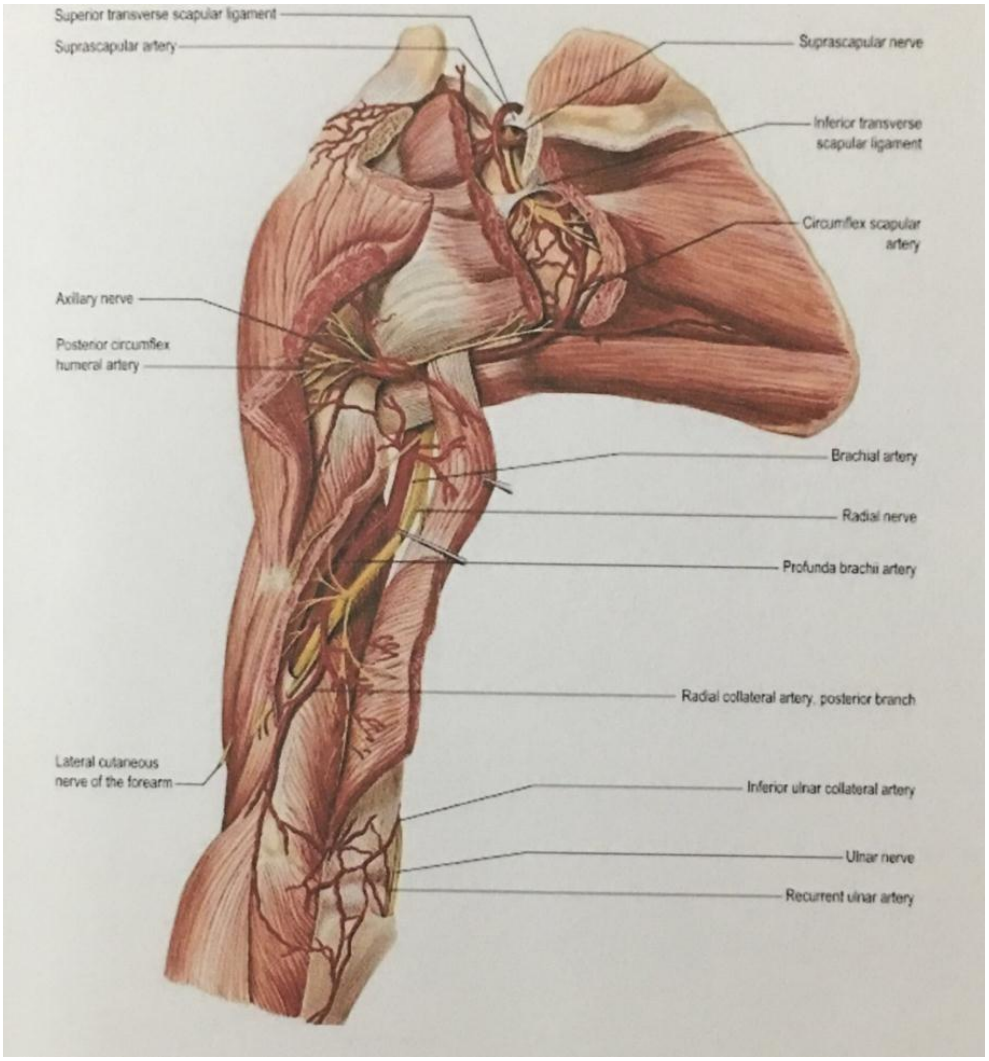



Fig 4 : Posterior Compartment of Arm

The radial nerve begins anteromedially, then it travels alongside the subscapularis proximally and it goes along to join with the profundabrachiimuscle. Then from there, through the lateral intermuscular septum, at about ten cm from the articulating distal surface, the nerve comes into the anterior compartment. At this level, as it is bound very tightly to the intermuscular septum, it is hence vulnerable to injuries caused due to traction and palsies of the radial nerve[71].

# SURGICAL ANATOMY

In the anterior compartment the median nerve, ulnar nerve and the brachial artery passes through at medial bicipital groove.

The radial grrove in the midshaft region is where the radial nerve occupies through the triceps and passes through the intermuscular septum at a deeper level.
The radial nerve is 10-14cm proximally to lateral epicondyle and 16-20cm proximally to medial epicondyle.

The posterior circumflex humeral artery and axillary nerve both begin posteriorly and approximately 5-6cm distal to the acromion they wrap around the surgical neck and about 3-7cm distal to the acromion, axillary nerve is located.


Fig 5 : Surgical Anatomy of humerus

# CLASSIFICATION

There is no universally acccepted classification for shaft humerus fractures. Depends on the factors influencing treatment they are classified.

"Depending on fracture pattern on radiographs :

a. Transverse
b. Oblique
c. Spiral
d. Segmental
e. Comminuted"

- condition of the bone : pathological or normal

- We can use Oestern and Tscherne classification for soft tissue injury :

1) Grade 0 - Minimal or no soft tissue injury
2) Grade 1 - Superficial abrasion/contusion, Simple fracture pattern
3) Grade 2 - Direct trauma, deep abrasions, muscle/skin contusion, Severe fracture pattern
4) Grade 3 - Extensive skin contusion or crushed skin or destruction of muscle, acute compartment syndrome[101].

- We can use Gustilo-Anderson classification for open fractures :

a) Grade I - clean, wound < 1cm
b) Grade II - no extensive soft tissue damage, wound >1cm but <10cm
c) Grade III - extensive soft tissue damage, typically high velocity injury, wound > 10cm

- IIIa - adequate soft tissue available to cover the fractured bone
- IIIb - IIIa injury with periosteal stripping and bone exposure
- IIIc - open fracture associated with vascular injury requiring repair[101].

# "AO CLASSIFICATION"[97]

"The humerus is designated Bone '1' and is further subdivide into equal 3rds as upper 1/3rd as proximal, middle 1/3rd as shaft and lower 1/3rd as distal. Hence, the shaft is designated as 1.2

Again these fractures are further subdivided into :
A - Simple fractures

- ❖ A1 - Spiral fracture
- ✓ A 1.1 - Fracture in proximal diaphysis
- ✓ A 1.2 - Fracture in middle diaphysis
- ✓ A 1.3 - Fracture in distal diaphysis

- ❖ A2 - Oblique fracture
- ✓ A 2.1 - Fracture in proximal diaphysis
- ✓ A 2.2 - Fracture in middle diaphysis
- ✓ A 2.3 - Fracture in distal diaphyis

- ❖ A3 - Transverse fracture
- ✓ A 3.1 - Fracture in proximal diaphysis
- ✓ A 3.2 - Fracture in middle diaphysis
- ✓ A 3.3 - Fracture in distal diaphysis

B - Wedge fractures where there is one or more intermediate fragments but after reduction cortical continuty is present between the proximal and distal fragments.

- ❖ B 1 - Spiral wedge
- ✓ B 1.1 - Fracture in proximal diaphysis
- ✓ B 1.2 - Fracture in middle diaphysis
- ✓ B 1.3 - Fracture in distal diaphysis

- ❖ B 2 - Bending wedge
- ✓ B 2.1 - Fracture in proximal diaphysis
- ✓ B 2.2 - Fracture in middle diaphysis
- ✓ B 2.3 - Fracture in distal diaphysis

- ❖ B 3 - Fragmented wedge
- ✓ B 3.1 - Fracture in proximal diaphysis
- ✓ B 3.2 - Fracture in middle diaphysis
- ✓ B 3.3 - Fracture in distal diaphysis

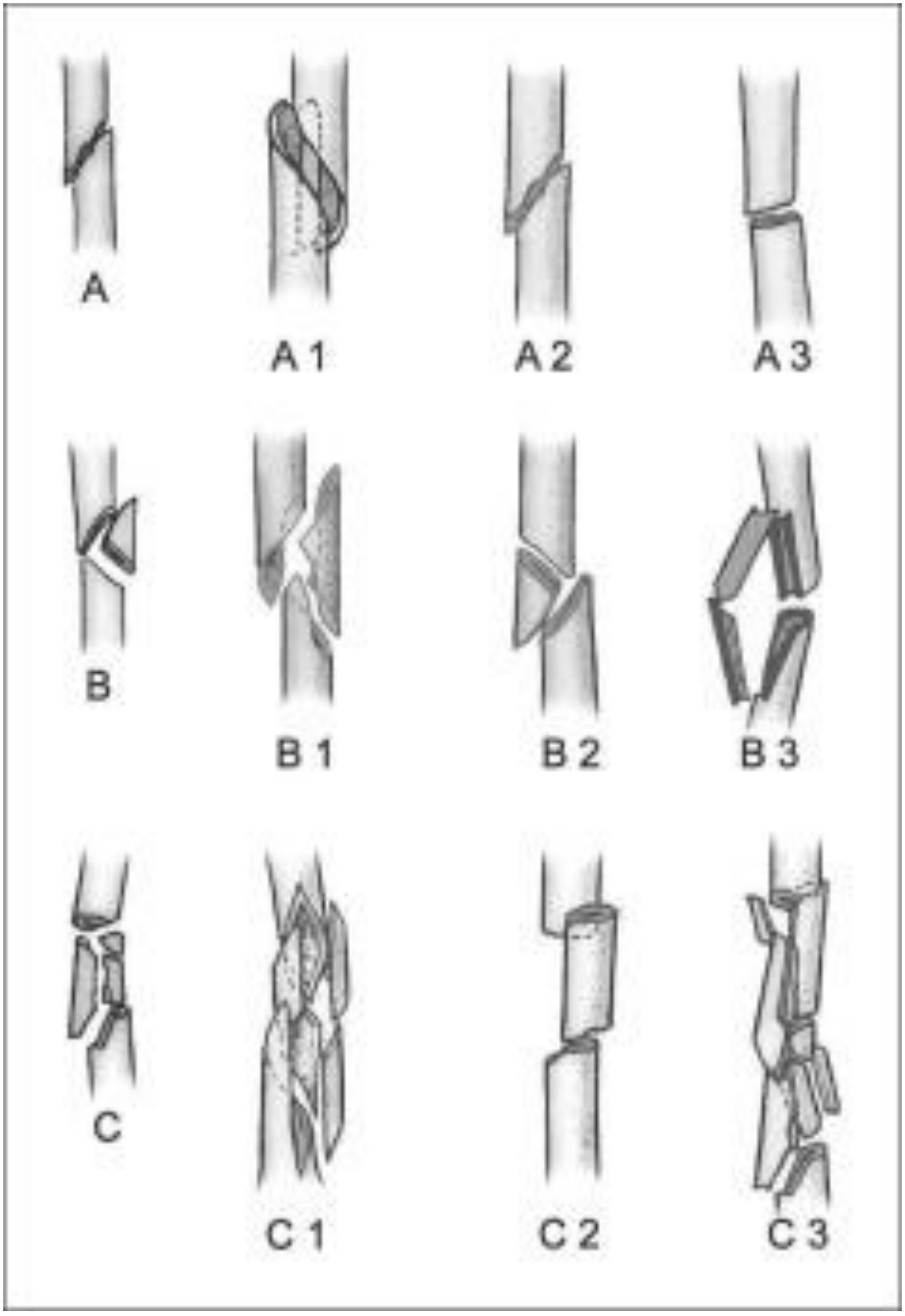
C - Complex fractures

- ❖ C 1 - Spiral
- ✓ C 1.1 - with two intermediate fragments
- ✓ C 1.2 - with three intermediate fragments
- ✓ C 1.3 - with more than three intermediate fragments

- ❖ C 2 - Segmental fractures
- ✓ C 2.1 - with one intermediate fragment
- ✓ C 2.2 - with one intermediate and one wedge fragment
- ✓ C 2.3 - with two intermediate fragments

- ❖ C 3 - Irregular fractures
- ✓ C 3.1 - with two or three intermediate fragments
- ✓ C 3.2 - with limited shattering
- ✓ C 3.3 - extensive shattering (>4 cm)”

Fig 6 : AO Classification



Fracture classification aids in treatment plan. Conservative treatment of a simple oblique fracture produces positive outcomes. A hanging arm cast cannot be used for a transverse fracture because of the possibility of complications and distraction[50].

Radial nerve palsy frequently complicates in distal third spiral fractures, also known as Holstein-Lewis fractures, either primarily or after closed reduction[51].

Internal fixation is typically required for segmental fractures. In closed fractures and in osteoporotic bones, intramedullary nailing is more effective than plating.

# MECHANISM OF INJURY

Although indirect trauma may sometimes be the cause, direct trauma is the most frequent cause of humeral diaphyseal fractures[3].

Usually transverse or comminution at fracture site resutls from direct impact or from road traffic accidents.

Twisting injuries, severe muscle contractions, and falls on outstretched hands are examples of indirect violence. Usually, these result in a spiral oblique fracture. Muscular violence rarely results in humeral diaphyseal fractures. Nonetheless, reports of these fractures have been made after baseball and hand grenade tossing, as well as arm wrestling. Commonest part is middle lower junction[52-55].

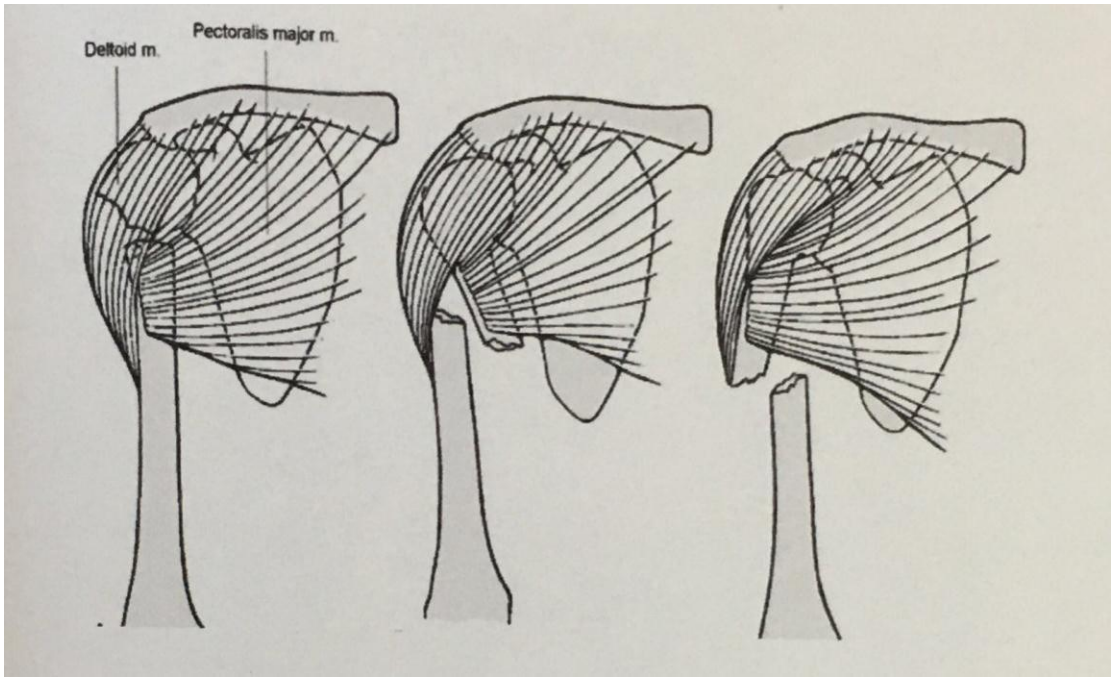
A combination of bending and compressive forces produce oblique or wedge fractures. Simple fractures like transverse are caused by bending and more complex like spiral are usually by torsional force.

# DEFORMING FORCES

The muscle pull leads to deforming forces on the proximal fragment in shaft fractures.

Usually the proximal fragments gets abducted and externally rotated because of the deltoid action in low lying shaft fractures and in high lying shaft fractures the proximal fragment gets adducted because of the pectoralis major action[2].

Fig 7 : Displacement as per fracture level to muscle pull



# REVIEW OF LITERATURE

"The past is our foundation for future development." History is very important for any surgeon. Technology must be incorporated into a surgeon's practice, but it works best when a surgeon is well-versed in the background of his specialty.

The humerus is a long bone that is located in the arm and plays an important role in the totality of the activities that we perform on a daily basis. One of the most common types of fractures that can occur in adults is a break in the humerus shaft fractures.

The therapy of shaft humerus fractures is a tough one. Since the beginning of recorded medical history, medical practitioners and orthopaedicians have utilized a variety of management strategies, each with varying degrees of success in treating fractures of the humerus shaft.

The treatment of decrease with foothold, which was then trailed by dressing with cloth and a few other moderate medicines, has been recorded in reading material of medical procedure from more established times, tracing all the way back to around 1600 BC[29].

Treatment by conservative techniques is not merely vital from a historical perspective, but in case of isolated fractures of humerus shaft, they continue to be an important mode of treatment with overall good results. Nevertheless, the nonsurgical methods of management are related with complications like malunion, and radial nerve palsy.

The incidence of non-unionization among heavy workers is high with traditional management practices accounting to almost 20%[30]. Though humerus shaft fractures can be conservatively treated, there are certain situations during which there is a need for operative treatment primarily or secondarily.

With advances in modern science, both the general public and also the orthopedician treating the patients, have moved on from the labor-intensive techniques for

conservative treatment of shaft of the humerus and they are now less tolerant towards even a small deformity which was considered formerly acceptable[28].

And also in the past few decades, with advances in modern science, newer developments in implant designs and techniques of internal fixation, there has been a wide increase in the indications for the surgical procedures.

460-377 B.C. - Hippocrates put forth two concepts for managing fractures: exercise develops muscles, while inaction results in muscle wasting; and traction and counter-traction for fracture reduction[5].

Serefeddin authored texts on Imperial surgery which features colour pictures of surgical techniques, incisions, fracture dislocation reduction methods, and tools in 1385-1468.

1517 - Gersdorf employed ligature-bound wooden splints that were tightened by twisting them with wooden toggles that were cannulated[6].

1767 - Benjamin Gooch developed a brace which could allow the worker to continue the work before the fracture healed.

For long bone fractures treatment circlage wires were used by Lapujade and Sicre[7].

1801 - Physick PS[8] performed surgery to achieve bone union in a case of nonunion humeral fracture. For the same, he utilized a Seton with silk thread.

1827 - Dr Roberts K[9] used a silver wire as a bone suture during surgery to treat a case of pseudo-arthrosis of the humerus, and the union was satisfactory.

Hansmann of Hamburg[10] first used the plates to repair a fracture. In order to remove it later, he bent the end of a malleable plate so that it protruded through the skin. Later, under specific circumstances, Arbuthnott Lane promoted the method for the treatment of humeral fractures. The efforts of the AO group ultimately led to the popularization of plating.

1852 - Although plaster of Paris has been used for hundreds of years in the Arab world, Antonius Mathijsen[11] was the first to employ it as a plaster-impregnated bandage. In 1985, the first model of the functional cast brace was introduced.

The term osteosynthesis was coined by Lambotte[71] who also devised many devices for internal fixation like plates and screws.

U-slab was first used in 1935 by Bohler and others[72] in management of humerus shaft fractures. It was better than hanging arm cast.

With the use of steinmann pins in intramedullary fixation Rush[12] gave a description and also found flexible nailing system which can be used for any long bones and has pins of four various diameters.

1974 - Mast and colleagues[17] reported a high number of HSF, the majority of which were treated with closed procedures, such as thoracobrachial spica, U-slab, and hanging arm cast. He demonstrated that the results of closed techniques were superior to those of primary internal fixation.

Intramedullary nailing for humerus concept was putforth by Rush brothers[20]. In the proximal diaphyseal fractures they used elastic nails which allowed three point fixation in this medullary canal.

According to Stern and Colleagues[73], intramedullary fixation was used to treat 70 HSF. According to the author's findings, there is a considerable morbidity associated with surgically treating HSF. However, if appropriate timing and procedures are used, the morbidity associated with intramedullary fixation may be considerably decreased.

Hall and colleagues[25] did meta-analytic study on humeral shaft fractures treated with both conservative and operative. They demonstrated that the pseudo-arthrosis incidence was 2.1% in a series documenting the non-operative management of 2653 patients published between 1940 and 1984. Incidences of osteomyelitis and radial nerve paralysis were 0.3% and 9%, respectively. They analyzed 574 fractures that

were surgically treated and found that the pseudoarthrosis rate was 8.3, the osteomyelitis incidence was 3.8%, and the radial nerve lesions were 9.9%. After comparing the outcomes of plate osteosynthesis and intramedullary nailing, the author demonstrated that the former was associated with a greater incidence of osteomyelitis and pseudoarthrosis than the latter.

In order to stabilize 80 humerus shaft fractures, a unslotted locking intramedullary nail which shaped to fit the shaft humerus was created bye Seidel[26] and needed screws to achieve proximal locking and fins that were expanded using a spreading bolt to achieve distal locking. He reported a 100% union rate with only a slight reduction in shoulder mobility.

1990 - 1994 - In a research at the University of Bonn, Siebert and Colleagues[74] treated 62 patients with plating for shaft humerus fracture; the average duration for bone union was 16.2 weeks.

1991 - Habernek and colleagues[75] used Siedel's locking nail technique to assess 19 patients who had fractured their humerus. They concluded that all cases had full range of motion with no complications.

1997 - Interlocking nails were employed by Hems and colleagues[41] for HSF in both pathological and non pathological cases. They discovered that non pathological fractures should be managed cautiously.

