# "EVALUATION OF FUNCTIONAL AND RADIOLOGICAL OUTCOMES FOLLOWING BOTH BONE FRACTURE OF FOREARM FIXED WITH LOCKING COMPRESSION PLATE"


BY

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

**In partial fulfillment of the requirements for the degree of**

**MASTER OF SURGERY**

**IN**

**ORTHOPAEDICS**

**Under the Guidance of**


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***DR. MUTHUKUMAR R***

**EVALUATION OF FUNCTIONAL AND RADIOLOGICAL OUTCOMES FOLLOWING BOTH BONE FRACTURE OF FOREARM FIXED WITH LOCKING COMPRESSION PLATE**

# ABSTRACT

**Background:** Forearm fractures, particularly those involving both the radius and ulna, are common orthopaedic injuries that significantly impact upper limb function. Traditional treatment methods, such as cast immobilization, often yield poor outcomes, necessitating the development of more effective surgical techniques. Locking Compression Plates (LCPs) have emerged as a preferred method due to their biomechanical advantages, including enhanced stability and preservation of periosteal blood supply.

**Objective:** This study aimed to evaluate the functional and radiological outcomes of both-bone forearm fractures treated with LCP fixation, focusing on fracture union, range of motion, and functional recovery using the Disabilities of the Arm, Shoulder, and Hand (DASH) scoring system.

**Methods:** A prospective interventional study was conducted on 37 patients hospitalized to RL Jalappa hospital from May 2023 to November 2024, with diaphyseal fractures of the radius and ulna, treated with open reduction and internal fixation using 3.5mm LCPs. Patients were followed up for six months, with assessments of pain (Visual Analog Scale), radiological union, range of motion (elbow, wrist, and forearm rotation), and functional outcomes (DASH scores).

**Results:** Majority of patients were found in 50-59 years (29.73%) age group, with 27.03% younger patients (10-39 years). There was male predominance (56.76% vs 43.24% female) among study participants. Right forearm fractures were more common (56.76%) compared to left side.

In this study, falls from height (43.24%) and motor vehicle accidents (37.84%) most frequent. Midshaft location of fractures were most common (43.24%) and Oblique pattern predominated (40.54%). Open fractures occurred in 59.46% of cases. Predominant associated injuries were soft tissue injuries and head trauma (24.32% each). 81.08% had no complications, delayed union (13.51%) was most common complication and there was low rates of infection.

The study demonstrated a high union rate of 91.5%, with minimal complications (delayed union: 13.51%; infection: 5.41%). Pain scores significantly decreased from $5.7 \pm 2.3$ at one month to $1.9 \pm 1.2$ at six months ($p < 0.001$). Functional recovery improved markedly, with DASH scores declining from $52.1 \pm 18.3$ (moderate disability) to $15.2 \pm 11.6$ (minimal disability) by six months. Range of motion also showed substantial improvement, with elbow and wrist mobility reaching 93% and >80% of normal function, respectively.

**Conclusion:** LCP fixation is an effective treatment for both-bone forearm fractures, providing stable fixation, early rehabilitation, and excellent functional and radiological outcomes. The technique’s advantages, including angular stability and reduced soft tissue irritation, make it superior to conventional plating methods. These findings support LCP as the gold standard for managing such fractures, particularly in complex and unstable cases.

**Keywords:** Forearm fractures, Locking Compression Plate (LCP), functional outcomes, radiological outcomes, DASH score, fracture union.

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# ABBREVIATIONS

| Abbreviation | Full Form |
|---|---|
| **LCP** | Locking Compression Plate |
| **DASH** | Disabilities of the Arm, Shoulder and Hand (Score) |
| **VAS** | Visual Analog Scale (Pain Score) |
| **ROM** | Range of Motion |
| **OTA** | Orthopaedic Trauma Association |
| **AO** | Association for the Study of Internal Fixation (Arbeitsgemeinschaft für Osteosynthesefragen) |
| **RBS** | Random Blood Sugar |
| **ECG** | Electrocardiogram |
| **ESR** | Erythrocyte Sedimentation Rate |
| **HBsAg** | Hepatitis B Surface Antigen |
| **HCV** | Hepatitis C Virus |
| **HIV** | Human Immunodeficiency Virus |
| **NVD** | Neurovascular Deficit |
| **DCP** | Dynamic Compression Plate |
| **AP view** | Anteroposterior View (Radiograph) |
| **2D ECHO** | Two-Dimensional Echocardiography |
| **SPSS** | Statistical Package for the Social Sciences |
| **EPI Info** | Epidemiological Information (Software by CDC) |
| **TFCC** | Triangular Fibrocartilage Complex |

# INTRODUCTION

# INTRODUCTION

Forearm fractures are common injuries that can occur due to falls, direct trauma, or high-impact activities.[1] The forearm consists of two long bones, the radius and ulna, which play a crucial role in arm movement, stability, and function.[2] Fractures in these bones can range from simple, non-displaced breaks to complex, open fractures requiring surgical intervention.[1]

Forearm fractures can affect people of all ages, from children who experience buckle fractures due to softer bones[3] to adults who suffer more severe breaks from sports injuries or accidents.[4] Symptoms typically include pain, swelling, deformity, and limited movement of the wrist and elbow.[4] Prompt diagnosis and appropriate treatment are essential to ensure proper healing and restore full function to the arm.[5]