Crates and Whittle[42] studied antegrade interlocking nailing for fractures of the humeral shaft. Using antegrade Russell Taylor humeral nailing, 73 acute humeral shaft fractures were treated. 94.5% of fractures were largely united. Iatrogenic radial nerve palsies, which were temporary, happened in 2 7% of cases. Ninety percent had full shoulder function. Proximal locking screws impinged on 2.7% of patients, while conspicuous nails impinged on 1.4%. 96% of patients were able to return to normal elbow function. Functional results were rated using Rodriquez-Merchan criteria. They came to the conclusion that treating acute humerus shaft fracture in patients with multiple injuries with antegrade Russell-Taylor nailing is a suitable substitute.

1998 - Lin[31] compared the use of interlocking nail and plate fixation for treating HSF.He came came to the conculsion that interlocking nails provided better treatment outcomes than plate fixation and a less invasive surgical approach.

2000 - In a prospective study of 111 fractures, Kropfl and colleagues[44] found that antegrade interlocking nailing is a safe technique in terms of consolidaton rate with benefits in terms of upper limb mobilization. Rotator cuff suturing and burying the proximal nail tip are essential to prevent rotator cuff damage.

In a study by McCormack and colleagues[23] at the university of calgary in canada, Dynamic compression plate and Intramedullary nailing were compared in 44 patients who had humerus shaft fractures. The group with interlocking nails had experienced more complications and they found that the most effective treatment for humeral diaphyseal fractures was plating. Although intramedullary interlocking nailing is more technically complex and has a greater likelihood of complications, it may be appropriate in some circumstances.

In a similar study, Chapman and colleagues[76] found that insignificant difference in shoulder impingement, functional outcomes, range of motion, and strength. If done correctly, the antegrade nail insertion is likely not the primary cause of shoulder joint impairment following Intramedullary nailing.

In a restrospective research, Cox and Dolan[77] used Russell Taylor nails in 37 patients with humeral shaft fractures in an antegrade manner. Four nonunions were noted by the author, along with four instances of delayed unionization. One infection and one intraoperative fracture occurred. Since conservative approaches can yield a high rate of union, the author concluded that the indications and indications and justification for Intramedullary nailing should be explicitly specified.

1999 - 2001 - To address the prevention and treatment of these issues, Farragos and Schemitsch[78] studied the problems that arise when humeral nails are locked. Clinical investigations have not demonstrated the benefits of locking humeral nails, they concluded. There are currently no known complications related to the use of interlocking nails in the treatment of humerus shaft fractures. The preferred therapy

for humerus shaft fractures at the moment is still open reduction with compression plating.

2002 - In six matched pairs of human cadaveric humeri, stability of the fixation treated with intramedullary nailing or dynamic compression plate for shaft humerus fractures was conducted by Andrew and Chen[47] under cyclic and physiological stress. They found that both plate fixation and intramedullary nailing provide comparable fixation stability under physiologic loading with comparable stiffness and insignificant under cycling. However, intramedullary fixaion is much stronger than plate fixation. In cases of extensive bone loss, this may be crucial for weight bearing in the upper extremities following surgical repair of diaphyseal fractures.

2005 - In a retrospective analysis of 114 humerus shaft fractures using Intramedullary nailing, Demirel and collegues[48] concluded that intramedullary nailing is better than plating in terms of union rate, range of motion, surgical time and soft tissue stripping. They also emphasized the significance of nailing in patients who have suffered comminuted, segmental, or polytrauma injuries.

2008 - Walter and Viruks[49], In a transverse diaphyseal humeral fracture model, concluded that humeral nails can produce greater compression than plating using eccentric drill holes. Further clinical research is required to determine the union rate in humerus fractures.

2014 - Hashmi PM[35] et al. led a review concentrate on looked at the results of shaft humerus fractures which were dealt with either by plate fixation or by utilizing antegrade intramedullary nails. They were surveyed for results practically and radiologically. Follow up was planned after 1year. Totally 61 patients were incorporated as study members, among them 64% of the subjects went through plating while just 36% of them had intramedullary nailing. Between two review groups, no genuinely huge contrast was seen in mean age or mean term of the medical procedure and the time expected for mending ($p>0.05$ each). The authors concluded radiological result of the subjects on looking at the plating and intramedullary nailing groups has no significant changes.

2014 - Lopiz Y, Gracia-Coiradas J, Gracia-Fernandez C et al. emphasised the point that Straight Intramedullary nailing had union rate comparable to curved design with less frequency of problems. Using more recent straight nails, rotator cuff pain and dysfunction can be reduced[45].

2014 - A planned randomized study was directed by Wali, M. G., et al. for assessing the viability of inside fixation of humerus shaft fractures with Dynamic compression plate or with antegrade interlocking intramedullary nailing. They included 50 subjects who had humerus shaft fractures. The subjects who were arbitrarily distributed into one of the two cohorts. out of the 50 subjects, around 50% had shut antegrade interlocking intramedullary nail while the other 50% underwent open reduction and internal fixation (ORIF) with Dynamic compression plate. On contrasting the mean time of subjects between the two groups, the mean age was 37.28 years with SD 12.26 years in subjects with nailing while it was 37.72 years with SD of 12.70 years in subjects who went through plating. The familiar method of injury in the two groups was the road traffic accidents. However, result at the finish of one year follow up, there was no measurably massive contrast in the practical evaluation and the result. They reasoned that despite the fact that the shoulder related complexities are more in the nailing group, it enjoys the additional benefit of lesser length of the stay in the emergency clinic, lesser span of surgery, and negligible loss of blood in comparison,thus making interlocking intramedullary nailing a compelling methodology in dealing with these fractures[32].

2015 - Yu Fan, Md; Yue-Wang Li, Md; Jian-Fei Liu et al. have led a review to assess the viability of intramedullary nail against the Locking compression plate for the treatment of humerus shaft fractures. Absolutely 60 subjects with humerus shaft fractures were haphazardly dispensed to be worked with an intramedullary interlocking nail or to be worked with a Locking compression plate(LCP) with 30 subjects in each gathering. They presumed that intramedullary interlocking nail with lesser term of the stay in the emergency clinic, lesser length of surgery, and negligible loss of blood in examination and diminished association times; and furthermore a lower frequency of serious entanglements is a superior reasonable choice for treatment of humerus shaft fractures[33].

2016 - Ruipeng Zhang, Zhiyong Hou et al. Conducted study on cases with humerus shaft fractures, there were 46 cases in group B (LCP) and 32 cases in group A (IMN). Group B saw a higher mean incision length and blood loss than group A ($p<0.001$).Group A's average surgical time was 118.53min,while group B's was 128.91min ($p=0.114$).“Group A's mean dash scores were 23.76±16.78, whereas group B's were 22.37±15.18 ($p=0.609$). Similar therapeutic outcomes were confirmed in both groups by the complication rates, which were 8/34 in group A and 7/46 in group B, respectively ($p=0.887$)”[79].

2017 - G Campochiaro, P Baudi et al. Reported the findings of nine patients with atrophic pseudoarthrosis (PSA) of the humeral shaft who received angular stability plates linked to allograft and platelet-rich plasma (PRP) following an initial intramedullary nail treatment to fix the fracture. The average UCLA score was 27 points, the DASH score was 22.25 and the constant score was 64 points at the final follow-up (23.7 months). For the interested arm, the average pain score was 2, and for PSA focus, it was 0. At seven months, radiographic healing was achieved [80].

2018 - Dennis Den Hartog, Kiran C Mahabier et al. A prospective cohort study was conducted on 245 patients, of whom 169 received nailing treatment and 76 received plating treatment. The median age of cases in nailing was 57 years old and in plating was 43 years old. At 12 months, the mean DASH score following plating increased more quickly than the score following nailing, but they were not substantially different for plating and for nailing. While nailing group experienced 24 implant-related problems, including 8 screw protrusions and 13 nail protrusions, the plating group experienced only 2. Compared to nailing, plating caused a significant increase in postoperative transient RNP 8 cases against 1 case and non unions 3 cases in plating and 16 cases in nailing group[81].

2019 - C R Chávez-Galván, R Martínez-Pérez conducted a retrospective cohort study on seventeen patients, sixteen of whom had been treated for humerus shaft fractures and one for humeral fibrous dysplasia. The anterolateral approach for humeral nailing had a good functional outcome, with a mean score of 84.05 on the Constant-Murley

scale, with 76.4% of cases had excellent outcomes and 1 case had poor functional result with mean quickDASH scire of 17.5[82].

2020 - Mohammed Othman Mohammed, Ahmed Hatem et al. a prospective clinical trial involving 36 patients with humerus shaft fractures found that intramedullary nail fixation is the preferred method for treating osteoporotic bone because it has a lower infection rate and less blood loss than plate fixation. Still, it is also linked to a higher incidence of shoulder pain, as well as a higher rate of malunion and nonunion[46].

A systematic study has been conducted by Bryan and Frank et al., in 2020 - The findings indicate that both conservative and operative management can produce good results; however, operative treatment lowers the chance of non-union relative to conservative treatment. Short-term functional outcomes were not different, and the mean time to union was not different[39].

2020 - Torsten Gerich, Caroline Mouton, Lea Jabbarian, Dietrich Pape et al. conducted a retrospective investigation on 27 patients who had proximal humerus fractures, stabilising the humeral shaft by antegrade nailing across the Neviaser portal and monitoring the patients prospectively. In comparison to the delta-split strategy, we were able to show that the length of the procedure and radiation exposure were reduced[40].

2020 - Shishir Murugharaj Suranigi, Lingaraj Reddy, and Syed Najimudeen performed a retrospective analysis on 52 patients who underwent intramedullary nailing for displaced mid-shaft humeral fractures. Thus, it was determined that the humeral shaft fracture's intramedullary nail fixation is a minimally invasive surgery with outstanding functional and radiological results[43].

Baltov et colleagues studied entanglements after interlocking intramedullary nailing for humerus shaft fractures. They concluded that Intramedullary nails will allow effective support than plating[34].

2020 - Yavuz Akalın, İsmail Gökhan Şahin et al. “Patients evaluated prospectively after fracture callus was radiologically observed showed no significant difference

between the two groups (p = 0.109, p = 0.082, p = 0.146, p = 0.322, and p = 0.175, respectively). It was concluded that the LCP group had significantly better shoulder function, while the IMILN group had significantly less pain, with similar complication rates. The UCLA score was significantly better in group 1 (LCP) (p = 0.034) at the last follow-up (24 months), while the VAS results was significantly worse in group 2 (IMILN) (p = 0.017). DASH, ASES scores, and SF-36 questionnaires had no difference (p = 0.193, p = 0.088, p = 0.289)"[83].

2020 - Chrystina L James, Jager Haan et al. 233 of the 517 adult patients in the research had nonoperative treatment, while 284 received surgical treatment. The median time to radiographic union for surgical patients was 113 days, which was considerably shorter than the median for nonoperative patients, which was 161 days (P=0.001). In comparison to patients treated nonoperatively, they found that patients with HSF treated operatively had a quicker time to union, were able to bear weight earlier, and experienced no change in the rate of complications [84].

2021 - Lisa K Cannada, Lauren Nelson et al. In a prospective trial of 179 patients, they compared plate and screw fixation (ORIF) and functional brace for isloated HSF, 45 received treatment with ORIF and 57 received treatment with functional brace (FB). At 6 months, there was no difference in the DASH score, VAS score, or elbow ROM, however, 11% of the FB group experienced nonunion, while the ORIF group experienced complications of 2% infecton and nonunion rate and 13% iatrogenic radial nerve injury (iRNI)[85].

2021 - Nicolas Gallusser, Bardia Barimani and Frédéric Vauclair et al. Concluded the conservative approach to treating humerus shaft fractures yields high union rates and good functional outcomes. It continues to be the preferred treatment method for most humerus shaft fractures for this reason. Surgery should be undertaken if the alignment is unacceptable, especially in cases over 55 years with oblique fracture pattern of proximal shaft[36].

2021 - Fabrizio Mocini, Giuseppe Rovere, Amarildo Smakaj et al. 243 patients with humerus shaft fractures were treated with antegrade intramedullary straight nailing or curvilinear nailing, and the functional and radiological results were compared. And

finally, came to the conclusion that using newer generation straight nails to treat diaphyseal humerus fractures allows for faster bone healing and improved functional outcomes[37].

2021 - Usman Amjad, Kiran zarnab khalid, Waleed et al. conducted a six-month, 190-patient, randomised clinical trial. It concluded that treating humerus shaft fractures with an intramedullary nail and plating results in good results with no problems[38].

2022 - S-Y Shi, X-L Du did a retrospective study of 58 patients with radial nerve injuries and shaft humerus fractures, and found that minimally invasive intramedullary nailing is an effective treatment for radial nerve damage and shaft humerus fractures. It may help patients' shoulder and elbow joint function as well as their nerve function and lower their stress response [86].

2022 - Dhruva Angachekar, Shivam Patel, Shaswat Shetty et al. Concluded both intramedullary nailing and dynamic compression plating are good options for surgical fixation for humerus shaft fractures[87].

2023 - Haci Bayram Tosun, Sancar Serbest et al. did retrospective study on 99 patients with humerus shaft fractures. IMIN was applied to 29, double plating was applied to 24, and single plating was applied to 46. DASH scores, union time, union rate, and complications were used to assess the results. The nonunion rate was 6% of patients, and the average union time was 17 weeks. The DASH functional score and nonunion insignificant in both groups. The IMIN group experienced significantly less bleeding and a shorter surgery time than the other groups ($p < 0.05$). Both plating groups showed a statistically significant short union time when compared to intramedullary nailing ($p < 0.05$), with no significant difference between both plating ($p > 0.05$)[88].

2023 - Nilesh Joshi, Shantanu S. Deshmukh, Yash S. Shewale et al. concluded that the closed antegrade interlocking nail was preferred to an open procedure for treating adult fractures of the shaft of the humerus due to its advantages over an open procedure in terms of short operating times, immediate patient mobilization following surgery, and low complication rates[24].

2024 - Tushar Gupta, Sharib Shamim et al. Conducted study on 40 patients and concluded that conservative management of shaft humerus fractures can be opted as the most effective way of treatment[89].

2024 - Kiera Lunn, Eoghan T Hurley et al. came to the conclusion that after Intramedullary nailing of humerus fractures, there was a low rate of revision but a considerable rate of morbidity [90].

2024 - Zeyu Zhang, Zhongpei Lin et al. did systemic review and concluded that, the best internal fixation technique for HSF with the lowest incidence of iRNI (iatrogenic radial nerve injury) is intramedullary nailing. Comparing to anterolateral and posterior methods, the lateral approach had greater prevelance of iatrogenic radial nerve injury. In MIPO, the rate of iRNI was lower than in internal fixation and open reduction [91].

2024 - Adeel Nadeem, Hannah Abbasi came to the conclusion that IMN showed a shorter time to union, which would have allowed for a quicker recovery than ORIF. Bone union was successfully accomplished by both methods, and the non-union rates did not differ much. IMN was linked to decreased rates of surgical site infections and iatrogenic radial nerve palsy. In patient groups with polytrauma and frailty, this review suggests IMN. ORIF is advised outside of these circumstances [92].

2025 - Jawad Derbas, Isam Moghamis et al. 65 patients with HSF treated with either “IMN or DCP fixation were included in the retrospective research. Compared to the IMN group, the DCP group had greater non-union rates (13% vs. 4%). Additionally, the DCP group had greater re-operation rates (20% vs. 4%). Neuropathy resolution was considerably higher in the IMN group (92% vs 68%), with postoperative neuropathy rates of 4 % for IMN and 10% for DCP. The DCP group was preferred in terms of shoulder range of motion (ROM) and pain, with a reduced incidence of shoulder pain (28% vs 98%, $p < 0.001$) and 98% unaltered ROM in the plate group to 76% in the IMN group ($p = 0.007$) and found that fracture union was successfully accomplished by IMM and plate fixation.”

On the other hand, plate fixation was linked to improved shoulder function , less

discomfort, and increased reoperation rates. Although IMN reduced shoulder range of motion and increased postoperative discomfort, it was associated with a decreased risk of nerve damage [93].

# CLINICAL EVALUATION

The diagnosis is evident in displaced shaft fractures with shortened extremity, palpable crepitus or abnormal mobility, accompained by swelling and pain. The diagnosis is difficult in undisplaced or incomplete fracture which can be makeout only with the local tissue tenderness.

It is necessary to assess the limb's neuromuscular condition. A confirmatory X-ray examination has to show the elbow joints, shoulder, and both ends of the bone.

# TREATMENT

Restoring patients to their previous level of function and achieving appropriate alignment are the two main objectives of treatment for humerus shaft fractures. There are two methods of management: non-operative and operative.

## NON OPERATIVE TREATMENT

As Sir John Charnley once stated, "the humerus is perhaps the easiest of the major long bones to treat by conservative methods"[99], closed treatment was the first treatment of choice for the majority of HSF. The humerus has a strong blood supply and is well-encased by muscle. A union rate of 90–100% could be anticipated [4].

**Indications for Nonoperative Management :**

Strong Indication:

a patient who is compliant and ambulatory has an isolated, acute closed fracture.

Relative indications:

"Patients with proximal third fractures, segmental fractures, long oblique fractures, type A (AO) fractures and noncomplaint patients."

Contraindications :

• Injury to the brachial plexus or worsening nerve dysfunction
• Various injuries
• Additional ipsilateral arm injuries (such as floating elbow or open fracture)
• Bilateral fractures
• Peri-prosthetic fractures
• Pathological Fracture

Two general categories can be used to classify the different treatment modalities:

- Dependency traction techniques and
- Immobilization of the thoracobrachial region.

- "Dependency traction happens if the arm is dependent on gravity in order to reduce the fracture and keep it that way.

- ✓ Hanging cast,
- ✓ U-slab or Coaptation splint,
- ✓ Functional bracing and
- ✓ Skeletal traction."

- "Thoraco brachial immobilization types :

- ✓ Shoulder spica,
- ✓ Joacksonville sling[4],
- ✓ Sling and swathe and
- ✓ Open Velpeau type cast".

**Hanging arm cast -**

This technique was invented in 1933[3,4,50] by Caldwell and it is still a good one today. It uses the cast's weight to achieve reduction.

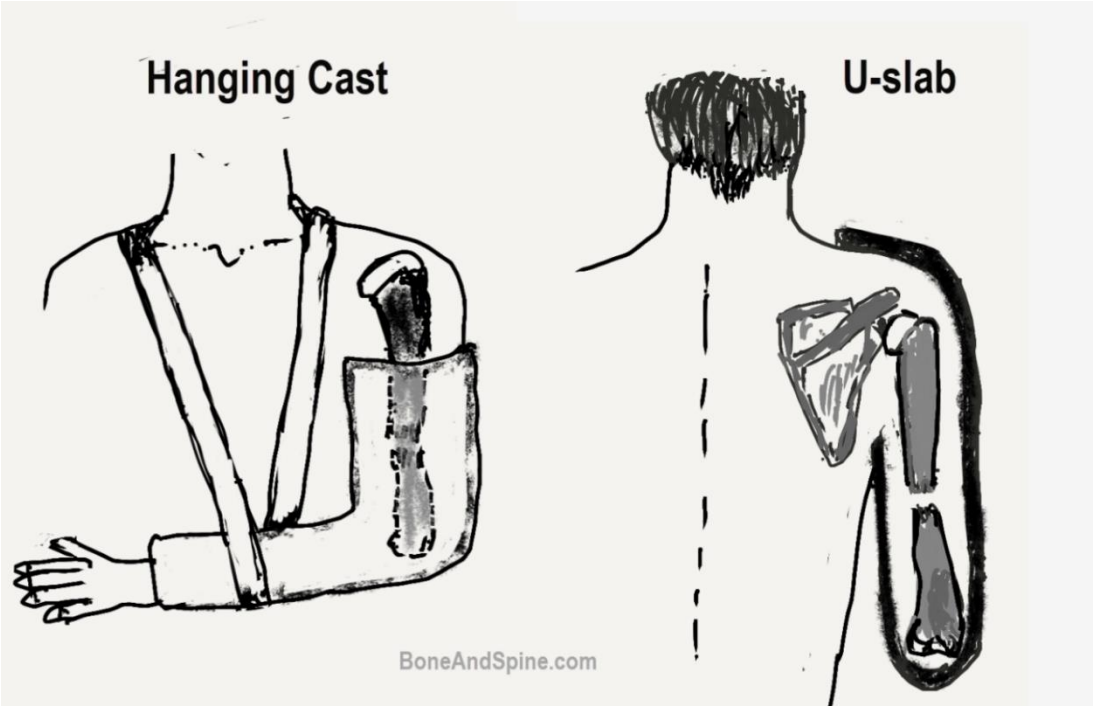



Fig 8 : Hanging cast and U-Slab

This cast is indicated for use in cases of displaced midshaft fractures that shorten in an oblique or spiral pattern. If transverse fractures are treated in this way, there is a risk of distraction and healing issues. The cast should be put with the forearm in the mid-prone position and the elbow at a 90-degree angle while it is lightly weighted [50].

The cast must be 2cm proximal to the fracture site till the wrist with the minimum of three loops in all directions and it should be freely hanging from the body. Patient should sleep in semi erect or erect position.

Shoulder isometric exercises are started to prevent the stiffness and later once the reduction is achieved, it can be converted to functional brace.

**U - slab or Coaptation Splint -**

It is recommended for fractures with minimal shortening[50]. it extends from nape of the neck along the shoulder down to the elbow and around the back of the arm, creating a U - shape. It helps in reducing the fracture deformity.

This permits movement of the hands, wrists, and elbows to a limited degree. Loss of elbow extension and axillary discomfort are drawbacks. As quickly as feasible, it ought to be transformed into a functional brace.