Both bone forearm fractures, involving simultaneous fractures of the radius and ulna, are common orthopaedic injuries that significantly impact upper limb function.[6] These fractures often result from high-energy trauma such as falls, motor vehicle accidents, or sports injuries.[7] Anatomical reduction and stable fixation are crucial for restoring forearm rotation and overall limb functionality.[8]

“The forearm's unique anatomical structure, which relies on the intricate interplay between the radius and ulna for pronation and supination, makes the restoration of anatomical alignment and stability critical for optimal functional outcomes.[6,8]

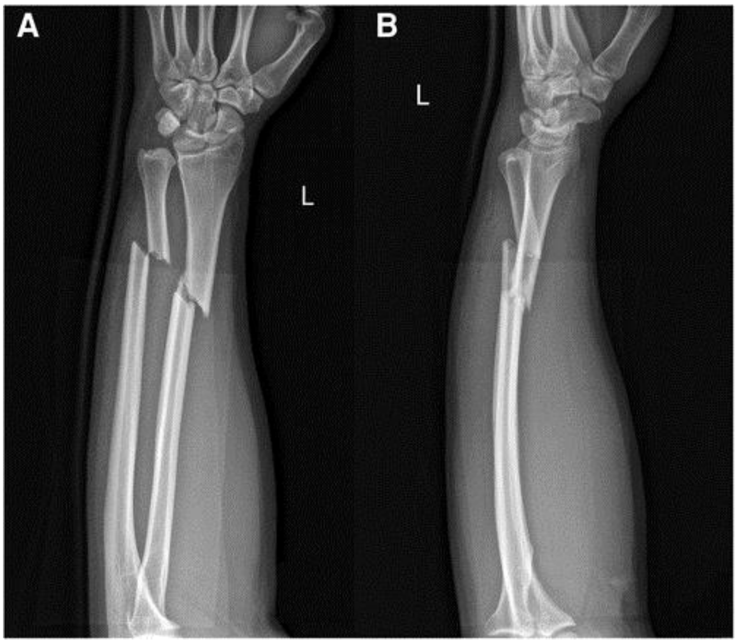


**Figure 1: Fracture of Radius and Ulna**

Both bone forearm fractures in adults are most commonly encountered fractures in day to day practice accounting for almost 31% of all upper limb fractures. [9] These can be regarded as articular fractures as when there is slight deviations in the spatial orientation of the radius and ulna will alters or decreases forearm's rotational amplitude and results in impairment of positioning and function of hand. [5] When both bones get fractured anatomical reduction and internal fixation are required to restore movement of elbow, forearm and wrist along with grip strength.[10] Closed reduction and cast immobilization of forearm fractures have yielded poor results as reported up to 92 % of cases owing to malunion, non union or synostosis. [11]

Locking compression plate (LCP) consists of self compression plate and screw system where the screws are locked in the plate. This locking minimizes the compressive forces exerted on the bone by the plate[12]. Locking Compression Plates (LCPs) have become a preferred method for internal fixation due to their biomechanical advantages, including enhanced stability, preservation of periosteal blood supply, and better resistance to torsional and bending forces[13]. The LCP system allows both compression and locking techniques, making it particularly beneficial for complex fractures, osteoporotic bones, and cases with poor bone quality. [14]

Locking compression plates offer several other advantages, including angular stability[15], reduced risk of implant failure [16], and the ability to maintain fracture reduction without excessive compression on the periosteum. [13]

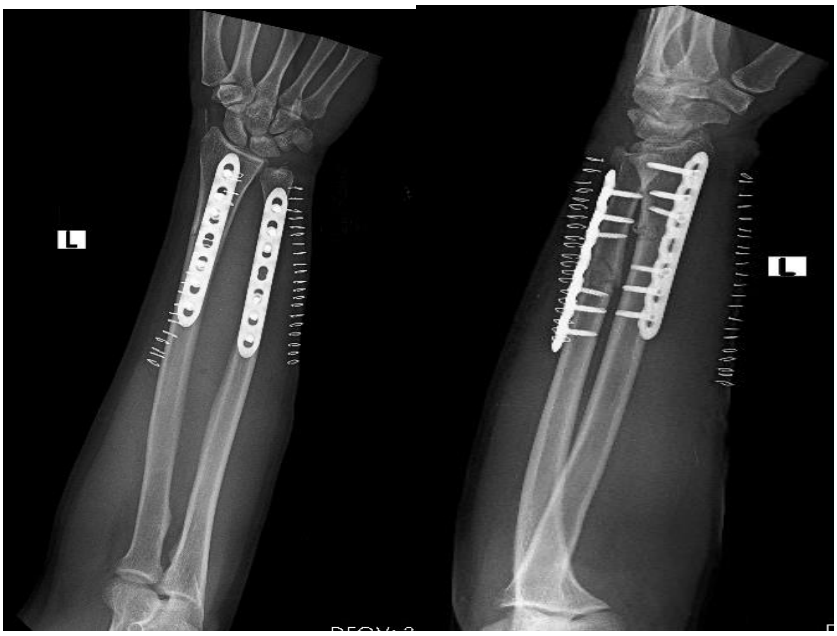


**Figure 2: Forearm fracture fixed using LCP**

Despite these benefits, the functional and radiological outcomes following LCP fixation can vary depending on factors such as fracture pattern, surgical technique, patient compliance, and postoperative rehabilitation.