**Functional Brace -**

Principle behind the brace was active muscle contraction, where the fracture pieces are aligned by the hydraulic impact of soft tissue compression and the advantageous effects of gravity.

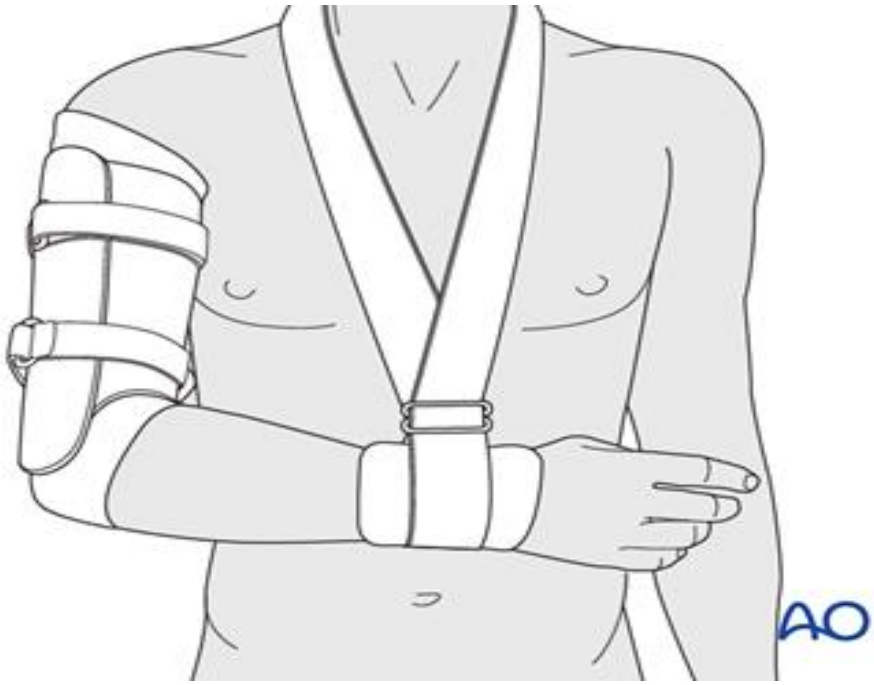



Fig 9 : Functional brace

Augus Sarmiento invented the functional cast bracing in 1977[56] which extends laterally just below the acromion to slightly proximal to the lateral epicondyle and medially from 2.5cm distal to the axilla to 1.3cm proximal to medial epicondyle. Prefrabricated braces were available now a days with 2 plastic sleeves that can encircle the arm with 2 adjustable straps to hold them.

Functional brace can be used when the patient had low energy trauma with mild swelling. Generally, cast or splint has to be applied till the symptoms and swelling subsides.In most incidences, brace is applied 12 days post injury[57].

Sarmiento in 2000 managed 920 cases with cast bracing and concluded 98% of union rate in closed fractures and 94% of union rate in open fractures. For non operative treatment, cast bracing has become the gold standard[2] as described by many authors[58-61]. Early range of movements reduces the risk of shoulder and elbow stiffness[62].

**Jacksonville Sling -**

This is recommended for slightly displaced fractures in children < 8 years and oldage patients who are unfit for surgery[4,50].

**Shoulder Spica Cast -**

Seldom it is utilized. It is only used when holding reduction requires a large amount of abduction and external rotation of the upper extremities [50]. But operative in the majority of these circumstances

**OPERATIVE TREATMENT :**

Despite the fact that most simple fractures are treated non-operatively, there are some indications that call for surgical intervention[2]. Fracture indications, patient indications, and associated injuries.

"Fracture indications :

A) failure to attain and maintain sufficient closed reduction.

- ✓ a rotation of more than 30 degrees
- ✓ a shortening of more than 3 centimeters
- ✓ an angle of more than 20 degrees

B) Intra-articular extension

- ✓ Shoulder joint
- ✓ Elbow joint

C) Segmental fractures

D) Pathologic fractures"

Patient indications :

a. Polytrauma

b. Head injuries (less than eight on the Glasgow Coma Scale)

c. Trauma to the chest

d. Inadequate patient tolerance

e. Adverse body habitus (Example: obesity)[3]

Associated injuries :

a. Compound injury

b. Damage to the vessels

c. Injury to the brachial plexus

d. Bilateral humeral fractures

e. Ipsilateral forearm fractures

f. Fractures of the lower extremities necessitating weight bearing on the upper extremities (Crutch walking).

g. Burns

h. High-velocity bullet wounds

i. Prolonged elbow or shoulder joint stiffness.

"The main methods employed for internal fixation of humeral shaft fractures are :

- ✓ Intramedullary nailing
- ✓ Plates and Screws
- ✓ External fixation"

**INTRAMEDULLARY NAILING :**

Preoperative Planning:

Upon admission, patients had a thorough history taking, physical examination, systemic examination, and general examination to assess their overall health.

Antero-posterior and lateral views of the injured arm were obtained by X-ray, and the diagnosis was verified. Analgesics were administered while the patients damaged arm was immobilized in POP U - slab. Patients were posted as soon as feasible after completing pre-operative hematological and other examinations. Written informed consent has to be taken from the patient.

Determining ideal nail length and diameter will be aided by preoperative measurements of the humeral length and the width of the narrowest segment of the complete humeral canal, accounting for x-ray magnification.

Additional x-ray scans may be required if fracture lines extend toward the elbow or shoulder joints.

Positioning:

With a padded support beneath the shoulder, the patient is in supine position. The injured limb hangs to the side of the table, while the patients torso rests on the operating table. The sterile field includes the elbow, humerus, and shoulder. On the other side of the surgical field lies the image intensifier.

In the current study, humerus shaft fractures were rigidly fixed using strong interlocking nails of the Russell-Taylor variety with a tapered tip for simpler insertion. This allowed the nail to glide easily over the medullary canal.

Anteriolateral approach :

After palpating the acromion, a 2- to 3 cm incision is taken from the anterolateral border of the acromion obliquely forward and the deltoid muscle is split along its fibers, the subacromial bursa and the rotator cuff are exposed. The entry portal for standard antegrade nailing is opened with the hand awl.

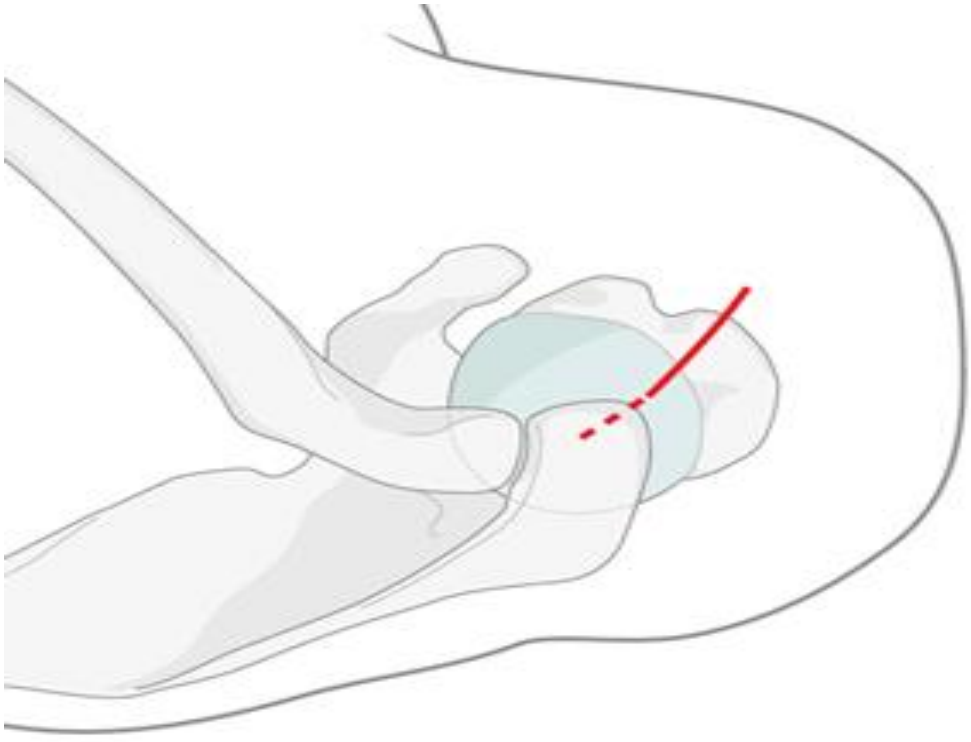


Fig 10 : skin incision

To make room for the guidewire, the hand awl needs to pierce the head till 4-5cm deep. The assistant applies and maintains 90 degrees of elbow flexion, supination of the forearm, and traction to achieve the proper alignment of the arm.

Its not easy to obtain the lateral view of the fracutre site, so the passage of the guidewire to distal fragment can be confirmed with rotation of the arm by 40 to 50 degrees or allowing some angulation at the fracture site.

After the insertion of the nail to its final position it must be locked to provide adequate stability to the fracture proximally and distally respectively. Distally incision is made, care given to the neurovascular structures, then distal locking is done with the 'freehand' technique .

Rotator cuff has to be repaired. The deltoid muscle is sutured with one or two absorbable stitches and the superficial layers are closed[64].

Postoperative management:

Patients should have their arm supported by a collar and cuff after surgery, if required POP splint is applied for comminuted and poor bone stock patients. Rehabilitation started right away.

On the second postoperative day, they could begin passive flexion and abduction exercises for the shoulder and elbow range of movements as the pain permits. After 10 to 15 days, more active exercises should be started, and rotational exercises should be instructed when soft callus is visible on radiographs.

In the outpatient clinic, routine follow-up involves radiographic and clinical evaluation at intervals of 4 to 6 weeks until the fracture heals, after which follow-up visits must continue at intervals of 2 to 3 months until the arm has fully recovered functionally. Weightlifting and heavy works are adviced based on the radiographs with minimum of 3 months post surgery.

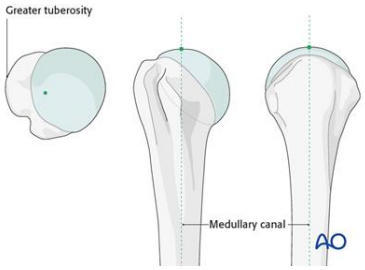



Fig (a)

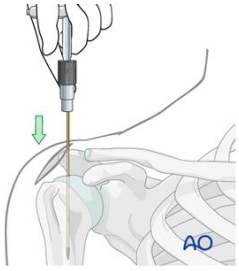



Fig (b)

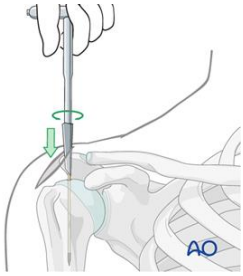



Fig (c)

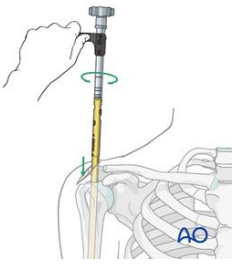



Fig (d)

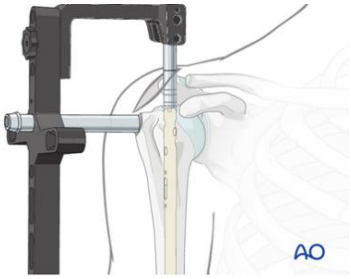



Fig (e)

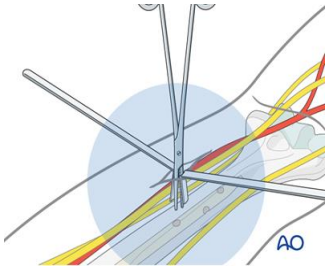



Fig (f)

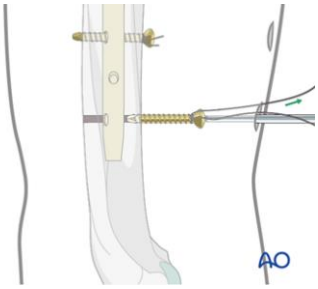



Fig (g)

Fig 11 : IMILN technique - surgical steps a) entry point b) skin incision and guide wire passed c) cannulated awl entry d) appropriate nail is passeed with help of zig e) proximal locking f) distal incision with neurovascular bundle secured g) distal locking

**OPEN REDUCTION AND INTERNAL FIXATON WITH PLATES AND SCREWS :**

There are two methods for plating. Anterolateral approach is used for proximal and mid third shaft fractures and posterior approach is used for distal one third.

In the posterior method, the lateral head of triceps was retracted laterally and the long head of triceps was retracted medially. Midline incision is taken over the medial head of triceps down to periosteum, exposing the fracture site.

Fracture fixation was done by using at least six holes of DCP, and three cortical screws were inserted distal and three more proximal to the fracture site to achieve rigid fixation [63].

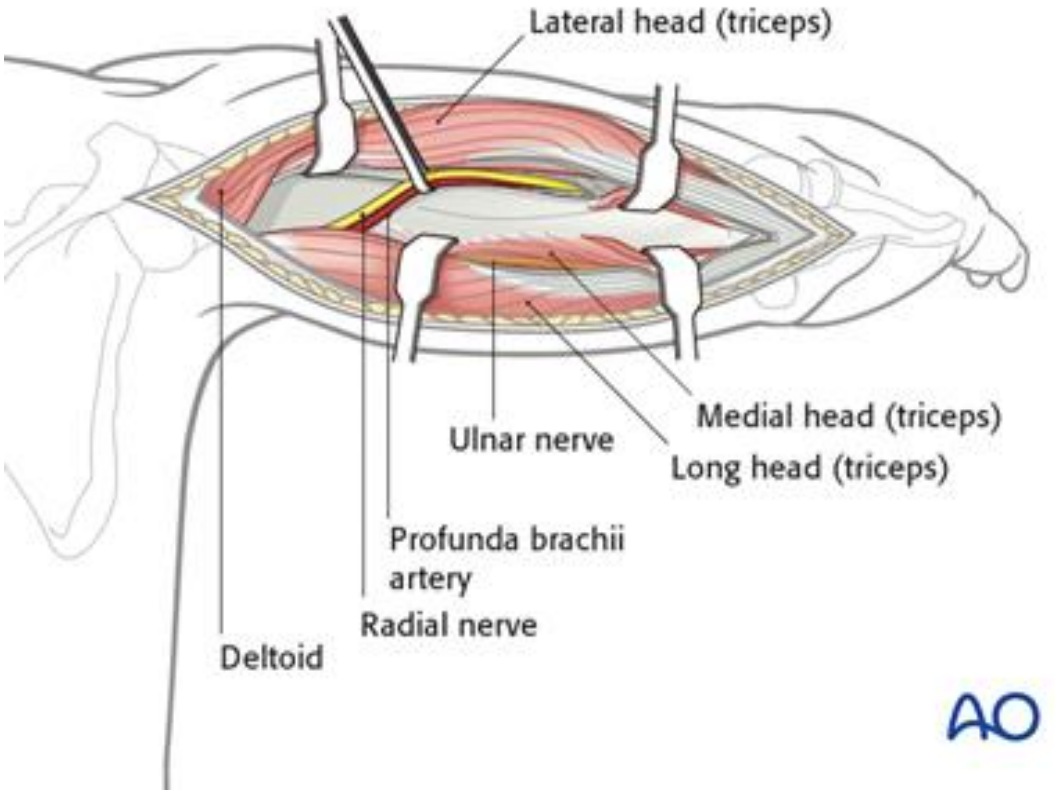



Fig 12 : Posterior aproach for plating

In anterolateral method, the brachialis muscle and biceps muscle were retracted

medially, while the brachio-radialis muscle was retracted laterally. The brachialis muscle then elevated subperiosteally, exposing the humeral shaft beneath. A Dynamic compression plate is put with three screws below fractures and four screws proximal to them [63].

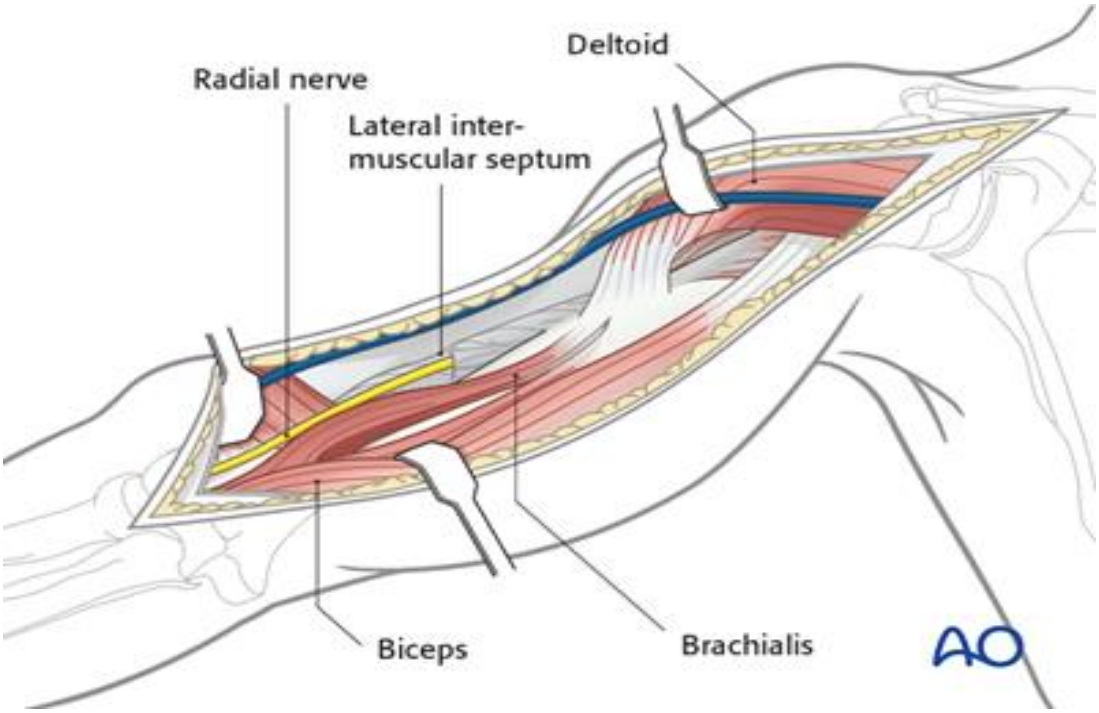



Fig 13 : Anterior approach for plating

Postoperative management :

It is generally possible to utilize a plate to achieve a stable fixation. As a result, the patient is free to engage in active and active-assisted mobilization without any limitations on their elbow or shoulder range of motion. For a few days, a sling might be used to relieve pain.

Weight restriction following surgery should be kept to a maximum of one kilogram until the fracture heals, which normally takes three months. For young patients, weight bearing as tolerated (such as the requirement to use crutches for walking) is acceptable; however, for elderly patients, this should be reviewed case by case.

**EXTERNAL FIXATION :**

"Indications :

External fixation remains an option in select circumstances such as polytrauma patients with severe soft tissue damage, open fracture with considerable contamination, or accompanying vascular injury necessitating quick stabiliation prior to vascular repair [36]".

Surgical procedure :

For this surgical treatment, a thorough understanding of neurovascular structures that are susceptible to damage, particularly the radial nerve, is necessary. The safe placement of pins has been explained by a number of publications [36]. Starting immediately lateral or slightly anterolateral (maximum 30°), to avoid axillary nerve injury proximal pins are inserted 8cm below the acromion and at the level of deltoid tuberosity.

Pin insertion in the mid diaphysis should be avoided because of the several structures that are at danger, including the brachial artery, ulnar and median nerves, musculocutaneous, and radial.

To prevent difficulties, a mini-open technique rather than a percutaneous one should be employed if a pin is absolutely required in this area. Pins can be inserted lateromedial or anteroposterior in the distal portion; however, to minimize damage to the radial (lateral) or musculocutaneous (anteroposterior) nerves, a small hole (2–3 cm) is recommended.

# COMPLICATIONS

Malunion, nonunion, infection, and radial nerve deficiency are the primary complications of treating humerus shaft fractures.

Malunion :

Rarely is a 20–30 degree angular malunion or a 2-3 cm shortening problematic. The impact of rotational malunion of up to 15 degrees may be lessened by the shoulder joint's large range of motion.

Rarely should cosmesis be regarded as a sign requiring surgical intervention. If required, osteotomy with stable internal fixation might offer a good reconstructive option.

Nonunion :

In conservatively managed injuries and in open reduction and internal fixation treatment non union rates are 2-5% and 25% respectively[19,65]. Mostly all conservative managed fractures unite within 6 weeks.

Nonunions are more prone in compound injuries, high energry trauma, segmental fractures, poor reduction and fracture with inadequate stabilization. Factors which contributes to nonunion are steroids, osteoporotic patient, metastasis, soft tissue loss and alcohol.

Patients with osteoporotic or pathological fractures are better off with IMIL nail fixation, while patients with sufficient bone stock are better off with compression plate stabilization. Eight cortices of the nonunion site should be in contact. Cortico-cancellous grafts may be used to improve screw purchase and boost fixation rigidity. Humeral nonunion can satisfactory outcomes with stable fixation.

Infected nonunion:

It has been demonstrated that instability and infection are directly correlated [25,42]. In most cases, union will achieve wound debridement and irrigation, discarding the nonviable tissue along with the necrotic bone and antibiotics. Although it is frequently contraindicated in infected instances, intramedullary stabilization or plate and screw fixation may be used once the infection has been eliminated.

Non unions with bone loss :

A nonunion should be categorized as a reconstructive case if there is a bone deficit of at least 5 cm. Reconstruction techniques include vascularized bone transfer, humeral allograft, and full thickness corticocancellous autografts.

**Neurological Complications :**

The most frequent neurologic consequence linked to humeral fractures is radial nerve damage. Most frequently, transverse or short oblique humeral fractures are followed by transient neuropraxia damage.

The most frequent causes of radial nerve transaction have been open fractures, or fractures brought on by penetrating trauma. Up to 18% of closed humerus shaft fractures can result in radial nerve palsy. Of these, over 90% are neuropraxia, which resolves on its own in three to four months after the injury.

Six weeks following injury, radian nerve dysfunction should be assessed by nerve conduction tests and electromyography if there is no clinical indication of function recovery. The extensor carpi radialis longus and brevis muscles and the brachioradialis has to be primarily checked.

Conservative treatment is maintained if action potentials are detected; however, surgical investigation and repair, with or without cable grafts, are recommended if denervation fibrillation or total denervation is detected on these tests.

“Indications of primary exploration include :

i. Open fractures

ii. Fracture associated with penetrating injury and

iii. Holstein-lewis fracture”

**Vascular complications :**

Although they are uncommon, vascular problems related to humerus shaft fracture typically arise from open fractures or penetrating injuries.If vascular injury is suspected arteriography should be done and repaired. Vascular reconstruction need to be seen as a clear sign that the fracture can be securely fixed, either externally or with a plate and screw. Once flow has been restored, fasciotomies of the hand, arm, and forearm might be required.

Holstein and Lewis fracture :

It occurs in distal 1/3$^{rd}$ of the humerus with closed spiral fracture pattern. Following manipulation or the installation of a cast or splint, radial nerve palsy develops in these fractures. As the nerve passes through the lateral intermuscular septum, it is least mobile which can be identified at the distal portion of the arm. The distal fragment is usually displaced proximally in these fractures, which are frequently oblique and angulated laterally.

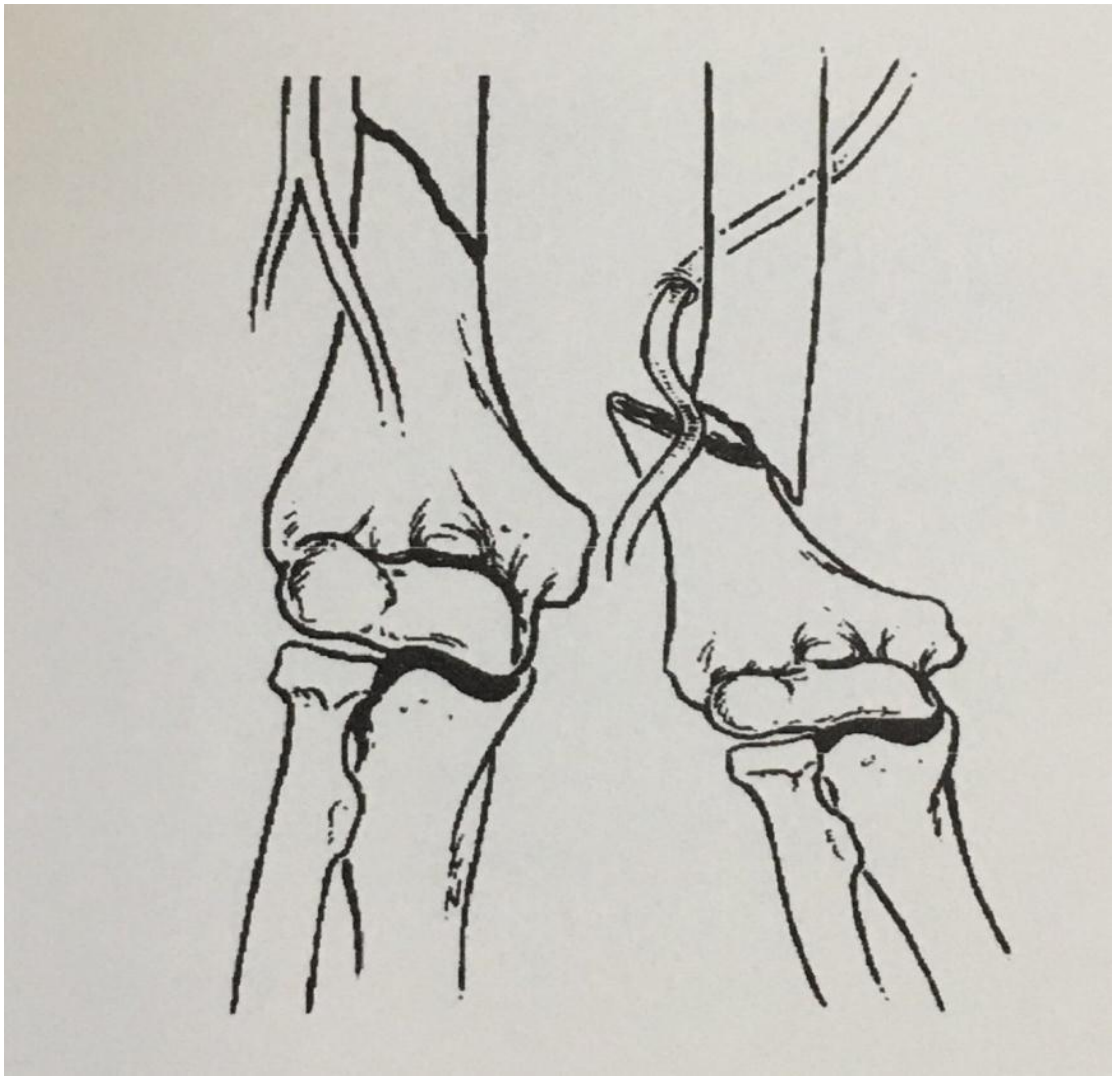


Fig 14 : Radial nerve entrapment at the fracture site

When closed reduction is performed, the radial nerve might get caught between the pieces. Before the manipulation, the radial nerve's function can be normal, but when the fracture is lessened, it is observed to vanish. Internal fixation and open exploration is recommended.

# INSTRUMENTS AND IMPLANTS

1. Zig
2. Conical bolt
3. Protection sleeve
4. Trocar
5. Drill sleeve
6. Depth Gauge
7. Screw Driver
8. Cannulated Awl
9. Curved awl
10. Spanner
11. Ram
12. Ram Rod
13. Ram Rod Handle
14. 2mm Guide wire
15. Drill bit
16. Entry Reamer


Fig 15.1 : Humerus Zig with handle

Fig 15.2 : Screw drivers

Fig 15.3 : Protection sleeve and trocar

Fig 15.4 : entry reamer and ram

Fig 15.5 : curved awl, cannulated awl and ram rod


Fig 15.6 : Locking bolts

Fig 15.7 : Conical bolt/ Insertion bolt

Fig 15.8 : Drill bit 3.2mm and 2.2mm

Fig 15.9 : Instruments used

Fig 16 : Nails Used

Fig 17 : OT Trolly

Fig 18 : CLINICAL IMAGES

IMAGE 1 : PATIENT POSITIONING

IMAGE 2 : PATIENT POSITIONING

# OPERATIVE IMAGES

Fig 18.1 : Skin Incision

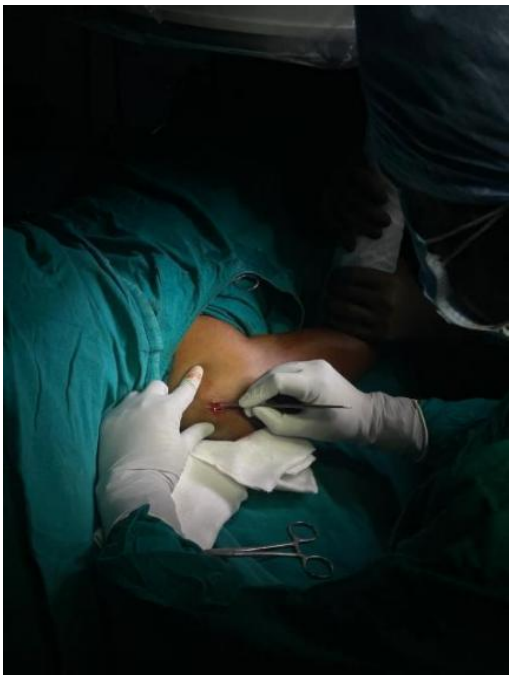


Fig 18.2 : Cannulated awl entry and with guide wire

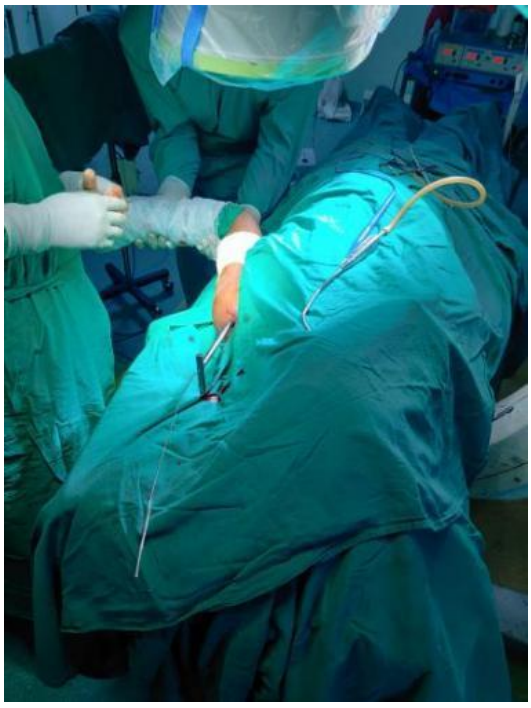


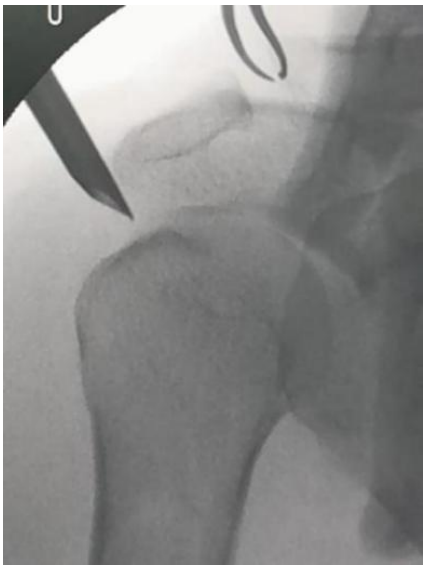
Fig 18.3 : Nail insertion

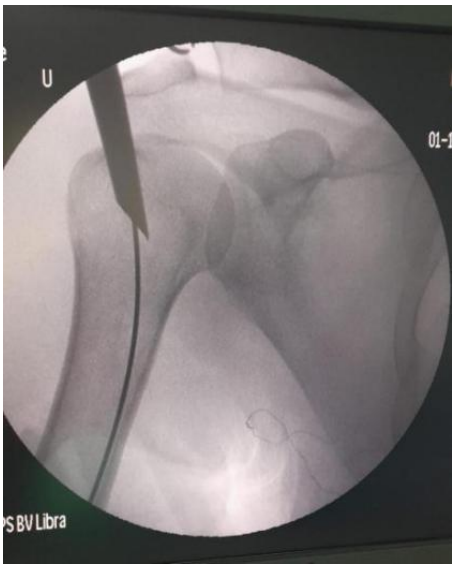
Fig 18.4 : Proximal locking

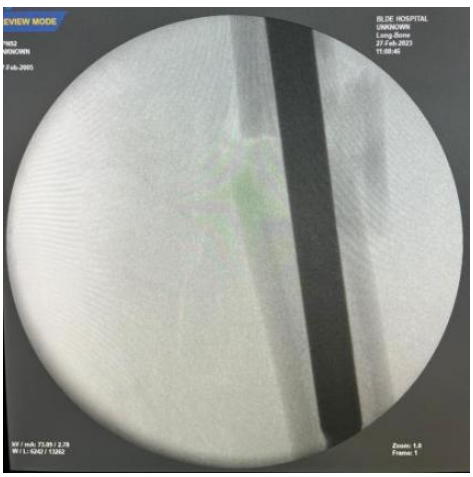
Fig 18.4 : Distal locking

Fig 18.5 : Final skin closure

# Fig 19 : C ARM IMAGES





## MATERIALS AND METHODS :

"We conducted a prospective study on patients admitted to the department of Orthopaedics in B.L.D.E (DU) Shri B M Patil Medical College, Hospital and Research Centre, Vijayapura, with the diagnosis of humeral shaft fracture from march 2023 to march 2025".

In our study, 40 patients were involved, of whom 24 (60%) were male and 16 (40%) were female. 25 (62.5%) patients sustained right sided injury, where as 15 (37.5%) patients sustained a left sided injury. A minimum of 6 weeks and a maximum of 6 months followup were achieved.

## INCLUSION CRITERIA :

- Patients of age above 18 and below 70 years.
- Closed fractures.
- Segmental fractures

## EXCLUSION CRITERIA :

- Patients below age of 18 and above 70 years
- Fractures of proximal and distal ends of humerus
- Patients suspected of pathological fractures
- Patients with compound fractures
- Polytrauma
- Evidence of neurological or vascular diseases
- Associated radial nerve injury

The patients who met the inclusion criteria were included in the study after taking written informed consent. A thorough history and clinical examination was done. The status of radial nerve injury was recorded.

Anterolateral approach with IMIL nailing was used in all patients with HSF.

## SAMPLE SIZE CALCULATION:

With the anticipated incidence of humeral shaft fractures 13-20 per lakh population (0.02%)1, the study would require a sample size of 40 patients with a 97% confidence level and 5% absolute precision.

Formula used

$$\mathbf{n = \frac{z^2\ p*q}{d^2}}$$

Where Z= Z statistic at α level of significance

$d^2$= Absolute error

P= Proportion rate

q= 100-p

## STATISTICAL ANALYSIS:

The data obtained will be entered into a Microsoft Excel sheet, and statistical analysis will be performed by a statistical package for the social sciences ( Version 20).

Results will be presented as Mean (Median) ±SD, counts and percentages, and diagrams.

**CASE 1 :**

A 50 years old male had met with road traffic accident and came with diffuse swelling and deformity over the left arm with painful movements. On examination palpable crepitus felt with no neurovasular injury. Radiographs of left arm was done shows left shaft humerus fracture and no associated injury.

Preoperative : U slab applied with analgesia.

Pre-op x ray


post op ray

After 6 weeks

**Operative Management:**

Under all aseptic conditions patient parts are scrubbed, painted and drapped. An incision of 2-3 cm taken, soft tissue dissection done. Entry is made with hand awl and guide wire is passed, Nail is inserted till its tip was buried into the bone by 5mm under c-arm guidance. Proximally fixed with locking screws and Distally with locking bolt locking is done with the free hand k wire technique, rotator cuff is sutured back and wound is closed layer by layers.

**Post-operative period:**

Following surgery, an arm pouch was provided and a compression bandage was put on. For five days, parenteral antibiotics were administered. On days 2, 5, and 8 following surgery, the wound is examined. After surgery, a check x-ray was taken. On the second post-operative day, rehabilitation was started right away. shoulder and elbow range of motion exercises that involve passive flexion and abduction. Between the twelfth post-operative day and discharge, sutures were taken out.

Adviced patient to continue exercises at home. Patient was followed up postoperatively every month and restricted lifting of weights and heavy work till fracture healing is evident. Later patient was followed up for every 3 months till full functional recovery. No associated complications till 6 months of followup.

**CLINICAL PICTURES :**

**CASE 2 :**

A Case of 58 year female patient had fall from stairs presented with left arm deformity. She presented with painful movements in the arm with no neurovascular injury. Radiographs of anteroposterior and lateral veiws was done shows left humerus shaft comminuted fracture and no associated injury. Preoperative : U slab applied with analgesia. Patient was adviced for surgery and did antegrade intramedullary interlocking nailing.


Preoperative x ray


Immediate Post operative x ray

The patient had undergone the same operative technique as mentioned above intramedullary interlocking nailing. Proximally it is fixed with 2 locking screws and distally with 1 locking bolt after back hammering of the nail.

The limb was maintained in an arm pouch after surgery. Exercises with a shoulder pendulum were initiated right after surgery. On the second postoperative day, activities for active elbow mobilization and passive shoulder mobilization began.

Suture removal was done on 13th day of post operative and discharged. Active overhead shoulder mobilization was started 3 weeks after surgery. Arm pouch was discontinued 4 weeks post surgery.

**CLINICAL PICTURES :**

**Case 3 :**


Pre op x ray


post op x ray

**Case 4 :**

Pre op x ray


post op x ray

## FOLLOWUPS : SIX WEEKS


X ray 1 x ray 2

**AFTER 1 YEAR -**

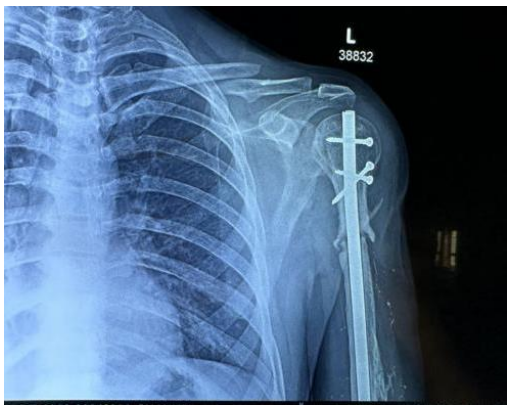
X ray image 1


X ray image 2

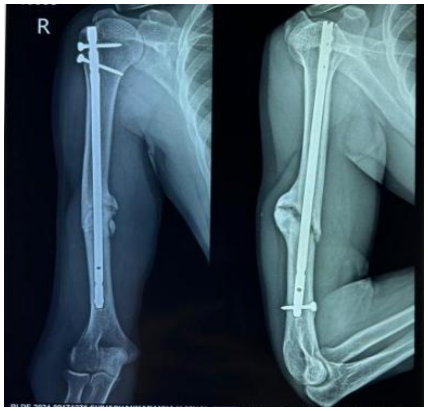
# COMPLICATIONS

**INTRA - OP COMMUNITION:**


**NON - UNION:**




Case 1:




Case 2 :

Implant (nail) removal with bone grafting and plating done

# FOLLOWUP AND CRITERIA FOR EVALUATION

Following surgery, the cases were followed for 6 weeks, 3 and 6 months, and subsequently every 2 weeks until radiological union was observed. Clinical examinations were performed at each followup to evaluate the stability of the fracture, shoulder and elbow ROM, pain, tenderness, and the state of the surgical site.

In order to search for indications of radiological union, roentgenograms were obtained in AP and Lateral perspectives.

The radiological union time was recorded. An injury was classified as delayed union if there were no radiological indications of union by 20–24 weeks, and as nonunion if there were no symptoms of union beyond 32 weeks.

We noticed one patient with post-operative rotator cuff dysfunction, one with shoulder stiffness who received physiotherapy, two with non-union who had their nails removed and ORIF with plating and bone grafting performed, one with superficial infection (treated with antibiotics and regular dressings), and one with radial nerve palsy was examined and power was documented. Complete recovery was seen.

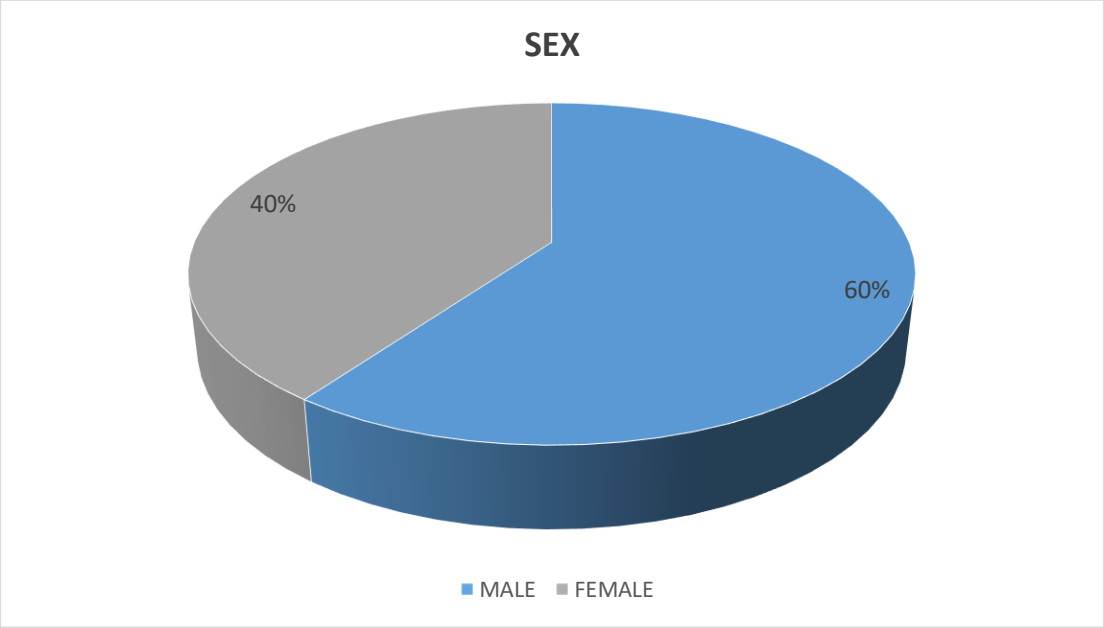
Functional results was assessed by DASH score.