This study aims to evaluate the functional and radiological outcomes of forearm fractures treated with LCP fixation.

Evaluating the functional outcomes involves assessing the patient's ability to regain full range of motion, grip strength, and overall upper limb functionality, while radiological outcomes focus on the accuracy of fracture reduction, union rates, and the presence of complications such as malunion, non-union, or hardware failure.

Understanding these outcomes is essential for optimizing surgical techniques, improving patient care, and guiding postoperative rehabilitation protocols.

By analysing these outcomes, this study seeks to determine the efficacy of LCP fixation in restoring forearm function and improving patient prognosis.

# OBJECTIVES

# OBJECTIVES OF THE STUDY

To evaluate the outcomes of both bone forearm fractures treated with open reduction and internal fixation with locking compression plate in terms of

1. Fracture union by radiological assessment

2. Range of motion on every follow up

3. Functional outcome using disabilities of the arm, shoulder and hand (DASH) scoring

# REVIEW OF LITERATURE

## REVIEW OF LITERATURE

Forearm fractures, involving the radius and ulna, have been a recognized medical condition for centuries.

Their treatment has evolved significantly from rudimentary splinting methods to highly sophisticated surgical fixation techniques.

The earliest evidence of fracture management dates back to Ancient Egypt and Greece, where physicians used simple splints made of wood, linen, or reeds to immobilize broken bones.[17] Hippocrates (460–370 BCE) and Galen (129–216 CE) provided some of the earliest descriptions of fracture treatment, advocating for manual reduction and external stabilization.[18,19] Archaeological findings of Egyptian mummies have shown signs of healed forearm fractures, suggesting that early immobilization techniques were somewhat effective.[20] However, without knowledge of infection control or surgical intervention, these treatments were limited to external splinting.

During the medieval and Renaissance periods (500–1700 CE), bone-setting practices continued to be passed down through generations, with little advancement beyond external immobilization.[21] Surgeons of the time, such as Ambroise Paré in the 16th century, introduced more refined splinting techniques and the use of plaster casts to improve fracture stability.[22] However, fracture management remained non-surgical due to the high risks of infection and limited understanding of bone healing.

It was not until the 19th century that major breakthroughs in fracture treatment occurred. The establishment of the first orthopaedic hospital by Jean-André Venel (1740–1791) provided a dedicated space for treating musculoskeletal injuries.[23] The development of antiseptic techniques by Joseph Lister in 1867 revolutionized surgery, significantly reducing the risk of infection and making open reduction and internal fixation (ORIF) a more viable option.[24] The Thomas splint, introduced in 1875, became a widely used method for stabilizing fractures, especially in trauma cases.[23]

The early 20th century marked a turning point in the treatment of forearm fractures with the advent of internal fixation methods.[25] External fixation, using pins and rods, was introduced for severe fractures, but the results were inconsistent due to the lack of precise surgical techniques. By the 1930s and 1940s, orthopaedic advancements led to the development of internal fixation devices.[26] The establishment of the AO Foundation (Arbeitsgemeinschaft für Osteosynthesefragen) in 1958 by Swiss surgeons Hans Willenegger and Maurice Müller played a crucial role in modern fracture fixation.[26] They emphasized the principles of rigid fixation and anatomical reduction using compression plates, which significantly improved healing outcomes. The introduction of dynamic compression plates (DCPs) in the 1950s to 1970s allowed for better mechanical stability and controlled bone healing.[12] Additionally, intramedullary (IM) nails began to be used selectively for certain forearm fractures, although plating remained the preferred method.

By the 1980s and 1990s, orthopaedic surgeons introduced more advanced fixation techniques, including locking plates that provided enhanced biomechanical stability, particularly for complex and osteoporotic fractures.[27]The use of titanium implants also became widespread due to their superior biocompatibility, reducing the risk of allergic reactions and implant-related complications.[28]

As the 21st century progressed, the focus shifted towards minimally invasive techniques to reduce soft tissue trauma and improve post-operative recovery.[29]Minimally invasive plating osteosynthesis (MIPO) became a preferred approach, as it preserved blood supply and accelerated healing.[29] Anatomically contoured locking plates, designed specifically for the radius and ulna, improved fixation in cases of comminuted or unstable fractures.[27]Emerging technologies such as 3D printing have enabled patient-specific implants, allowing for greater surgical precision and customization based on individual bone anatomy.[30] Furthermore, researchers are exploring biodegradable implants and bone graft substitutes that could eventually replace traditional metal fixation methods, reducing the need for implant removal surgeries.[31]

The management of forearm fractures has evolved from primitive splinting techniques to highly advanced internal fixation systems.[28] The introduction of antiseptic principles, dynamic compression plates, and minimally invasive surgical techniques have greatly improved patient outcomes.[32] With ongoing advancements in biomechanics, robotics, and regenerative medicine, the future of forearm fracture fixation is likely to incorporate personalized implants and biological solutions that enhance bone healing and functional recovery.[32]

In 1894 Albin Lambotte, a Belgian surgeon, introduced the term Osteosynthesis. He is widely recognized as the pioneer of modern internal and external fixation techniques. Lambotte developed an external fixator, along with various plates, screws, and surgical instruments, revolutionizing fracture treatment.[33]

In 1912, Beckman advocated for the use of plate fixation in diaphyseal fractures, emphasizing the need for rigid stabilization. A year later, in 1913, Nicholaysen introduced the concept of intramedullary nailing, a method further refined by Schöne, who applied the technique specifically to forearm fractures. Around the same time, Gilfillan devised metallic plates for the fixation of radius and ulna fractures.