# RESULTS

"From March 2023 - March 2025, 40 patients of HSF treated with IMIL nail were followed up at B.L.D.E (DU) Shri B.M. Patils Medical College, Hospital and Research Centre, Vijyapura. Observations of the study are as follows" :

| SEX | N | % |
|---|---|---|
| MALE | 24 | 60 |
| FEMALE | 16 | 40 |
| TOTAL | 40 | 100 |

Table 1: cases distribution by sex



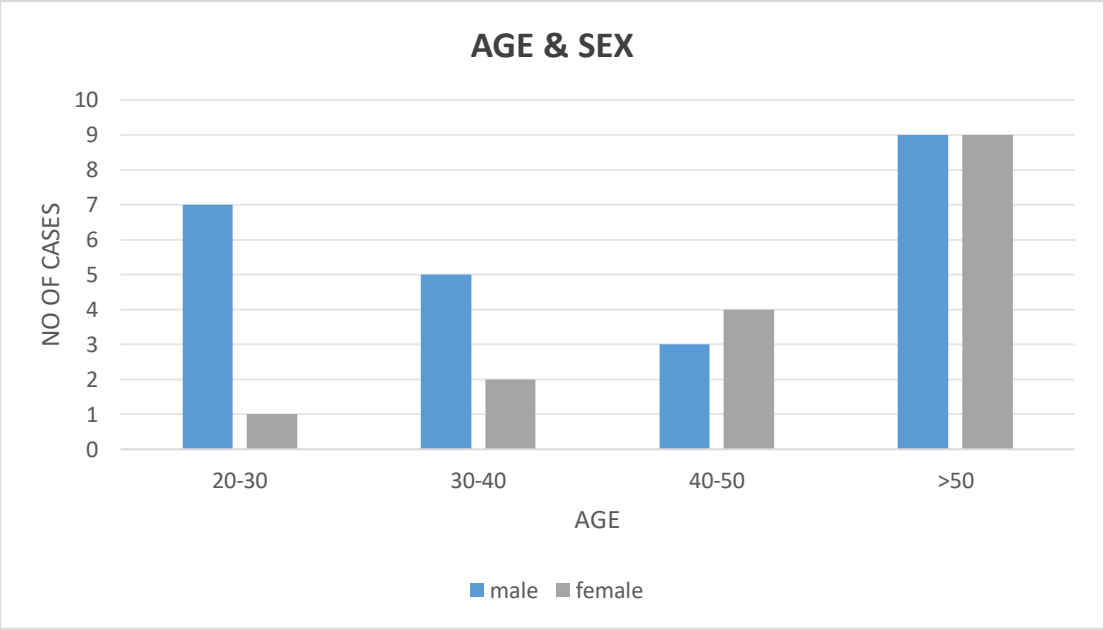

Graph1: Distribution of cases by sex

In our study, A male preponderance of 60% was seen.

| | Minimum | Maximum | Mean | SD |
|---|---|---|---|---|
| AGE(Yrs) | 20 | 70 | 46.5 | 15.756 |

Table 2 : Mean Age among cases

“The mean age of patients presenting with HSF was 46.5 years. The youngest was 20 year old and oldest was 70 year old. The modal age group was >50 years with 45% preponderance.”

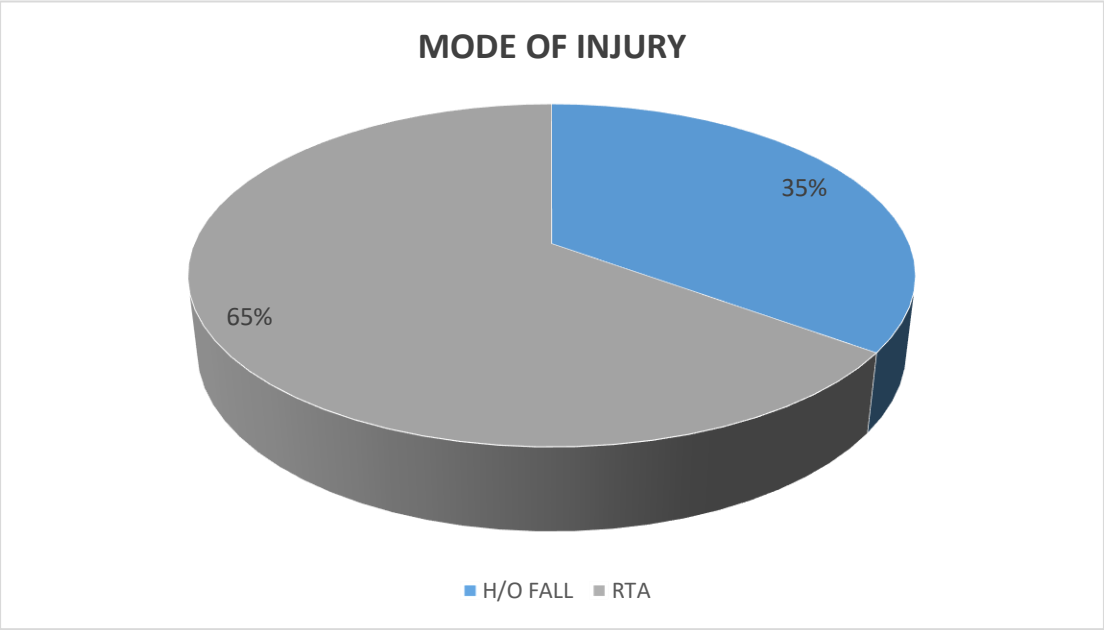



Graph 2 : Association of age and sex among cases

| MODE OF INJURY | N | % |
|---|---|---|
| H/O FALL | 14 | 35 |
| RTA | 26 | 65 |
| TOTAL | 40 | 100 |

Table 3 : Distribution of cases by Mode of Injury

The majority of humerus fractures admitted in SBMPH were due to RTA (65%), followed by history of fall (35%).

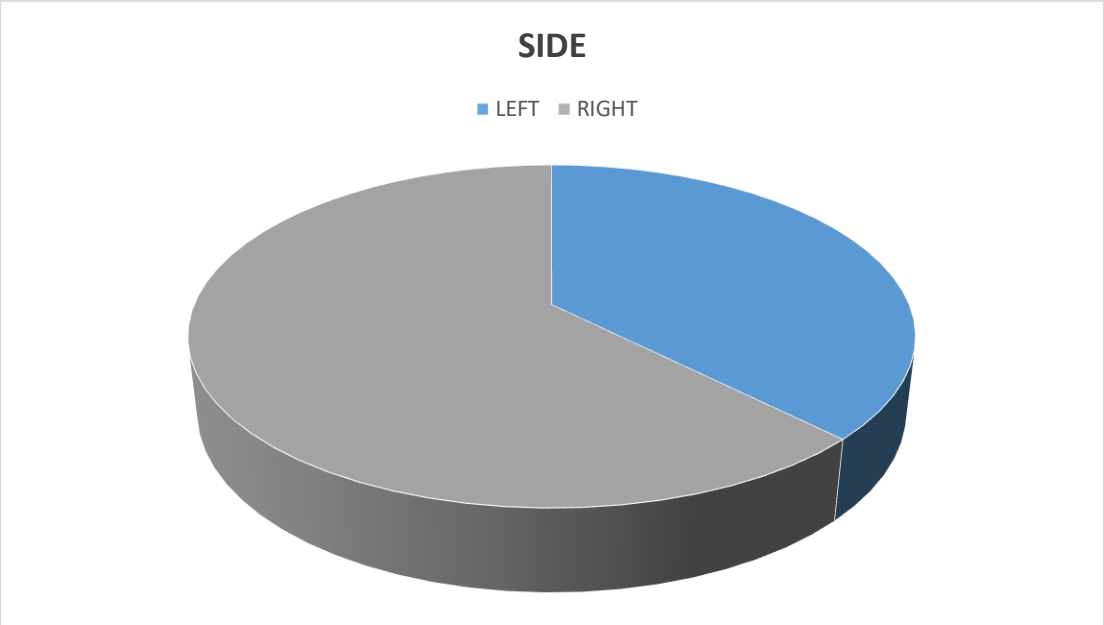



Graph 3 : Distribution of cases by Mode of Injury

| SIDE | N | % |
|---|---|---|
| LEFT | 15 | 37.5 |
| RIGHT | 25 | 62.5 |
| TOTAL | 40 | 100 |

Table 4 : Distribution of cases by Side

Out of 40 patients with humerus fractures there was right side preponderance of 62.5% was seen.

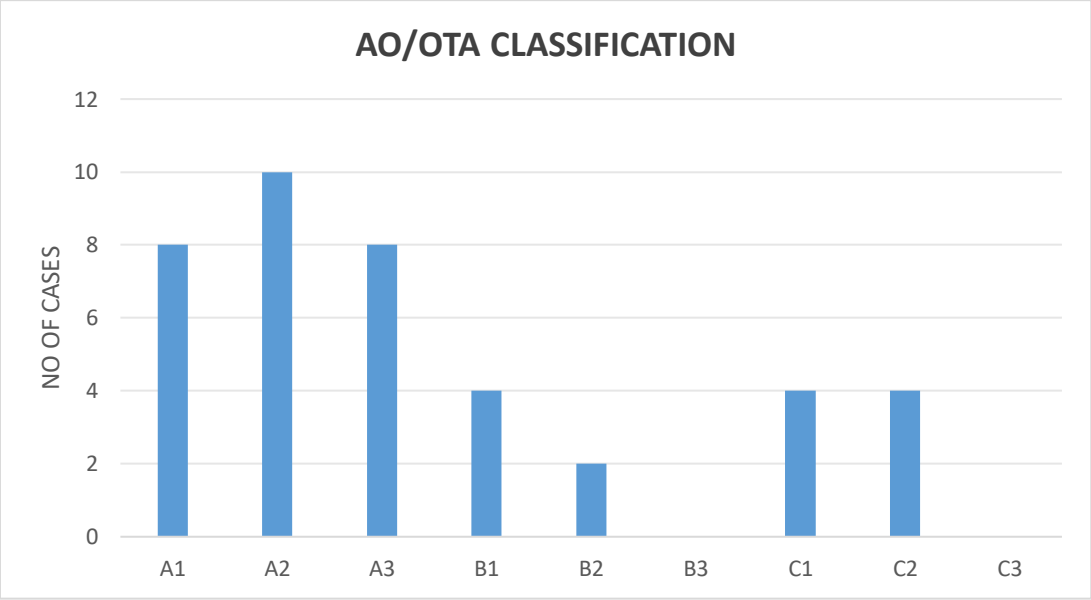



Graph 4 : Distribution of cases by Side

| AO/OTA CLASSIFICATION | N | % |
|---|---|---|
| A1 | 8 | 20 |
| A2 | 10 | 25 |
| A3 | 8 | 20 |
| B1 | 4 | 10 |
| B2 | 2 | 5 |
| B3 | 0 | 0 |
| C1 | 4 | 10 |
| C2 | 4 | 10 |
| C3 | 0 | 0 |
| TOTAL | 40 | 100 |

Table 5 : Distribution of cases by AO classification

There were 26(65%) type A fractures, 6(15%) type B fractures and 8(20%) type C fractures.

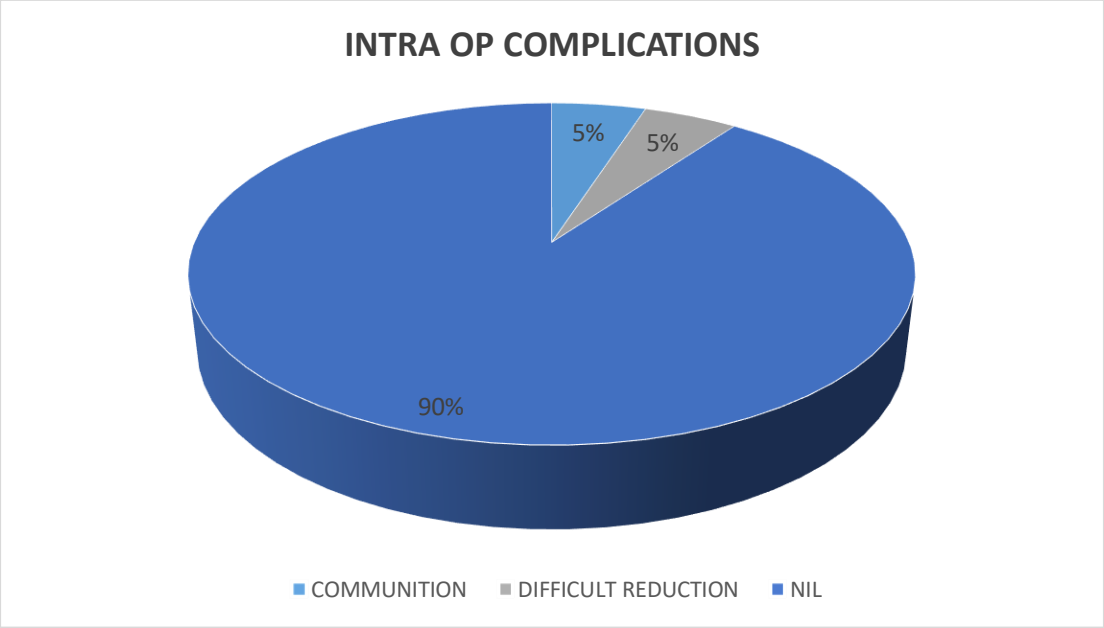



Graph 5 : Distribution of cases by AO classification

| INTRA-OP COMPLICATION | N | % |
|---|---|---|
| COMMUNITION | 2 | 5 |
| DIFFICULT REDUCTION | 2 | 5 |
| NIL | 36 | 90 |
| TOTAL | 40 | 100 |

Table 6 : Distribution of cases by INTRA-OP complication

36 patients (90%) had no intra operative complications. Rest patients had communition (5%), and difficult reduction (5%).




Graph 6 : Distribution of cases by INTRA-OP complication

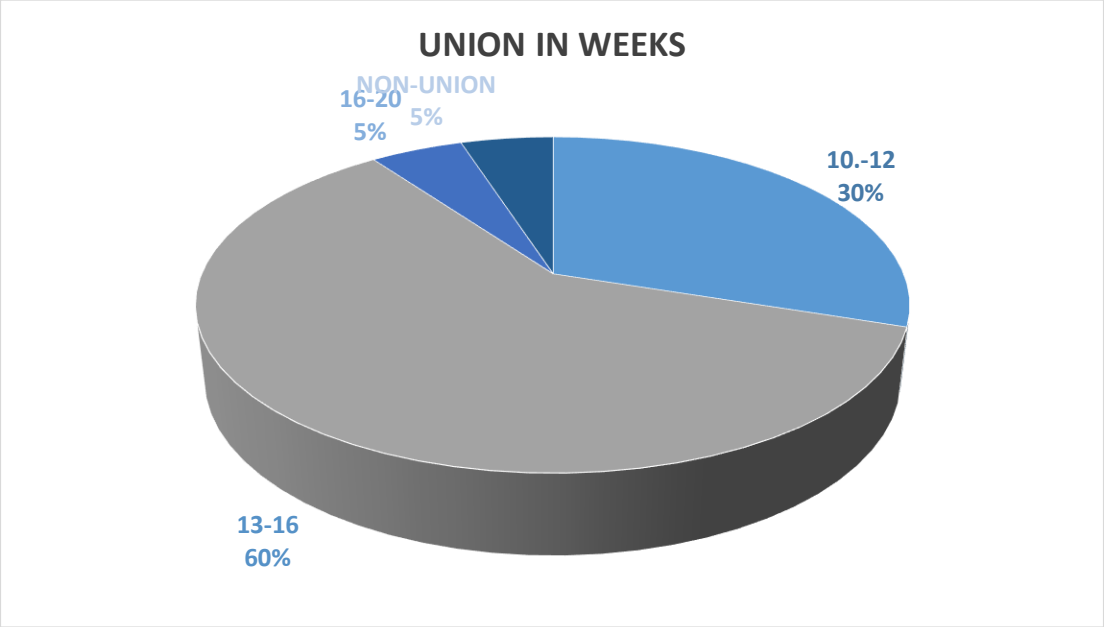
| UNION IN WEEKS | N | % |
|---|---|---|
| 10-12 | 12 | 30 |
| 13-16 | 24 | 60 |
| 16-20 | 2 | 5 |
| Non Union | 2 | 5 |
| TOTAL | 40 | 100.0 |

Table 7 : Distribution of cases by duration of union in weeks

| | Minimum | Maximum | Mean | SD |
|---|---|---|---|---|
| UNION IN WEEKS | 11 | 19 | 13.42 | 1.703 |

Table 7.1 : Mean duration of union in weeks

Majority (90%) of fractures united within 16 weeks. 30% of for fractures united within 10 to 12 weeks. 60% of fractures united within 13-16 weeks. Mean duration of union was 13.42 weeks. 5% of fractures took more than 16 weeks for union. There were 2 non-union cases.

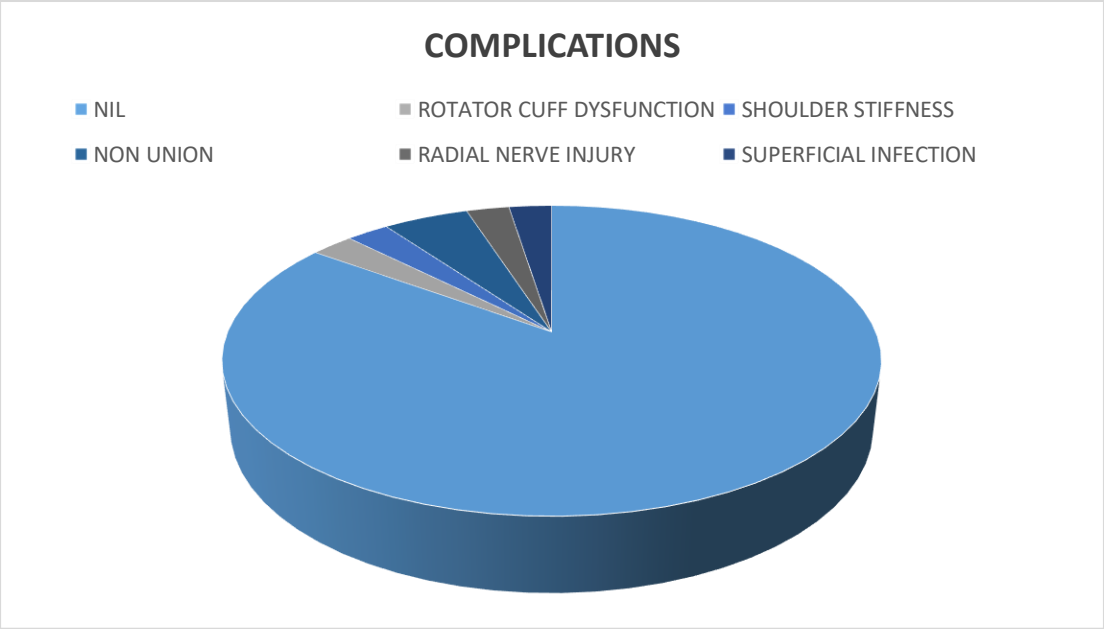



Graph 7 : Distribution of cases by duration of union in week

| COMPLICATIONS | N | % |
|---|---|---|
| ROTATOR CUFF DYSFUNCTION | 1 | 2.5 |
| SHOULDER STIFFNESS | 1 | 2.5 |
| NON UNION | 2 | 5 |
| RADIAL NERVE INJURY | 1 | 2.5 |
| SUPERFICIAL INFECTION | 1 | 2.5 |
| IMPLANT FAILURE | 0 | 0 |
| NIL | 34 | 85 |
| TOTAL | 40 | 100 |

Table 8 : Distribution of cases by Complications

85% patients had an uneventful outcome while few had rotator cuff dysfunction (2.5%), shoulder stiffness (2.5%), non union (5%), radial nerve injury (2.5%) and superficial infection (2.5%).



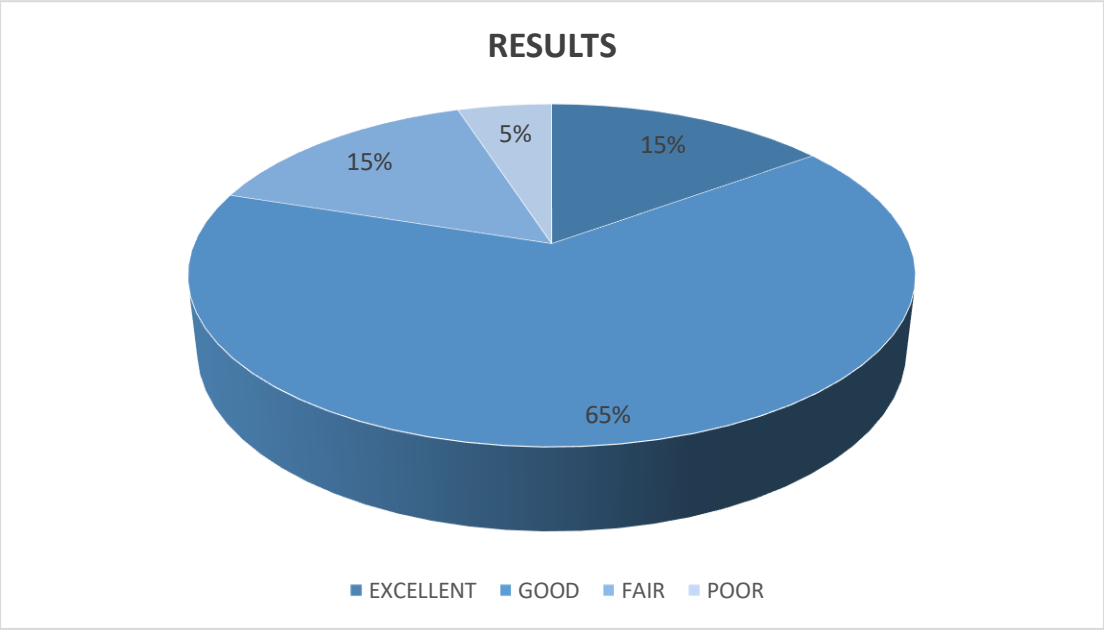

Graph 8 : Distribution of cases by Complications

| RESULT | N | % |
|---|---|---|
| Excellent | 6 | 15 |
| Good | 26 | 65 |
| Fair | 6 | 15 |
| Poor | 2 | 5 |
| TOTAL | 40 | 100 |

Table 9 : Distribution of cases by Result using DASH score

“DASH score of less than 5 was taken as excellent, 6 to 15 as good, 15 to 35 as fair/satisfactory and more than 35 as poor. DASH scores were assessed at the end of six months or full recovery whichever was earlier”.