A significant milestone in osteosynthesis was achieved by Robert Danis, a Belgian surgeon, who published two influential books in 1932 and 1949. These works detailed his groundbreaking observations on rigid fixation and its impact on fracture healing, laying the foundation for modern orthopaedic surgery.[34]

In 1945, Mervyn Evans introduced the tuberosity view to evaluate the rotational alignment in forearm fractures. By 1949, Danis became the first surgeon to document the use of interfragmentary compression, applying plates under tension along the bone's longitudinal axis to enhance fracture stability.[34]

A major leap occurred in 1958 when Maurice E. Müller, a Swiss surgeon, was inspired by Danis' research and established the AO group (Arbeitsgemeinschaft für Osteosynthesefragen), later known as the Association for the Study of Internal Fixation (ASIF). This group became instrumental in advancing osteosynthesis research, designing specialized instrumentation, and standardizing surgical techniques.[35]

In 1959, Sage introduced the medullary forearm nail system, conducting an extensive review of 555 fractures repaired with intramedullary devices in both the radius and ulna, demonstrating its effectiveness.[36] Around this period, the compression plate was increasingly used to treat forearm fractures, further improving healing outcomes.

The AO group continued its innovations, and in 1963, they developed the removable compression device, which ensured bone compression through plate-to-bone friction, significantly improving fixation stability.[12] The first documented attempts at biological plating were made by Biotzy and Weber in 1964, where they used plates to treat forearm fractures in adults, highlighting its advantages in achieving functional recovery while minimizing complications.[37]

In 1969, a large-scale study examined 1,903 radial shaft fractures and 666 ulnar shaft fractures, with narrow dynamic compression plates (DCPs) used in 97% of cases. The study reported a 3.2% non-union rate, while the majority of patients achieved good functional outcomes, leading to the recommendation of the 3.5mm DCP for forearm fracture fixation.[38]

By 1975, significant advancements in cast bracing were published, showing that joint immobilization was not necessary for excellent functional results. The same year, a study of 244 patients with 330 diaphyseal fractures of the radius and ulna, treated with ASIF compression plates, reported an overall union rate of 97.9% for the radius and 96.3% for the ulna. Surgeons emphasized the importance of minimizing periosteal stripping before plate application to preserve vascular supply and improve healing.[10]

A major breakthrough in 1979 was the development of dynamic compression plates (DCPs) by Perren, successfully implemented in clinical practice by Allgöwer et al. These plates featured spherical geometry, enabling self-compression while maintaining an adaptable screw-plate interface, allowing for greater flexibility in internal fixation techniques.[12]

Animal studies conducted in this era examined the effects of compression on bone healing, using measuring devices to track changes in fracture site stability over time. Researchers observed a gradual loss of compression as healing progressed, attributed to Haversian remodelling. The findings confirmed that compression and absolute rigidity of fracture ends promote optimal fracture healing.[39]

In 1980, a study on 64 patients with forearm fractures treated with AO compression plates investigated the benefits of early postoperative mobilization, demonstrating that rigid fixation allows for faster rehabilitation without compromising healing.[6]

By 1983, complications related to forearm fractures were systematically analysed in 87 cases of diaphyseal radius/ulna fractures.[40] The study found that major complications occurred in 28% of cases, with non-union reported in 93% of fractures fixed with only four screws. The authors concluded:

1. Four-screw fixation may be inadequate, and a minimum of five screws should be used for stable plate fixation.[40]

2. The ulna remains challenging for primary healing, likely due to increased torsional stresses during forearm pronation and supination.[40]

3. Synostosis (abnormal bone fusion) is more frequent in patients with head injuries, suggesting a link between heterotopic ossification and trauma-related neurovascular changes.[40]

The evolution of osteosynthesis has been driven by continuous research, technological advancements, and improved surgical techniques.

The introduction of plate fixation, intramedullary nailing, interfragmentary compression, and dynamic compression plating has significantly enhanced fracture management.

Modern principles emphasize minimally invasive techniques, early mobilization, and biological fixation to achieve better functional outcomes while reducing complications.[12]

In 1989, a retrospective study was conducted on 129 cases of diaphyseal fractures of the radius and ulna, in which the 3.5mm and 4.5mm AO Dynamic Compression Plate (DCP) was utilized for internal fixation.[6]

The study reported a high success rate, with 98% of fractures achieving union and 92% of patients experiencing excellent clinical outcomes.[6]

Researchers observed that immediate internal fixation played a significant role in minimizing complications. Based on their findings, they concluded that internal fixation using the 3.5mm AO DCP was highly effective in managing diaphyseal fractures of the radius and ulna, offering reliable fracture stabilization and promoting optimal healing.[6]

The following year, in 1990, further advancements in plating technology led to the development of the Limited Contact Dynamic Compression Plate (LC-DCP).[41]

This innovation was introduced to support the concept of biological internal fixation, which emphasizes the preservation of blood supply and bone viability.[41]

The LC-DCP was essentially an improved version of the standard DCP, featuring a symmetrical self-compressing plate hole design and eliminating the elongated distance between the innermost screw holes.[41]

These modifications enhanced the versatility of the LC-DCP, making it suitable for use in a wide range of fracture types. Additionally, grooves were incorporated on the undersurface of the plate to achieve three primary benefits. First, they improved blood circulation by reducing the contact area between the plate and the bone, thereby minimizing disruption to periosteal blood supply. Second, they allowed the formation of a small bone bridge beneath the plate, particularly in areas that are structurally weak due to stress concentration effects. Lastly, the distribution of holes in the LC-DCP was more uniform compared to conventional plates, contributing to better load distribution and stability.[41]

In 1991, further refinements were made to plate design, leading to the creation of the Dynamic Compression Unit (DCU), which served as the precursor to the LC-DCP.[41]

The DCU incorporated modifications to the plate holes, the lower surface of the plate, and the overall hole distribution pattern. These improvements aimed to enhance the biomechanical properties of the plate, ensuring more effective fracture stabilization while further supporting the principles of biological fixation.[41]

Studies have shown that LCPs act as internal fixators with a combination of compression and locking mechanisms, ensuring better anatomical alignment and early mobilization.[13,14]

Radiological assessment plays a crucial role in evaluating post-operative outcomes, with union rates, callus formation, and alignment being key indicators of success.[42]

Several studies have reported high union rates and minimal complications with LCP fixation in diaphyseal fractures of both the radius and ulna.[43] However, some researchers have noted complications such as non-union, implant failure, and soft tissue irritation, though these are less frequent compared to conventional plating systems.[15]

Functional outcomes, often measured using scoring systems like the Disabilities of the Arm, Shoulder, and Hand (DASH) score, indicate that early rehabilitation and rigid fixation contribute to better patient satisfaction and range of motion recovery.[15]

Several studies have evaluated the functional and radiological outcomes of both bone forearm fractures treated with Locking Compression Plates (LCP).

Fernandez et al. (2014, Brazil) – A long-term follow-up study analysing the outcomes of 85 patients treated with LCP fixation. The study found that 91% of patients maintained good functional outcomes even after five years. The authors highlighted the durability of LCP implants and their role in preventing malunion.[44]

Omar et al. (2015, Egypt) – A study evaluating 75 patients with diaphyseal forearm fractures treated with LCP. The results showed that 90% of patients regained near-full forearm function within six months. Radiological assessment confirmed satisfactory alignment, with only two cases of non-union requiring additional intervention.[45]

Smith et al. (2015, Australia) – A long-term follow-up study of 80 patients treated with LCP fixation. The findings showed that even after three years, 90% of patients maintained good to excellent functional outcomes. The study reported minimal complications, with only two cases of hardware loosening. The authors highlighted the durability and reliability of LCP in forearm fracture management.[46]

Goyal et al. (2016, India) – A prospective study evaluating 75 patients with both bone fractures of the forearm treated with LCP. The study found that 92% of patients achieved full forearm function within six months. Radiographic assessment confirmed proper fracture alignment in all cases, with no significant implant failures. The authors concluded that LCP provides superior fixation with excellent long-term outcomes.[47]

Patel et al. (2016, Canada) – A systematic review of 15 studies concluded that LCP fixation leads to better alignment, lower rates of non-union, and higher patient satisfaction compared to conventional plating. The average time to union across studies was 10–14 weeks, with most patients reporting excellent functional outcomes.[48]

Wilson et al. (2016, UK) – A comparative study of 100 patients treated with either LCP or conventional plating. The LCP group demonstrated superior outcomes, with a union rate of 96% compared to 88% in the conventional plating group. Patients treated with LCP had fewer implant-related complications and a faster return to daily activities.[49]

Kumar & Mehta (2017, UK) – This comparative study analysed 50 cases of forearm fractures managed with either LCP or DCP. The LCP group had a higher rate of union (95% vs. 88% in the DCP group) and better functional outcomes based on Mayo Elbow Performance Scores. However, the study noted that LCP is costlier and requires precise surgical expertise.[50]

Rodríguez et al. (2017, Mexico) – A clinical study on 70 patients with both bone fractures of the forearm treated with LCP. The average healing time was 13 weeks, with 92% of patients achieving full range of motion. Only four cases of delayed union were reported, but none required revision surgery. The study concluded that LCP offers a stable and reliable fixation method.[51]

In another comparative analysis, Gupta et al. (2017) investigated the outcomes of LCP versus intramedullary nailing in forearm fractures. Their findings suggested that while both methods achieved satisfactory bone healing, LCP provided better rotational stability and allowed for a quicker return to daily activities. However, they noted that LCP fixation required a longer operative time and a more extensive surgical approach compared to intramedullary nailing.[52]

Ali et al. (2017, Pakistan) – A study on 100 patients with diaphyseal forearm fractures treated with LCP. The results showed a high union rate of 95% within 16 weeks, with only five cases of hardware-related irritation. Functional assessment using the Mayo Elbow Performance Score indicated excellent results in 88% of patients. The study recommended LCP as a reliable fixation method, especially for young adults with high-demand activities.[53]

Similarly, a prospective study by Sharma et al. (2018) assessed 50 patients with diaphyseal fractures of the radius and ulna and reported a high union rate of over 95% within six months post-surgery. Radiological evaluation showed proper alignment and early callus formation, while functional assessment using the DASH (Disabilities of the Arm, Shoulder, and Hand) score indicated excellent outcomes in most patients. The study emphasized the importance of early rehabilitation to maximize functional recovery.[54]