Among 40 patients, 15% had excellent outcome, 65% had a good outcome and 15% had fair outcome.

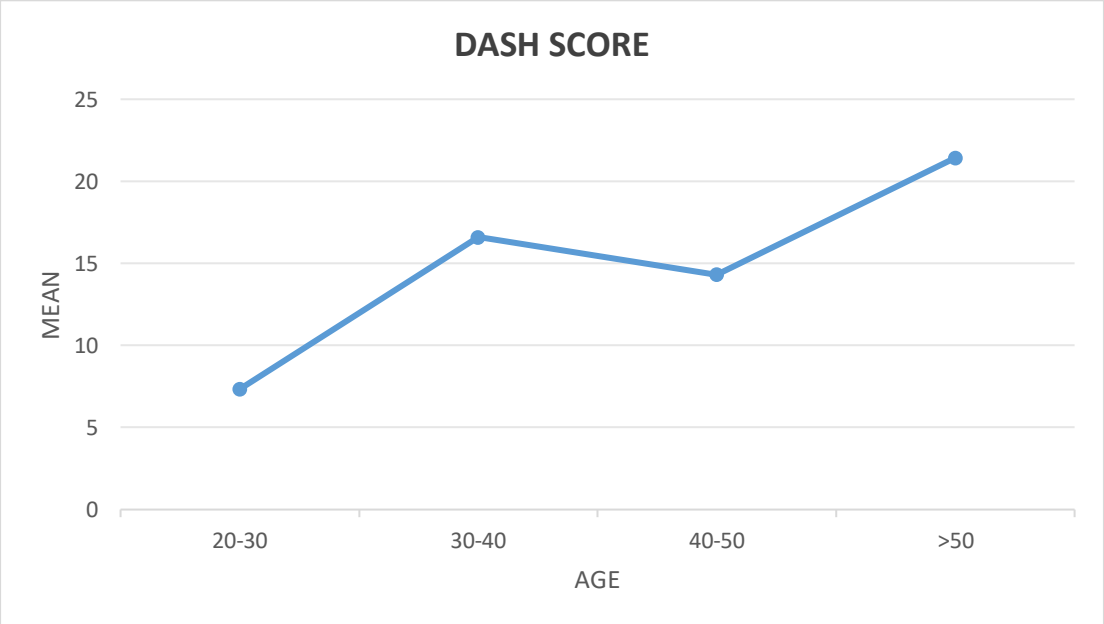



Graph 9 : Distribution of cases by Result

| AGE(Yrs) | DASH SCORE | |
|---|---|---|
| | Mean | SD |
| 20-30 | 7.34 | 3.9 |
| 30-40 | 16.6 | 13.33 |
| 40-50 | 14.32 | 8.11 |
| >50 | 21.43 | 10.78 |
| Total | 16.51 | 10.96 |

Table 10.1 : Association of Age and mean DASH Score

The average DASH score was 16.5 with standard deviation of 10.96. Maximum Mean score 21.43 was seen in age group of >50 years.




Graph 10.1 : Association of Age and mean DASH Score

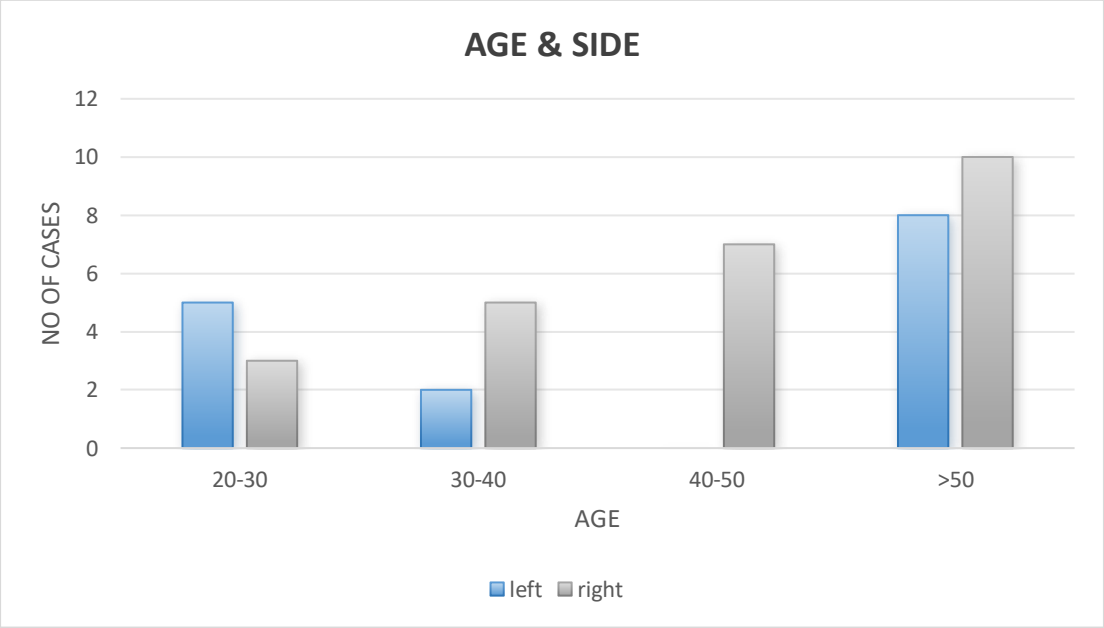
| SIDE | 20-30 | | 30-40 | | 40-50 | | >50 | | Total | | p value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % | N | % | |
| Left | 5 | 62.5 | 2 | 28.6 | 0 | 00.0 | 8 | 44.4 | 15 | 37.5 | 0.074 |
| Right | 3 | 37.5 | 5 | 71.4 | 7 | 100.0 | 10 | 55.6 | 25 | 62.5 | |
| Total | 8 | 100 | 7 | 100.0 | 7 | 100.0 | 18 | 100.0 | 40 | 100.0 | |

Table 10.2 : Association of Age and Side

Left arm was involved most commonly in age group of 20–30 years (62.5%), while right arm was involved most commonly in 40 -50 years (100%) and >50 years (55.6%) age groups.

Overall there was right side preponderance of 62.5% was seen.

„p„–value being 0.074, there was no statistical significance.

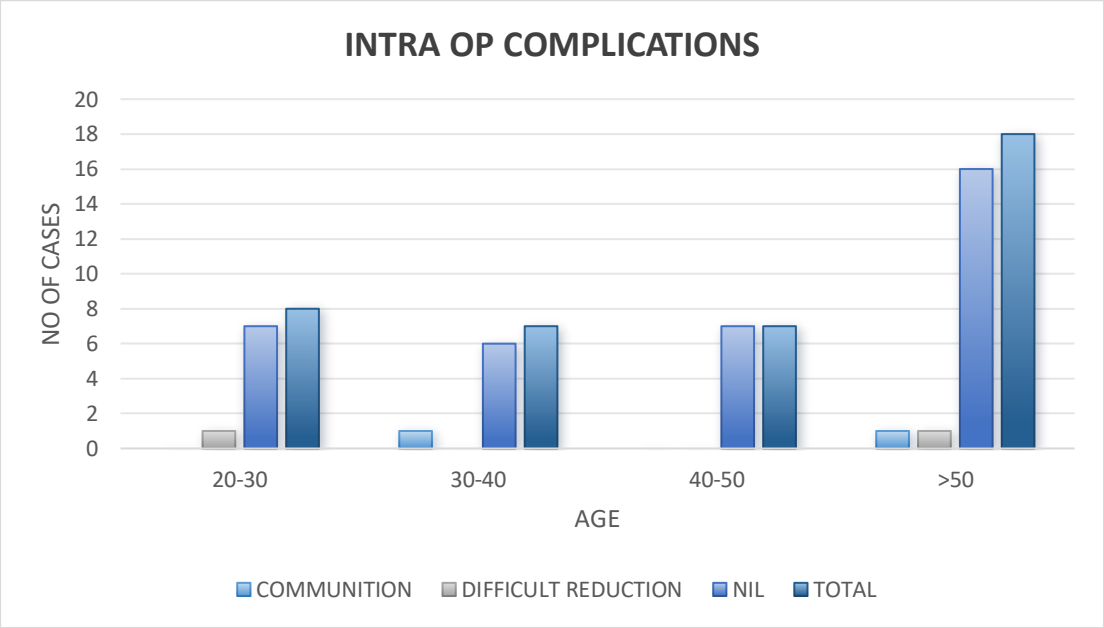



Graph 10.2 : Association of Age and Side

| INTRA-OP COMPLICATION | 20-30 | | 30-40 | | 40-50 | | >50 | | Total | | p value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % | N | % | |
| COMMUNITION | 0 | 0.0 | 1 | 14.3 | 0 | 0.0 | 1 | 5.6 | 2 | 5 | 0.720 |
| DIFFICULT REDUCTION | 1 | 12.5 | 0 | 0 | 0 | 0.0 | 1 | 5.6 | 2 | 5 | |
| NIL | 7 | 87.5 | 6 | 87.5 | 7 | 100.0 | 16 | 88.9 | 36 | 90 | |
| Total | 8 | 100 | 7 | 100.0 | 7 | 100.0 | 18 | 100.0 | 40 | 100.0 | |

Table 10.3 : Association of Age and INTRA-OP complication

„p„–value being 0.720, there was no statistical significance.

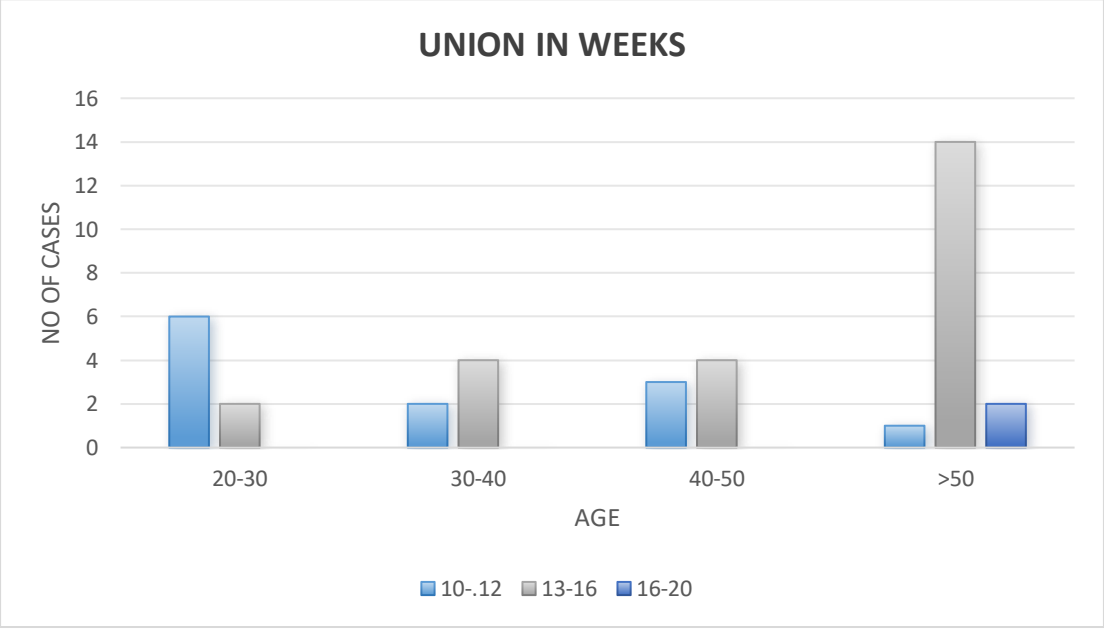



Graph 10.3 : Association of Age and INTRA-OP complication

| UNION IN WEEKS | 20-30 | | 30-40 | | 40-50 | | >50 | | Total | | p value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % | N | % | |
| 10-12 | 6 | 75 | 2 | 28.6 | 3 | 42.9 | 1 | 5.6 | 12 | 30 | 0.059 |
| 13-16 | 2 | 25 | 4 | 57.1 | 4 | 57.1 | 14 | 77.8 | 24 | 60 | |
| 16-20 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 2 | 11.1 | 2 | 5 | |
| Total | 8 | 100 | 6 | 85.7 | 7 | 100.0 | 17 | 94.3 | 38 | 95 | |

Table 10.4 : Association of Age and duration of union

„p„–value being 0.059, there was no statistical significance.

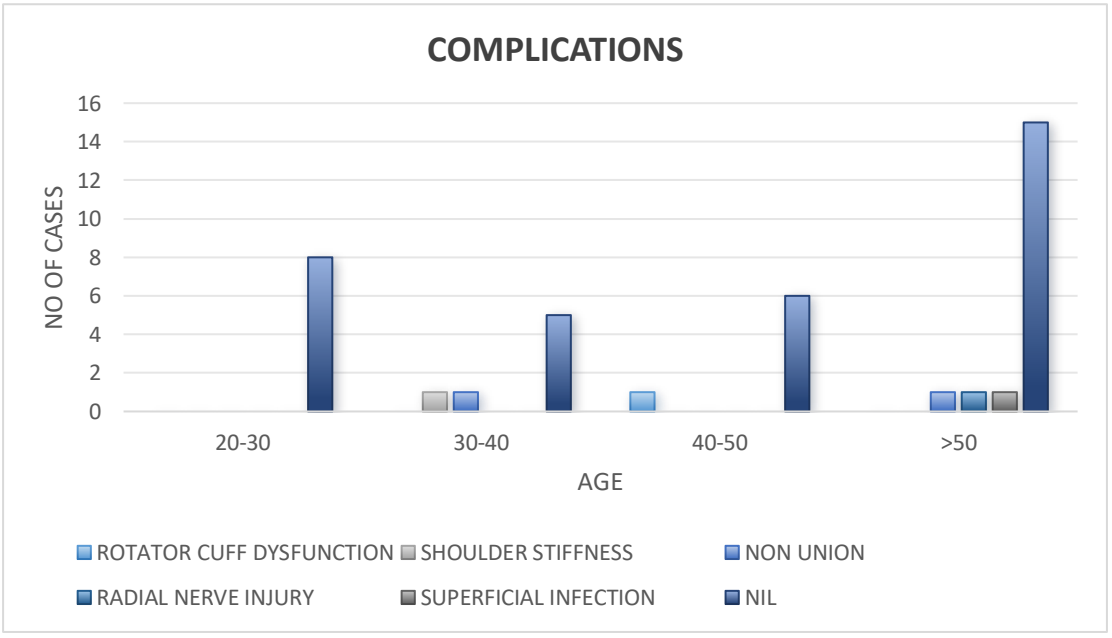



Graph 10.4 : Association of Age and duration of union

| COMPLICATIONS | 20-30 | | 30-40 | | 40-50 | | >50 | | Total | | p value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % | N | % | |
| ROTATOR CUFF DYSFUNCTION | 0 | 0.0 | 0 | 0.0 | 1 | 14.3 | 0 | 0.0 | 2 | 2.5 | 0.510 |
| SHOULDER STIFFNESS | 0 | 0.0 | 1 | 14.3 | 0 | 0.0 | 0 | 0.0 | 1 | 2.5 | |
| NON UNION | 0 | 0.0 | 1 | 14.3 | 0 | 0.0 | 1 | 5.6 | 2 | 5 | |
| RADIAL NERVE INJURY | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 5.6 | 1 | 2.5 | |
| SUPERFICIAL INFECTION | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 1 | 5.6 | 2 | 2.5 | |
| NIL | 8 | 0.0 | 5 | 71.4 | 6 | 85.7 | 15 | 83.3 | 34 | 85 | |
| Total | 8 | 100 | 7 | 100.0 | 7 | 100.0 | 18 | 100.0 | 40 | 100.0 | |

Table 10.5: Association of Age and Complications

„p„–value being 0.510, there was no statistical significance.



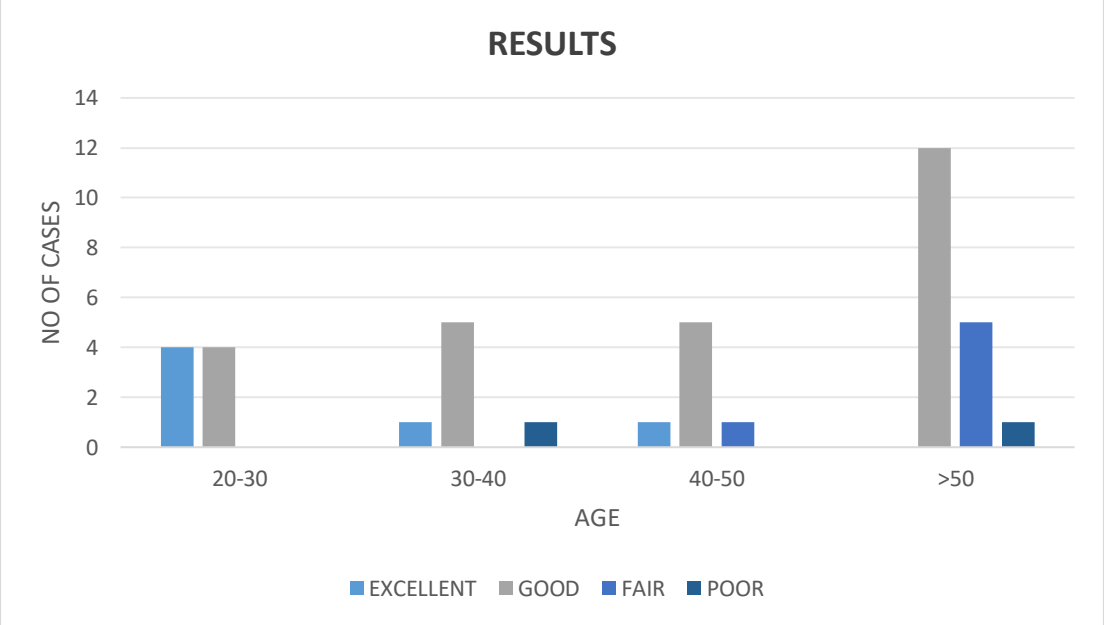

Graph 10.5 : Association of Age and Complications

| RESULT | 20-30 | | 30-40 | | 40-50 | | >50 | | Total | | p value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % | N | % | |
| Excellent | 4 | 50.0 | 1 | 14.3 | 1 | 14.3 | 0 | 0.0 | 6 | 15 | 0.071 |
| Good | 4 | 50.0 | 5 | 71.4 | 5 | 71.4 | 12 | 66.7 | 26 | 65 | |
| Fair | 0 | 0 | 0 | 0 | 1 | 14.3 | 5 | 27.8 | 6 | 15 | |
| Poor | 0 | 0 | 1 | 14.3 | 0 | 0 | 1 | 5.6 | 2 | 5 | |
| Total | 8 | 100 | 7 | 100.0 | 7 | 100.0 | 18 | 100.0 | 40 | 100.0 | |

Table 10.6: Association of Age and Result

50% Excellent outcome was seen among 20–30 years age group, 71.4% good result among 3rd and 4th decade. Among age group more than 50 years, 66.7% outcome was good.

„p„–value being 0.071, there was no statistical significance.




Graph 10.6 : Association of Age and Results

# DISCUSSION

Though conventional open reduction and internal fixation with plates and srews is considered as gold standard, still there is a debate on what is most ideal treatment for humerus shaft fractures.

The pattern of the fracture, the strength of the bone and patients age are to be considered while formulating the treatment. Though plate fixation resulted in high union rates, it necessitates extensive surgery, removing soft tissues from bone, increasing the risk of infection and nerve damage.

Also, plate fixation is less secure in osteoporotic bone and healing is slow. IMIL Nails doesn't disturb the periosteal blood flow and fracture hematoma which is required for fracture union. Nailing offers load-sharing mechanical qualities that are biomechanically superior to plating and give relative stability, which allows micromotion at the fracture. Intramedullary interlocking nail reduces the stress shielding effect and also after implant removal reducs the risk of refracture[95,96]. Since it is intramedullary implant, it suits better for osteoporotic bone.

In our study period, 40 patients with HSF were admitted at "Shri B M Patil Medical College and Hospital". The mean age group waas 46.5 years with range between 20-70 years.

Especially in woman , increased incidence noted by Ekhlom and Adami[27] from 5$^{th}$ decade of life who are more prone to osteoporosis[66,67].

In this study, the most prevalent age group afflicted was 46.5 years old, and 45% of patients were in their fourth or fifth decade. This is comparable with outcomes of Nilesh et al.[24] were the mean age was 40.6 years and 33.34% of patients are in the 40–60 age range.

Most of these fractures occurred more commonly in males. This is in keeping with previous publications [66,68]. In our study, 60% were males.