Al-Taher et al. (2018, UAE) – In this study of 80 patients, the researchers compared LCP fixation with intramedullary nailing. The LCP group showed superior results in terms of rotational stability and early functional recovery, with 92% of patients achieving bone union within 14 weeks. The authors concluded that LCP is a more reliable option for complex diaphyseal fractures.[55]

Park et al. (2018, South Korea) – A clinical study of 95 cases comparing LCP with conventional plating systems. The results showed that LCP fixation led to better fracture union rates (96% vs. 89% in conventional plating) and fewer implant-related complications. The study concluded that LCP provides better biomechanical stability, particularly in osteoporotic bones.[56]

Ahmed et al. (2018, Saudi Arabia) – A study comparing LCP fixation to intramedullary nailing in 85 patients. The LCP group showed a higher success rate (95%) and fewer post-operative complications. The study found that LCP provided better rotational stability, leading to faster rehabilitation and improved functional scores.[57]

A systematic review by Patel and colleagues (2019) analysed multiple studies on LCP use in forearm fractures and concluded that LCP is an effective fixation method with a low risk of non-union and malunion. They found that complications such as infection, implant irritation, and delayed union were relatively rare, reinforcing LCP as a reliable option for both bone fractures of the forearm.[58]

Jones et al. (2019, USA) – This multicentre study evaluated 100 cases of both bone forearm fractures treated with LCP. The findings indicated a 94% success rate, with minimal implant failure. Patients demonstrated improved grip strength and wrist function, with only five cases of hardware irritation requiring removal. The study highlighted that proper surgical technique and post-operative care are critical for optimal outcomes.[59]

Martínez et al. (2019, Spain) – A retrospective analysis of 60 patients treated with LCP for both bone forearm fractures. The study reported an average bone healing time of 12 weeks, with 90% of patients regaining near-complete forearm rotation. Three patients had delayed union, but none required revision surgery. The study emphasized the advantage of LCP in achieving early functional recovery.[60]

Lee et al. (2019, South Korea) – A retrospective study of 90 patients evaluating the functional outcomes of LCP fixation. The study found that 94% of patients achieved complete fracture union within 12–14 weeks. Radiological analysis confirmed precise anatomical reduction, and functional recovery was excellent, with most patients regaining full wrist and elbow mobility.[61]

A study by Anderson et al. (2020) compared LCP fixation with traditional Dynamic Compression Plates (DCP) and found that LCP provided superior stability, reduced implant failure rates, and led to earlier functional recovery. Their study highlighted that patients treated with LCP demonstrated better range of motion and lower complication rates compared to those treated with DCP.[62]

Hassan et al. (2020, Egypt) – This study compared LCP fixation with intramedullary nailing in 85 patients. The LCP group had a higher success rate (94%) and significantly better rotational stability compared to the nailing group.[63] Radiological assessment showed proper alignment in 96% of LCP cases, while 10% of the nailing group had malalignment issues. The authors recommended LCP for complex fractures requiring precise anatomical reduction.

Kumar et al. (2020, India) – This study assessed 80 patients with both bone forearm fractures, comparing LCP with dynamic compression plates (DCP). The results showed that LCP had a significantly higher union rate (98% vs. 89% in the DCP group) and fewer hardware-related complications. Functional assessment using the Mayo Elbow Performance Score demonstrated superior recovery in LCP-treated patients.[64]

Chen et al. (2020, China) – A retrospective study involving 75 patients compared LCP with traditional plating methods. Radiographic analysis showed significantly faster bone healing in the LCP group (average union time of 12 weeks) compared to the conventional plating group (16 weeks). Functionally, 90% of patients in the LCP group regained near-full range of motion within six months. The authors recommended LCP as the preferred method due to its biomechanical advantages.[65]

Singh et al. (2021, India) – This prospective study assessed 60 patients with diaphyseal fractures of both the radius and ulna treated with LCP. The results showed a union rate of 96% within six months, with an average DASH score of 10, indicating excellent functional recovery. Complications were minimal, with only three cases of delayed union. The study concluded that LCP offers superior stability and promotes early rehabilitation.[66]

Rahman et al. (2021, Bangladesh) – A prospective study on 70 patients with both bone forearm fractures treated with LCP fixation. The results showed a union rate of 97% within 14 weeks, with excellent functional outcomes assessed using the DASH score. Only four patients reported mild wrist stiffness, which improved with physiotherapy. The study concluded that LCP provides stable fixation with minimal complications.[67]

Das et al. (2021, Nepal) – A prospective study on 65 patients treated with LCP fixation. The study reported a 96% union rate within 14 weeks and excellent functional outcomes based on the DASH score. Only three patients experienced minor complications, such as transient nerve irritation, which resolved without surgical intervention. The study concluded that LCP is highly effective in restoring forearm function.[68]

These studies consistently demonstrate the effectiveness of LCP fixation for both bone forearm fractures, emphasizing high union rates, excellent functional outcomes, and minimal complications. They also highlight the advantages of LCP in providing superior stability and allowing for early rehabilitation, ultimately leading to better patient satisfaction and long-term success.