Out of 40 patients with humerus shaft fractures who got operated, 25 patients were right sided and 15 were left sided. This is in contrast with the previous studies where left side is affected more[66,67].

In the majority of recorded studies, the most of fractures united within 16 weeks. 90% of participants in this study came together in 16 weeks. 86.67% of the patients in the Nilesh et al. research[24] united within 16 weeks. Within 16 weeks, 100% of the cases in the Lal et al. series[15] came together. "In this series, the average union time was 13.42 weeks. This is equivalent to 13.26+3.9 and 13.4 weeks respectively in the series of mohammed et al.[46] and shishir et al.[43] and 13.7 and 13.4 weeks, respectively, in the series of Rommens et al.[14] and Ingmann et al." [18].

The incidence of non-union after nailing according to previous reports range from 2%-13%. In our study, there was two cases of non-union. On subsequent questioning, we found that the patients were chronic smokers. They underwent nail removal, excision of nonunion ends, plating and bone grafting. Fracture subsequently united without further complications.

In previous studies, injury to radial nerve after humerus shaft fractures surgery was 6–15%[69]. Lin Yeh et al. in his study incidence of post- operative radial nerve palsy was observed in 5 patients (7.1%). In our study, considering less sample size, only 1(2.5%) patient persisted with post-operative palsy at a later date and was examined in each visit. Patient recovered completely at 6 months of followup. This is comparable to 5.6% and 4% of patients in the series of mohammed et al.[46] and DerbasJ et.al.[93] respectively.

In our study, there were only one superficial infection (2.5%), responded well to wound debridement and antibiotics. This complication was described in the series of Mohammed et al.[20] and Nilesh et al.[24] with 11.1% and 3.33% respectively. There were no patients with fixation failure. Two patients (5%) had difficult reduction, and two patients (5%) had intraoperative communition.

Shoulder stiffness is the most common complication, as we encountered 1 patient (2.5%) in our study. However, none of the patients experienced functional limitations as a result of this. This complication was described in 5 patients (17%) by Robinson et al.[16] and in 4 patients (13.33%) by Nilesh et al.[24]. 15% of patients in the Srivastava et al.[21] series and 18% of patients in the Lal et al.[15] series had shoulder stiffness.

The primary reasons of the stiffness are patient noncompliance with the postoperative physiotherapy regimen and damage to the rotator cuff during nail insertion. Range of motion significantly improved with appropriate physiotherapy and rehabilitation. With proper adherence to the rehabilitation protocol, it took an average of six weeks to regain complete shoulder function. According to Riemer et al.[22], shoulder stiffness is caused by lingering irritation or thickening of the coracoacromial ligament or rotator cuff tendon.

In 2011, a Cochrane systematic review found that Intramedullary interlocking nailing was linked to a greater risk of shoulder pain, shoulder stiffness, and the need to remove the nail [13]. In our study, we found one case (2.5%) of shoulder impingement due to nail prominence, and after the nail was removed, the patient's shoulder function returned to normal. “This complication was observed in 3.33% of cases in the series of Nilesh et al.[24], 9% in the Lal et al.[15] series, 11.5% in the series of Shishir et al.[43] and 40% in the series of Robinson et al.” [16].

We compared our findings with :

| | Union rate | Non union | Infection | Shoulder Impingement | Complication rate |
|---|---|---|---|---|---|
| Our study | 95% | 5% | 2.5% | 2.5% | 15% |
| Mohammed et al | 95% | 5.6% | 11.1% | - | 16.6% |
| Shishir et al | 98% | 1.9% | 1.9% | 11.5% | 19% |
| McCormack et al | 89.48% | 9.5% | 4.7% | 14.2% | - |
| Dr Rahul et al | 90% | 10% | - | 15% | 30% |

Compared to alternative internal fixation techniques, in our study the majority of patients (80%) had good to excellent functional outcomes with Intramedullary interlocking nailing, with a comparatively low rate of complications.

The DASH score was used to evaluate functional outcomes. The average mean DASH score in our study was 16.5, with a standard deviation of 10.96. In Ruipeng Zhang et al.[79] and Dr. Rahul Kumar et al.[94] in their studies the average mean DASH score was 23.76 + 16.78 and 33.74 respectively. In the series of Torsten et al.[40] mean DASH score was 25.

We also studied, association of age with DASH score, side of fracture, intraop complications, time for union, complications and result. None had any statistical significance.

# SUMMARY

- ✓ From March 2023 to March 2025, our hospital operated on 40 patients who had humerus shaft fractures.
- ✓ Sixteen patients were female and 24 patients were male, with an average age of 46.5.
- ✓ Fourteen fractures were caused by falls, while 26 were caused by traffic accidents.
- ✓ There was right side preponderance of 62.5% was seen in our study.
- ✓ All the fractures were closed injuries. There were 26 (65%) type A (AO classification) fractures, 6 (15%) type B fractures and 8 (20%) type C fractures.
- ✓ The majority of the 40 patients experienced no intraoperative problems. Two patients had difficult reduction, and two patients had intraoperative comminution.
- ✓ The vast majority of fractures healed within 13–16 weeks. In this study, 15% of patients had had excellent results, 65% had good results, and 15% had fair results with over all complication rate of 15%.

# CONCLUSION

- ✓ Antegrade interlocking nails used for fracture shaft humerus has advantage over the conventional open reduction and internal fixation with plates and screws in having predictable union, less operative time and low complication rates.

- ✓ In our study, we had 80% of cases with good to excellent functional outcomes.

- ✓ Small percentage of patients do have shoulder stiffness and shoulder impingement as complications but they still do have good to fair outcomes.

- ✓ The limitation of the study was small sample size.

- ✓ Overall, Intramedullary Interlocking nailng is a good treatment option for shaft fractures of humerus with acceptable and complication rates.

## OUTCOME EVALUATION:

## SCORING SYSTEM:

| S.NO | ACTIVITIES | NO DIFFICULTY | MILD DIFFICULTY | MODERATE DIFFICULTY | SEVERE DIFFICULTY | UNABLE |
|---|---|---|---|---|---|---|
| 1. | Open a tight or new jar | 1 | 2 | 3 | 4 | 5 |
| 2. | Write | 1 | 2 | 3 | 4 | 5 |
| 3. | Turn a key | 1 | 2 | 3 | 4 | 5 |
| 4. | Prepare a meal | 1 | 2 | 3 | 4 | 5 |
| 5. | Push open a heavy door | 1 | 2 | 3 | 4 | 5 |
| 6. | Place an object on a shelf above your head | 1 | 2 | 3 | 4 | 5 |
| 7. | Do heavy household chores (wash walls, wash floors) | 1 | 2 | 3 | 4 | 5 |
| 8. | Garden or do yard work | 1 | 2 | 3 | 4 | 5 |
| 9. | Make a bed | 1 | 2 | 3 | 4 | 5 |
| 10. | Carry a shopping bag or briefcase | 1 | 2 | 3 | 4 | 5 |
| 11. | Carry a heavy object (over 10lbs) | 1 | 2 | 3 | 4 | 5 |
| 12. | Change a light bulb overhead | 1 | 2 | 3 | 4 | 5 |
| 13. | Wash or blow dry your hair | 1 | 2 | 3 | 4 | 5 |
| 14. | Wash your back | 1 | 2 | 3 | 4 | 5 |
| 15. | Put on a pullover sweater | 1 | 2 | 3 | 4 | 5 |
| 16. | Use a knife to cut food | 1 | 2 | 3 | 4 | 5 |
| 17. | Recreational activities which require little effort (e.g. cardplaying, knitting) | 1 | 2 | 3 | 4 | 5 |
| 18. | Recreational activities involve taking some force or impact through your arm, shoulder or hand (e.g. golf, hammering, tennis etc.) | 1 | 2 | 3 | 4 | 5 |
| 19. | Recreational activities in which you move your arm freely (e.g. playing badminton etc.) | 1 | 2 | 3 | 4 | 5 |
| 20. | Manage transportation needs (getting from one place to another) | 1 | 2 | 3 | 4 | 5 |
| 21. | Sexual activities | 1 | 2 | 3 | 4 | 5 |

| | | NOT AT ALL | SLIGHTLY | MODERATELY | QUITE A BIT | EXTREMELY |
|---|---|---|---|---|---|---|
| 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? | 1 | 2 | 3 | 4 | 5 |

| | | NOT LIMITED AT ALL | SLIGHTLY LIMITED | MODERATELY | QUITE A BIT | EXTREMELY |
|---|---|---|---|---|---|---|
| 23. | During the past week, were you limited in your work or other daily activities due to your arm, shoulder or hand problem? | 1 | 2 | 3 | 4 | 5 |

| | | NONE | MILD | MODERATE | SEVERE | EXTREME |
|---|---|---|---|---|---|---|
| 24. | Arm, shoulder or hand pain | 1 | 2 | 3 | 4 | 5 |
| 25. | Arm, shoulder or hand pain when performing any specific activity | 1 | 2 | 3 | 4 | 5 |
| 26. | Tingling (pins and needles) in your arm, shoulder or hand | 1 | 2 | 3 | 4 | 5 |
| 27. | Weakness in your arm, shoulder or hand | 1 | 2 | 3 | 4 | 5 |
| 28. | Stiffness in your arm, shoulder or hand | 1 | 2 | 3 | 4 | 5 |

| | | NO DIFFICULTY | MILD DIFFICULTY | MODERATE DIFFICULTY | SEVERE DIFFICULTY | SO MUCH DIFFICULTY THAT I CAN'T SLEEP |
|---|---|---|---|---|---|---|
| 29. | During the past week. How much difficulty have you had sleeping because of the pain in your arm, shoulder or hand? | 1 | 2 | 3 | 4 | 5 |

| | | STRONGLY DISAGREE | DISAGREE | NEITHER AGREE NOR DISAGREE | AGREE | STRONGLY AGREE |
|---|---|---|---|---|---|---|
| 30. | I feel less capable, less confident or less useful because of my arm, shoulder or hand problem | 1 | 2 | 3 | 4 | 5 |

DASH DISABILITY/SYMPTOM SCORE = ----------{[(sum of n responses /n) - 1] x 25, where n is the number of completed responses}

**Grading for the DASH score:**

Excellent = 0-5,
Good = 6-15,
Satisfactory = 15-35,
Poor > 35

- Pain is assessed
- Functions of the limb post-operatively are assessed.

**LIST OF REFERENCES:**


1. Rockwood CA, Bucholz RW, Court-Brown CM, Heckman JD, Tornetta P. Rockwood and Green's Fractures in Adults.7th ed. Philadelphia: Lippincott Williams & Wilkins; 2001.chapter 34, humerus shaft fractures; p.1000
2. Buckholz RW, Heckman JD, Court-Brown CM, Koval KJ, Tornetta P, Wirth MA. Rockwood and Green's Fractures In Adults, Vol 1, 6th Edition, Lippincott Williams and Wilkins, 2006.
3. Gustilo RB, Kyle RF, Templeman D. Fractures and dislocations. 1st edition: Mosby publications; 1993.
4. Browner BD, Jupiter JB, Levine AM, Trafton PG. Skeletal trauma. W.B Saunders Company; 1992.
5. Klenermann L, Injuries of arm. Wilson J N, Editor, Watson Jones Fractures and joint injuries. Sixth edition, volume two, B I Churchill Lingstone;1992.
6. Sarban S, Aksoy SA, Uzel IL, Ug Ur E. Isikan, Atik S. Orthopaedic techniques of sabuncuog lu in the 15th century ottoman period. Clinorthop; number 439; pp.253-259.
7. Evans PEL. Cerclage Fixation of a Fractured Humerus in 1775. Clinorthop; Number 174; 138-42.
8. The Classic, A case of fracture of the os humeri, In which the broken ends of the bone not uniting in the usual manner, a cure was effected by means of a seton. Communicated to Dr. Miller by Philip S. Physick; Clinorthop; Number 355S; S4-S6.
9. Rodgers JK. Case of Un-united fracture of os Brachii, Successfully Treated. Clinorthop; Number 419; February 2004; page 2-3.
10. David R, Jupiter, Jesse B. Internal Fixation of the Humerus with Locking Compression Plates Journal of Techniques in shoulder and elbow surgery Volume 4(4), December 2003, pp 169-174.
11. Mathijsen A. The Discoverer of the Plaster Bandage J. Bone Joint Surg. Am., Oct 1948; 30: 1018-1019.
12. Garnavos C, Lasanianos N, Kanakaris NK, Arnaoutoglou C, Papathanasopoulou V, Xenakis T. A new modular nail for the diaphyseal fractures of the humerus.

Injury 2009;40:604-10.

13. Kurup H, Hossain M, Andrew JG. Dynamic compression plating versus locked intramedullary nailing for humeral shaft fractures in adults. Cochrane Database Syst Rev 2011;15:CD005959.
14. Rommens PM, Verbruggen J, Broos P: Retrograde interlock nailing of fracture of the humeral shaft- A clinical study. Unfallchirurg. March 1995; 98(3) : 133-38.
15. Lal Y, Sharma S, Krishna LG, Ahmed A: Humeral shaft fractures treated by unreamed interlocking nail. Indian Journal of Orthopaedics. July 1999; 33(3).
16. Robinson CM, Bell KM, Court Brown CM, McQueen MM: Locked nailing in humeral shaft fracture. JBJS. July 1992;74B(4) : 558-62.
17. Mast JW, Spiegel PG. Fracture of the humerus shaft. Clin orthop1975 12:254-62.
18. Ingmann AM, Waters DA: Locked intramedullary nailing of humeral shaft fractures. JBJS. 1994; 76B: 23-29.
19. Bell M.J, Beauchamp, Kellam JK and McMurtry. The Results of Plating Humeral shaft Fractures in Patients with Multiple Injuries, the Sunny Brook Experience. JBJS Am 1985; Vol -67; 293-296.
20. Rush LV, Rush HC. Intramedullary fixation of fractures of the humerus by longitudinal pin surgery. 1950; 27: 268.
21. Srivastava A, Srivastava KP: Locking nails in humeral fractures. Indian Jr. of Orthopaedics vol 33(4)Oct. 1999.
22. Riemer BL, Butterfield SL, Ambrosia R, Kellam J: Seidel Intramedullary nailing of humeral diaphyseal fracture. Orthopaedics. 1991; 14 : 239.46.
23. McCormack RG, Brien D, Buckley RE, McKee MD: Fixation of fractures of the shaft of humerus by dynamic compression plate or Intramedullary nail- a prospective randomized trial. JBJS 2000; 82A: 336-339.
24. Joshi N, Deshmukh SS, Shewale YS, Halmare NA. Study of management of fracture shaft humerus by the antegrade interlocking nail in adults. European Journal of Molecular & Clinical Medicine.;10(02):2023.
25. Hall RF, Panrovick. Ender nailing of acute fractures of the humerus. J Bone Joint Surg. 1987; 9A: 558 567
26. Seidel. Humeral locking nail. Orthopedic 1989; 12: 129.
27. Ekholm R, Adami J, Tidermark J, Hansson K, Tornkvist H, Ponzer S. Fractures of the shaft of the humerus. An epidemiological study of 401 fractures. J Bone Joint Surg Br. 2006;88(11):1469-73.

28. Cole PA, Wijdicks CA. The operative treatment of diaphyseal humeral shaft fractures. Hand Clin. 2007;23(4):437-48, vi.
29. Brorson S. Management of fractures of the humerus in Ancient Egypt, Greece, and Rome: an historical review. Clin Orthop Relat Res. 2009;467(7):1907-14.
30. Denard A, Jr., Richards JE, Obremskey WT, Tucker MC, Floyd M, Herzog GA. Outcome of nonoperative vs operative treatment of humeral shaft fractures: a retrospective study of 213 patients. Orthopedics. 2010;33(8).
31. Lin J. Treatment of humeral shaft fractures with humeral locked nail and comparison with plate fixation. J Trauma. 1998;44(5):859-64.
32. Wali MG, Baba AN, Latoo IA, Bhat NA, Baba OK, Sharma S. Internal fixation of shaft humerus fractures by dynamic compression plate or interlocking intramedullary nail: a prospective, randomised study. Strategies Trauma Limb Reconstr. 2014;9(3):133-40.
33. Fan Y, Li YW, Zhang HB, Liu JF, Han XM, Chang X, Weng XS, Lin J, Zhang BZ. Management of humeral shaft fractures with intramedullary interlocking nail versus locking compression plate. Orthopedics. 2015 Sep 1;38(9):e825-9.
34. Baltov A, Mihail R, Dian E. Complications after interlocking intramedullary nailing of humeral shaft fractures. Injury. 2014;45 Suppl 1:S9-s15.
35. Hashmi PM, Mohib Y, Abbas K. Functional and radiological outcome of Intramedullary nailing vs. plate fixation for humeral shaft fractures. Does treatment method bring any difference? J Pak Med Assoc. 2014;64(12 Suppl 2):S135-8.
36. Gallusser N, Barimani B, Vauclair F. Humeral shaft fractures. EFORT Open Reviews. 2021 Jan;6(1):24.
37. Mocini F, Rovere G, De Mauro D, De Sanctis EG, Smakaj A, Maccauro G, Liuzza F. Newer generation straight humeral nails allow faster bone healing and better functional outcome at mid-term. Journal of Orthopaedic Surgery and Research. 2021 Dec;16(1):1-7.
38. Amjad U, Khalid Kz, Sattar A, Imtiaz W, Shakoor Ma, Ali Sw. Comparison of Outcomes of Nailing Versus Plating in Humeral Diaphyseal Fractures in Adults.
39. van de Wall BJ, Ochen Y, Beeres FJ, Babst R, Link BC, Heng M, van der Velde D, Knobe M, Groenwold RH, Houwert MR. Conservative vs. operative treatment for humeral shaft fractures: a meta-analysis and systematic review of randomized clinical trials and observational studies. Journal of shoulder and elbow surgery.

2020 Jul 1;29(7):1493-504.

40. Gerich T, Mouton C, Jabbarian L, Weydert JP, Hoffmann A, Pape D, Seil R. The portal of Neviaser: a valid option for antegrade nailing of humerus fractures. Journal of Experimental Orthopaedics. 2020 Dec;7(1):1-9.
41. Hems TE, Bhullar TP. Interlocking nailing of humeral shaft fractures: the Oxford experience 1991-1994. Injury 1996:27:485-489
42. Crates J. Whittle AP. Antegrade interlocking nailing of acute humeral shaft fractures. Clinorthop 1998 May (350); 40-50.
43. Suranigi SM, Reddy L, Najimudeen S. Antegrade intramedullary interlocking nailing for midshaft humerus fractures: A retrospective study evaluating the functional and radiological outcome. Journal of Current Research in Scientific Medicine. 2020 Jul 1;6(2):114.
44. Kropfl A, Naglik H, Niederwieser B, Hertz H. Unreamed antegrade humeral interlocking nailing. Unfallchirurg 2000 May; 103(5): 348-54.
45. Lopiz Y, Garcia-Coiradas J, Garcia-Fernandez C, Marco F. Proximal humerus nailing: a randomized clinical trial between curvilinear and straight nails. Journal of shoulder and elbow surgery. 2014 Mar 1;23(3):369-76.
46. Almantasir MO, HosamFathiMahmmod AH. Intramedullary Nailing Versus Plating for Treatment of Humeral Shaft Fractures in Adults. European Journal of Molecular & Clinical Medicine. 2021 Jun 7;8(3):2879-89.
47. Chen, Andrew L, Joseph, Thomas N. Wolinksy, Phillip R, Tejwani, Nirmal C Kummer, Frederick J. Egol, Kenneth A., Koval, Kenneth J. Fixation Stability of Comminuted Humeral Shaft Fractures: Locked Intramedullary Nailing versus Plate Fixation. J of trauma: injury, infection and critical care: Volume 53(4), October 2002, pp 733-737
48. Demirel M, Turhan E, Dereboy F, Ozturk A. Interlocking nailing of humeral shaft fractures a retrospective study of 114 patients. Indian J Med Sci 2005; 59:436-42.
49. Virkus, Walter, Goldberg, Steven, Lorenz, Eric et al. A Comparison of compressive Force Generation by Plating and Intramedullary Nailing Techniques in a Transverse Diaphyseal Humerus Fracture Model. Journal of Trauma-Injury Infection & Critical Care. 6501):103-108, July 2008.
50. Rockwood CA, Bucholz RW, Green DP, Heckman JD, Rockwood and Green's Fractures In Adults, Vol 1, 4th Edition, Lippincott Raven; 1996.