LCP provides superior stability, particularly in cases of complex fractures. While DCP relies on compression alone, LCP allows for both compression and bridging fixation, reducing the risk of hardware loosening.

Nonetheless, cost considerations and the need for precise surgical technique remain challenges.

Overall, the literature supports the use of LCP as an effective and reliable method for fixing both bone forearm fractures, with promising functional and radiological outcomes.

Further studies focusing on long-term follow-ups and patient-reported outcomes can provide deeper insights into the advantages and potential drawbacks of this fixation method.

## ANATOMY

## ANATOMY OF FOREARM

The forearm is a fundamental component of the upper extremity, contributing significantly to its integrated function by providing both structural stability and mobility.[69]

It serves as a crucial link between the elbow and wrist, ensuring coordinated movement and force transmission.[70] Additionally, the forearm acts as the origin for numerous muscles that control the hand and fingers, playing a key role in fine motor skills, grip strength, and overall dexterity.[71]

One of its most essential functions is enabling forearm rotation through pronation and supination, allowing the hand to be positioned effectively in space for various tasks, from simple daily activities to complex manual operations.[72]

The forearm is composed of two parallel bones, the radius and ulna, which work together to provide both stability and mobility.[85] These bones are connected by the interosseous membrane, which plays a critical role in force distribution and maintaining structural integrity.[73]

The forearm is also home to several neurovascular structures, including the radial, median, and ulnar nerves, as well as major arteries such as the radial and ulnar arteries, all of which contribute to sensory and motor functions.[2]

Acute injuries to the forearm are often complex due to the involvement of multiple anatomical structures, including bones, muscles, tendons, ligaments, and neurovascular components.[74]

Fractures of the radius and ulna can be particularly challenging, as they may result in malalignment, rotational instability, or impaired function if not properly managed.[75] Soft tissue injuries, such as tendon lacerations or nerve damage, can further complicate recovery and necessitate precise surgical intervention.[76]

Given this complexity, a comprehensive understanding of forearm anatomy is essential for accurate diagnosis, effective reduction techniques, and optimal surgical management.

Treatment approaches must aim to restore anatomical alignment, preserve joint function, and maintain a full range of motion while minimizing long-term complications such as stiffness, weakness, or impaired rotational movement.

Due to the forearm's critical role in upper limb function, rehabilitation following injury is equally important. Early mobilization, guided physical therapy, and appropriate surgical techniques can help ensure a successful recovery, allowing patients to regain strength, coordination, and functional independence.[77]

**EMBRYOLOGY**

The development of the forearm is a complex process that involves the coordinated growth of bones, muscles, nerves, and vasculature. It begins in the 4th week of embryogenesis and continues postnatally with skeletal ossification. The forearm forms from the upper limb bud, which arises from the somatic layer of the lateral plate mesoderm and paraxial mesoderm-derived somites.

1. Limb Bud Formation (Week 4-5)[78–80]

- The forearm develops from the upper limb bud, which appears around week 4 of gestation.

- The limb bud arises from the somatic layer of the lateral plate mesoderm (forms bones, blood vessels, and connective tissues) and paraxial mesoderm (somites) (forms muscles).
- The limb is patterned along three axes:
  - Proximodistal (shoulder to hand) – controlled by Apical Ectodermal Ridge (AER) and Fibroblast Growth Factors (FGFs).
  - Anteroposterior (thumb to little finger) – controlled by Zone of Polarizing Activity (ZPA) and Sonic Hedgehog (SHH).
  - Dorsoventral (back of hand to palm) – regulated by Wnt7a.

2. Development of Bones (Endochondral Ossification)[78,81,82]

- The humerus, radius, and ulna develop from mesenchymal condensations in the limb bud.
- Around week 6, mesenchymal cells differentiate into chondrocytes, forming a cartilaginous model.
- Ossification begins in the diaphysis (shaft) around week 7-8, while secondary ossification centers in the epiphyses (ends) develop after birth.
- The radius and ulna differentiate from a common condensation before separating.

3. Development of Muscles[81,83,84]

- Forearm muscles arise from paraxial mesoderm (somites), specifically from somitic myotomes of C5-T1.
- These mesodermal cells migrate into the limb bud and differentiate into two muscle masses:
  - Dorsal mass → Forms extensor and supinator muscles.

- Ventral mass → Forms flexor and pronator muscles.

4. Development of Nerves[81,85]

- The brachial plexus (C5-T1) provides motor and sensory innervation to the forearm.
- The major nerves arise from neural crest cells and migrate along the developing limb:
  - Radial nerve → Supplies extensor muscles.
  - Median nerve → Supplies most of the flexors.
  - Ulnar nerve → Supplies some flexors (e.g., flexor carpi ulnaris).

5. Development of Blood Supply[85,86]

- The primary axial artery (from the subclavian artery) initially supplies the upper limb.
- It later forms the brachial artery, which gives rise to the radial and ulnar arteries in the forearm."