51. Buckholz RW, Heckman JD, Rockwood, Green's. Fractures in Adults. Vol 1, 5th Edition. Lippincott Williams and Wilkins, 2001
52. Sangm OM, Kim I, Hyungh AI, Kwang THU, h JW. Arm Wrestler's Injury: Report of seven cases. clinorthop; Number 147; March-April; 1980; 219-21.
53. Heilbronner DM, Manoli A, Morawa LG. Fractures of the Humerus in Arm Wrestlers. Clinorthop; Number 149; June 1980; 169-71
54. Reed WJ, Mueller RW. Spiral Fracture of the Humerus in a Ball Thrower. Am J Emerg Med; 1998; 16; 306-308
55. Natarajan M, Williams s, Arm wrestler's Fracture. Ind J orthop, vol 25; No 2: July 1991; P 86.
56. Sarmiento A, Philip B, Kinman, Eugene G, Galvin, Roger H, Schmitt and Phillips JC. Functional bracing of fractures of the shaft of the Humerus. JBUS Am, 1977; 59; 596 601
57. Sarmiento A, Latta LL. Functional Fracture Bracing. J Am AcadorthopSurg; 1999; 7; 66-75.
58. Rangger C, Kathrein A, Klestil T. Immediate Application of Fracture Braces in Humeral Shaft Fractures. J Trauma; Volume 46(4); April 1999; 732-735.
59. Camden P, Nade S. Fracture bracing the humerus. Injury; Volume 23; Issue 4; 1992: 245-248.
60. Mittal J, Makker KK and Kacker JN. Functional Bracing in Fractures of Shaft of the Humerus. Ind J Orthop; Vol 24, No 2; July 1990; 154-156.
61. Mavani DP, Johari AN, Vengsarkar SS and Shah SV. Functional Bracing for Fractures of the Humeral Shaft. Ind J Orthop; Vol 20;No 2; July1986;192- 196
62. Sarmiento A, Zagorski JB, Zych GA, Latta LL and Capps C. Functional Bracing for the Treatment of Fractures of the Humeral Diaphysis. JBJS; Volume 82-A (4); April 2000; 478-486.
63. Muller ME, Algower M, Schneider R, Willenegger H. Manual of internal fixation. Springer-Verlag. 3rd Edition; 1991
64. Charles M. Court-Brown,, William MR, McQueen MM, Heckman JD, Rockwood and Green's Fractures In Adults, Vol 1, 8th Edition, Wolters Kluwer Health; 2015.
65. Charnley J. The closed treatment of common fractures. Vol. 3, 9th edition, Chapter 49, 2297 pp; edited by S. Terry Canale.
66. Tytherleigh-Strong, G.Walls, N.McQueen, M.M. The epidemiology of humeral

shaft fractures. J Bone Joint Surg Br. 1998;80:249–253.

67. Igbigbi.P.S, K. Manda International Orthopaedics (SICOT) (2004) 28: 338
68. Rockwood CA Jr, Green DP, Bucholz RW, editors. Rockwood and Green‟s fractures in adults. 3rd ed. Philadelphia: Lippincott Williams & Williams; 1991.
69. Garcia AJ, Maeck BH.Radial nerve injuries in the fractures of the shaft of the humerus.Am J Surg. 1960: 99: 625-627.
70. Walker M, Palumbo B, Badman B, Brooks J, Van Gelderen J, Mighell M. Humeral shaft fractures: a review. J Shoulder Elbow Surg. 2011;20(5):833-44.
71. Lambotte A. Trauma systems in Europe. The American Journal of Surgery, 1991;161 (2), p.226-229.
72. Bohler L. Conservative treatment of fresh closed fractures of the shaft of the humerus. J Trauma 1965: 5: 464 468.
73. Peter J, Stern, David A, Donald L. Intramedullary fixation of humeral shaft fractures. J Bone Joint Surg. 1984; 66A, 639
74. Siebert CH, Heinz BC, Hofler HR, Hansis M. Unfallchirurg; 1996; 99 (2);11.
75. Habernek H, Orthner E. Locking nail for fractures of the humerus. JBJS-B. 1991.73-B. 651-653.
76. Chapman JR, Henley MB, Agel J, Benca PJ. Randomised prospective study of humeral shaft fracture fixation: intramedullary nails versus plates. J orthop Trauma 2000; 31 (9): 683-5.
77. Cox MA, Dolan M, Synnot K. Closed interlocking nailing of humeral shaft fractures with the Russell Taylor nail. J. Orthop Trauma 2000; June-July; 14 349 53.
78. Farragos AF, Schemitsch EH. Complications of intramedullary nailing for fractures of the humeral shaft: a review. J Orthop Trauma. 1999 May; 13 (4): 258-67.
79. Zhang R Intramedullary nailing versus a locking compression plate for humeral shaft fracture: A retrospective study. Orthop Traumatol Surg Res. 2020 Nov;106(7):1391-1397.
80. Campochiaro G, Catani F. Humeral shaft non-union after intramedullary nailing. Musculoskelet Surg. 2017 Aug;101(2):189-193.
81. Den Hartog D, Mahabier KC on behalf of the HUMMER Investigators. Functional and Clinical Outcomes After Plate Osteosynthesis Versus Intramedullary Nailing of a HSF: J Bone Joint Surg Am. 2023 Jul

19;105(14):1101-1111.
82. Chávez-Galván CR, Martínez-Pérez R. Enclavado centromedular anterógrado de húmero [Humeral anterograde nailing. Functional results]. Acta Ortop Mex. 2019 Jan-Feb;33(1):36-38.
83. Akalın Y, Şahin İG, Çevik N LCP fixation versus IMN of HSF : which one is better? A single-centre prospective randomized study. Int Orthop. 2020 Oct;44(10):2113-2121.
84. James CL, Haan J, Wager SG Comparing the Clinical and Radiographic Outcomes of Humeral Shaft Fractures by Treatment Type. Cureus. 2024 Apr 20;16(4):e58658.
85. Cannada LK, Nelson L, Tornetta Operative vs. Nonoperative Treatment of Isolated Humeral Shaft Fractures: A Prospective Cohort Study. J Surg Orthop Adv. 2021 Summer;30(2):67-72.
86. Shi SY, Du XL, Ou XH. Clinical efficacy analysis of minimally invasive intramedullary nailing in the treatment of humeral shaft fractures combined with radial nerve injury. Eur Rev Med Pharmacol Sci. 2024 Jan;28(1):59-70.
87. Angachekar D, Patel S, Shetty S A Retrospective Analysis of Dynamic Compression Plating Versus Intramedullary Nailing for the Management of Shaft of Humerus Fractures in an Urban Trauma Care Center. Cureus. 2024 Jan 24;16(1).
88. Tosun HB, Serbest S Comparison of the Locking Intramedullary Nailing, Single Plate and Double Plate Osteosynthesis in Treatment of Humerus Shaft Fractures. J Coll Physicians Surg Pak. 2023 Nov;33(11):1315-1320.
89. Gupta T, Shamim S A Study on Outcome of Conservative Management of Shaft Humerus Fracture: A Case Report. J Orthop Case Rep. 2024 Dec;14(12):252-256.
90. Lunn K, Hurley ET Complications following intramedullary nailing of proximal humerus and humeral shaft fractures: a systematic review. J Shoulder Elbow Surg. 2025 Feb;34(2):626-638.
91. Zhang Z, Lin Z Systematic review of humeral shaft fracture (OTA/AO 12) complicated with iatrogenic radial nerve injury. Eur J Med Res. 2024 Jul 25;29(1):385.
92. Nadeem A, Abbasi H. Outcomes of Intramedullary Nailing Versus Plate Fixation in the Management of Humeral Shaft Fractures: A Systematic Review and Meta-

Analysis. Cureus. 2024 Oct 27;16(10).

93. Derbas J, Moghamis I Outcomes of intramedullary nailing versus plate fixation for humeral shaft fractures: a retrospective cohort study. Eur J Orthop Surg Traumatol. 2025 Feb 7;35(1):63.
94. Dr. Rahul Kumar Chandan, Dr. VP Sinha and Dr. DP Bhushan. Comparison of results between dynamic compression plate and interlocking nail for the management of fracture shaft of humerus. Int. J. Orthop. Sci. 2020;6(1):249-252.
95. Garnavos C. Diaphyseal humeral fractures and intramedullary nailing: Can we improve outcomes? Indian J Orthop 2011;45:208-15.
96. Schopfer A, Hearn TC, Malisano L, Powell JN, Kellam JF. Comparison of torsional strength of humeral intramedullary nailing: A cadaveric study. J Orthop Trauma 1994;8:414-21.
97. Marsh JL, Slongo TF, Agel J, et al. Fracture and dislocation classification compendium - 2007: Orthopaedic Trauma Association classification, database and outcomes committee. J Orthop Trauma. 2007org
98. Campbell's operative orthopaedics. Vol. 3, 9th edition, Chapter 49, pp 2297; edited by S. Terry Canale.
99. Crolla RMPH, deVries S, Clevers CJ. Locked intramedullary nailing of humeral fractures. Injury 1993:24: 403-455.
100. de Boer P, Buckley R, Hoppenfeld S. Surgical Exposures in Orthopaedics: The Anatomic Approach, 6e. Lippincott Williams & Wilkins, a Wolters Kluwer business; 2022.
101. Rockwood CA, Bucholz RW, Green DP, Court-Brown CM, Heckman JD, Tornetta P. Rockwood and Green's Fractures in Adults. Vol 1. Fractures in Adults. Philadelphia: Wolters Kluwer Health/Lippincott Williams & Wilkins; 2010.

# ANNEXURE I

BLDE
(DEEMED TO BE UNIVERSITY)
Declared as Deemed to be University u/s 3 of UGC Act, 1956
**Accredited with 'A' Grade by NAAC (Cycle-2)**
The Constituent College
SHRI B. M. PATIL MEDICAL COLLEGE, HOSPITAL & RESEARCH CENTRE, VIJAYAPURA

BLDE (DU)/IEC/ 978/2022-23 10/4/2023

## INSTITUTIONAL ETHICAL CLEARANCE CERTIFICATE

The Ethical Committee of this University met on **Saturday, 18th March, 2023 at 11.30 a.m. in the CAL Laboratory, Dept. of Pharmacology,** scrutinizes the Synopsis/ Research Projects of Post Graduate Student / Under Graduate Student /Faculty members of this University /Ph.D. Student College from ethical clearance point of view. After scrutiny, the following original/ corrected and revised version synopsis of the thesis/ research projects has been accorded ethical clearance.

**TITLE: "FUNCTIONAL OUTCOME OF INTRAMEDULLARY INTERLOCKING NAIL IN THE TREATMENT OF SHAFT HUMERUS FRACTURES" -A PROSPECTIVE STUDY.**

**NAME OF THE STUDENT/PRINCIPAL INVESTIGATOR:** DR.CHALLA VEERA NAVEEN KUMAR REDDY.

**NAME OF THE GUIDE:** DR. SANDEEP NAIK , ASSOCIATE PROFESSOR, DEPT. OF ORTHOPAEDICS

Dr. Santoshkumar Jeevangi
Chairperson
IEC, BLDE (DU),
VIJAYAPURA
Chairman,
Institutional Ethical Committee,
BLDE (Deemed to be University)
Vijayapura

Dr.Akram A. Naikwadi
Member Secretary
IEC, BLDE (DU),
VIJAYAPURA
MEMBER SECRETARY
Institutional Ethics Committee
BLDE (Deemed to be University)
Vijayapura-586103. Karnataka

Following documents were placed before Ethical Committee for Scrutinization.

- Copy of Synopsis/Research Projects
- Copy of inform consent form
- Any other relevant document

Smt. Bangaramma Sajjan Campus, B. M. Patil Road (Sholapur Road), Vijayapura - 586103, Karnataka, India.
**BLDE (DU):** Phone: +918352-262770, Fax: +918352-263303, Website: www.bldedu.ac.in, E-mail:office@bldedu.ac.in
**College:** Phone: +918352-262770, Fax: +918352-263019, E-mail: bmpmc.principal@bldedu.ac.in

## ANNEXURE II

## B.L.D.E. (DEEMED TO BE UNIVERSITY) SHRI B.M.PATIL MEDICAL COLLEGE HOSPITAL AND RESEARCH CENTER, VIJAYAPURA-586103

## INFORMED CONSENT FOR PARTICIPATION IN DISSERTATION/RESEARCH

I, the undersigned,_____, S/O D/O W/O_____, aged_____ years, ordinarily resident of_____, do hereby state/declare that Dr CHALLA VEERA NAVEEN KUMAR REDDY of Shri. B. M. Patil Medical College Hospital and Research Centre have examined me thoroughly on_____at_____(place), and it has been explained to me in my language that I am suffering from_____disease (condition). This disease/condition mimics the following diseases. Further, Dr CHALLA VEERA NAVEEN KUMAR REDDY informed me that he/she is conducting a dissertation/research titled "FUNCTIONAL OUTCOME OF INTRAMEDULLARY INTERLOCKING NAIL IN THE TREATMENT OF SHAFT HUMERUS FRACTURES - A PROSPECTIVE STUDY" under the guidance of Dr SANDEEP NAIK requesting my participation in the study. Apart from routine treatment procedures, the pre-operative, operative, post-operative and follow-up observations will be utilized for the study as reference data.

The Doctor has also informed me that adverse results may be encountered during this procedure. Most of the above complications are treatable but not anticipated; hence there is a chance of aggravation of my condition. In rare circumstances, it may prove fatal despite the anticipated diagnosis and best treatment made available. Further Doctor has informed me that my participation in this study helps evaluate the study's results, which is a useful reference to the treatment of other similar cases soon. Also, I may be benefited from getting relieved from suffering or a cure for the disease I am suffering.

The Doctor has also informed me that information given by me, observations made/ photographs/ video graphs taken upon me by the investigator will be kept secret and

not assessed by anyone other than my legal hirer or me except for academic purposes.
The Doctor did inform me that though my participation is purely voluntary, based on the information I gave, I can ask for any clarification during treatment/study related to diagnosis, the treatment procedure, the treatment result, or the prognosis. I have been instructed to withdraw from participating in this study at any time if I want, or the investigator can terminate me at any time, but not the procedure of treatment and follow-up unless I request to be discharged.
After understanding the nature of the dissertation or research, the diagnosis made, mode of treatment, I, the undersigned Shri/Smt_____, under my fully conscious state of mind, agree to participate in the said research/dissertation.

Signature of the patient:

Signature of Doctor:

Witness:
1.
2.

Date:

Place:

## ANNEXURE – III

## SHRI B.M. PATIL MEDICAL COLLEGE, HOSPITAL AND RESEARCH CENTRE, VIJAYAPURA - 586103

## PROFORMA

CASE NO. :

NAME:

AGE/SEX :

I P NO :

DATE OF ADMISSION :

DATE OF SURGERY :

DATE OF DISCHARGE :

OCCUPATION :

RESIDENCE :

Presenting complaints with duration :

History of presenting complaints :

Family History :

Personal History :

Past History :

General Physical Examination :

Vitals :

PR: R.R.:

B. P.: TEMP:

Systemic Examination:

Respiratory system :

Cardio vascular system :

Central nervous system :

Per abdomen :

Local examination:

Right/ Left Hand

Inspection:

1. Attitude/ deformity
2. Abnormal swelling
3. Skin condition
4. Shortening
5. Compound injury, if any

Palpation:

1) Swelling
2) Local tenderness
3) Bony irregularity
4) Abnormal movement
5) Crepitus
6) wound

| Movements : | Active | Passive |
|---|---|---|
| **Shoulder joint** | | |
| Flexion | | |
| Extension | | |
| Abduction | | |
| Adduction | | |
| Internal rotation | | |
| External rotation | | |
| **Elbow joint** | | |
| Flexion | | |
| Extension | | |

Intra-operative details :

Post operative :

-Rehabilitation protocol as per the guidelines

-Functional outcome evaluation with - DASH score

# MASTER CHART

| SLNO. | PATIENT NAME | AGE(YRS) | SEX | PATIENT ID | MODE OF INJURY | SIDE OF INJURY | DASH SCORE | | | INTRA-OP COMPLICATIONS | TIME FOR UNION | COMPLICATIONS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 6 WEEKS | 3 MONTHS | 6 MONTHS | | | |
| 1 | Latip k | 57 | M | 284127 | RTA | Left | 58.25 | 35 | 15 | - | 14 wks | - |
| 2 | Shabbir p | 32 | M | 371283 | RTA | Right | 33.25 | 10.75 | 4 | - | 14 wks | - |
| 3 | Basavaraj | 35 | M | 301624 | RTA | Right | 53.25 | 25 | 14 | Comminution | 15wks | - |
| 4 | Shantabai d | 62 | F | 278362 | Fall fromheight | Left | 58.25 | 40 | 15 | - | 14 wks | - |
| 5 | Ashok b | 65 | M | 234255 | Trivial fall | Left | 64 | 43.25 | 33.25 | Reduction | 19wks | - |
| 6 | Revati | 60 | F | 226862 | Fall fromheight | Right | 57.5 | 33.25 | 15 | - | 13wks | - |
| 7 | Rajeshwari | 60 | F | 283889 | Fall fromheight | Right | 66.5 | 41.5 | 29 | - | 14 wks | - |
| 8 | Mahantesh | 45 | M | 3391 | RTA | Right | 35 | 14 | 5 | - | 13wks | - |
| 9 | Harappa | 30 | M | 66719 | RTA | Right | 33.25 | 12.5 | 5 | - | 12wks | - |
| 10 | Mehboob | 30 | M | 66709 | RTA | Left | 48.25 | 29 | 14 | Reduction | 15wks | - |
| 11 | Rayappa | 28 | M | 36621 | RTA | Left | 29 | 10.75 | 4 | - | 11wks | - |
| 12 | Farooq | 70 | M | 3984 | Trivial fall | Right | 58.25 | 33.25 | 14 | - | 14 wks | - |
| 13 | Mahesh | 32 | M | 58622 | RTA | Left | 48.25 | 23.25 | 14 | - | 12wks | Shoulder Stiffness |
| 14 | Basagouda | 50 | M | 106845 | RTA | Right | 68.25 | 45.75 | 30.75 | - | 12wks | - |
| 15 | Babu | 56 | M | 6182 | Fall fromheight | Right | 57.5 | 33.25 | 12.5 | - | 13wks | - |
| 16 | Tasneem | 55 | F | 202881 | Fall fromheight | Right | 57.5 | 40 | 15 | - | 13wks | - |
| 17 | Sauheeni | 20 | F | 202926 | RTA | Left | 48.25 | 23.25 | 12.5 | - | 14 wks | - |
| 18 | Shantabai | 35 | F | 178513 | RTA | Right | 40 | 29 | 12.5 | - | 12wks | - |
| 19 | Gangabai | 55 | F | 67806 | RTA | Left | 48.25 | 25 | 14 | - | 16wks | - |
| 20 | Anand | 22 | M | 181152 | RTA | Right | 29 | 14 | 6 | - | 11wks | - |
| 21 | Yogesh | 38 | M | 181166 | RTA | Left | 60 | 29 | 13.25 | - | 16wks | - |
| 22 | Vijay | 24 | M | 180822 | RTA | Right | 25 | 12.5 | 5 | - | 12wks | - |
| 23 | Abdul | 20 | M | 180823 | RTA | Left | 35 | 16.5 | 4 | - | 12wks | - |
| 24 | Hanif | 60 | M | 160552 | Fall fromheight | Left | 68.25 | 50 | 35 | - | 14 wks | - |
| 25 | Ismail | 32 | M | 160558 | RTA | Right | 68.25 | 56.5 | 45.75 | - | - | Nonunion |
| 26 | Kankappa | 68 | M | 154139 | Trivial fall | Left | 68.25 | 45.75 | 32.75 | - | 13wks | RNP |
| 27 | Shankar | 51 | M | 148320 | RTA | Right | 40 | 29 | 14 | - | 12wks | Infection |
| 28 | Subash | 20 | M | 148329 | RTA | Left | 25 | 16.5 | 8.25 | - | 12wks | - |
| 29 | Chandhabai | 70 | F | 58622 | Trivial fall | Right | 68.25 | 50 | 34 | Comminution | 18wks | - |
| 30 | Ambavwa | 42 | F | 281792 | RTA | Right | 50 | 33.25 | 14 | - | 12wks | - |
| 31 | Maibubasab | 45 | M | 260174 | RTA | Right | 50 | 29 | 8.25 | - | 12wks | - |
| 32 | Kakandak | 57 | M | 184127 | RTA | Left | 53.25 | 33.25 | 14 | - | 13wks | - |
| 33 | Ashok m | 65 | M | 206599 | Fall fromheight | Left | 58.25 | 35 | 15 | - | 14 wks | - |
| 34 | Vaijanti | 60 | F | 110503 | Fall fromheight | Right | 57 | 35 | 15 | - | 13wks | - |
| 35 | Maitili | 45 | F | 130577 | RTA | Right | 50 | 33.25 | 15 | - | 13wks | Impingement |
| 36 | Shantavva | 50 | F | 160270 | RTA | Right | 53.25 | 35 | 14 | - | 13wks | - |
| 37 | Tabasum | 42 | F | 273102 | RTA | Right | 53.25 | 33.25 | 13.25 | - | 13wks | - |
| 38 | Noorjan | 65 | F | 187425 | Fall fromheight | Right | 48.25 | 33.25 | 15 | - | 14 wks | - |
| 39 | Sharadabhai | 68 | F | 182625 | Trivial fall | Right | 71.5 | 58.25 | 48.25 | - | - | Nonunion |
| 40 | Noorjahan | 40 | F | 72932 | RTA | Right | 53.25 | 25 | 12.5 | - | 13wks | - |

# 5% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.

## Filtered from the Report

- Bibliography
- Quoted Text
- Cited Text
- Small Matches (less than 10 words)

## Match Groups

**48** Not Cited or Quoted 5%
Matches with neither in-text citation nor quotation marks

**0** Missing Quotations 0%
Matches that are still very similar to source material

**0** Missing Citation 0%
Matches that have quotation marks, but no in-text citation

**0** Cited and Quoted 0%
Matches with in-text citation present, but no quotation marks

## Top Sources

3% Internet sources

4% Publications

0% Submitted works (Student Papers)

## Integrity Flags

**0 Integrity Flags for Review**

No suspicious text manipulations found.

Our system's algorithms look deeply at a document for any inconsistencies that would set it apart from a normal submission. If we notice something strange, we flag it for you to review.

A Flag is not necessarily an indicator of a problem. However, we'd recommend you focus your attention there for further review.