**OSTEOLOGY OF THE FOREARM**

**Radius:**

The radius is one of the two bones of the forearm, positioned on the lateral (thumb) side and playing a crucial role in forearm movement and wrist articulation. It consists of three main parts: the proximal end, the shaft, and the distal end. The proximal end features the head of the radius, which is disc-shaped and articulates with the capitulum of the humerus and the radial notch of the ulna, allowing rotational movement. "Below the head is the neck of the radius, which transitions into the radial tuberosity, a bony prominence that serves as the attachment site for the biceps brachii tendon.[83,87]

The shaft of the radius is slightly curved and has three distinct surfaces: anterior, posterior, and lateral, which provide attachment points for various muscles. Along the medial edge of the shaft lies the interosseous border, where the interosseous membrane connects the radius to the ulna, contributing to forearm stability and force transmission.[69,83]

At the distal end, the radius broadens and features several important structures. The styloid process of the radius, located on the lateral side, serves as a crucial attachment site for wrist ligaments. Medially, the ulnar notch accommodates the head of the ulna, forming the distal radioulnar joint, which allows rotational movements of the forearm. On the posterior aspect, the dorsal tubercle (Lister's tubercle) acts as a pulley for the extensor pollicis longus tendon. The distal radius also has an articular surface that articulates with the scaphoid and lunate bones, forming part of the radiocarpal (wrist) joint.[70,81,83]

Functionally, the radius is essential for forearm pronation and supination, enabling rotational movements as it pivots around the ulna. It also plays a key role in load transmission from the hand to the elbow and provides structural support for wrist movements. Clinically, the radius is a common site for fractures, particularly at the distal end (e.g., Colles' fracture), often occurring due to falls on an outstretched hand. Understanding its anatomy is vital for diagnosing and treating forearm and wrist injuries effectively.[1,88,89]

**Ulna:**

The ulna is a long bone located on the medial side of the forearm, running parallel to the radius. It plays a crucial role in forming the elbow joint and contributing to the movement of the forearm and wrist. The proximal end of the ulna features several important structures, including the olecranon process, which forms the tip of the elbow and serves as an attachment site for the triceps brachii muscle. Below the olecranon is the trochlear notch, a deep concavity that articulates with the trochlea of the humerus, allowing flexion and extension at the elbow. The coronoid process, another bony projection, fits into the coronoid fossa of the humerus during flexion, providing stability to the joint. On the lateral side, the radial notch articulates with the head of the radius, forming the proximal radioulnar joint, which enables supination and pronation of the forearm.[87,90,91]

The shaft of the ulna is triangular in cross-section and consists of three borders—anterior, posterior, and interosseous—and three surfaces—anterior, posterior, and medial. The anterior border provides attachment for the flexor digitorum profundus, while the posterior border is prominent and serves as a site for the extensor carpi ulnaris. The interosseous border is sharp and serves as the attachment for the interosseous membrane, which connects the ulna and radius, aiding in forearm stability. The surfaces of the shaft also provide attachment for various flexor, extensor, and pronator muscles.[69,70,90,92]

At the distal end, the ulna narrows and ends in a small, rounded head, which articulates with the ulnar notch of the radius at the distal radioulnar joint. This articulation allows for rotational movements of the forearm. A small bony projection called the styloid process extends from the medial side of the distal ulna and serves as an attachment for the ulnar collateral ligament, which stabilizes the wrist. Unlike the radius, the ulna does not directly articulate with the carpal bones; instead, the triangular fibrocartilage complex (TFCC) helps transmit forces to the ulna from the wrist.[69,75,90]

Functionally, the ulna is a critical component of the elbow joint (humeroulnar joint), where the trochlear notch of the ulna articulates with the trochlea of the humerus, allowing hinge-like movements.

It also participates in the proximal and distal radioulnar joints, which facilitate forearm rotation. Several muscles attach to the ulna, including the triceps brachii at the olecranon process, flexor and extensor muscles along the shaft, and pronator and supinator muscles that help rotate the forearm.[69,87,90,92]

Clinically, the ulna is prone to fractures, particularly in Monteggia fractures, where a fracture of the proximal ulna is accompanied by a dislocation of the radial head. Other conditions affecting the ulna include osteoarthritis of the elbow or radioulnar joints and ulna variance, where discrepancies in ulna length can contribute to wrist pain and dysfunction.[88,89,93]

**Radio-Ulnar Articulations:**

The radius and ulna are joined at the superior and inferior radio-ulnar joints, with additional support from the interosseous membrane. These structures collectively allow movement of the forearm, particularly pronation and supination.

**a) Superior Radio-Ulnar Joint**[69,87,90]

This is a pivot-type synovial joint where the annular ligament plays a key role in stabilizing the head of the radius. The annular ligament is attached to the anterior and posterior margins of the radial notch of the ulna, encircling the head of the radius without direct attachment to it. It blends superiorly with the joint capsule at the lower margin of the cylindrical articular surface.

**Movement at Superior Radio-Ulnar Joint:** Pronation and supination of the forearm.

**b) Inferior Radio-Ulnar Joint**[69,87,90]

This joint is supported by a triangular fibrocartilage disc, which attaches at its base to the ulnar notch of the radius and at its apex to a fossa at the base of the ulnar styloid.

- **Movement:** Pronation and supination of the forearm.

**c) Interosseous Membrane**[69,90,92]

The interosseous membrane connects the interosseous borders of the radius and ulna. Its fibers run obliquely downward from the radius to the ulna, playing a role in transmitting forces from the wrist to the elbow—specifically from the lower end of the radius to the upper end of the ulna and ultimately to the humerus. Additionally, it serves as an attachment site for several forearm muscles.

The membrane remains relaxed in full pronation and supination but becomes taut when the hand is in a neutral position between these two movements.

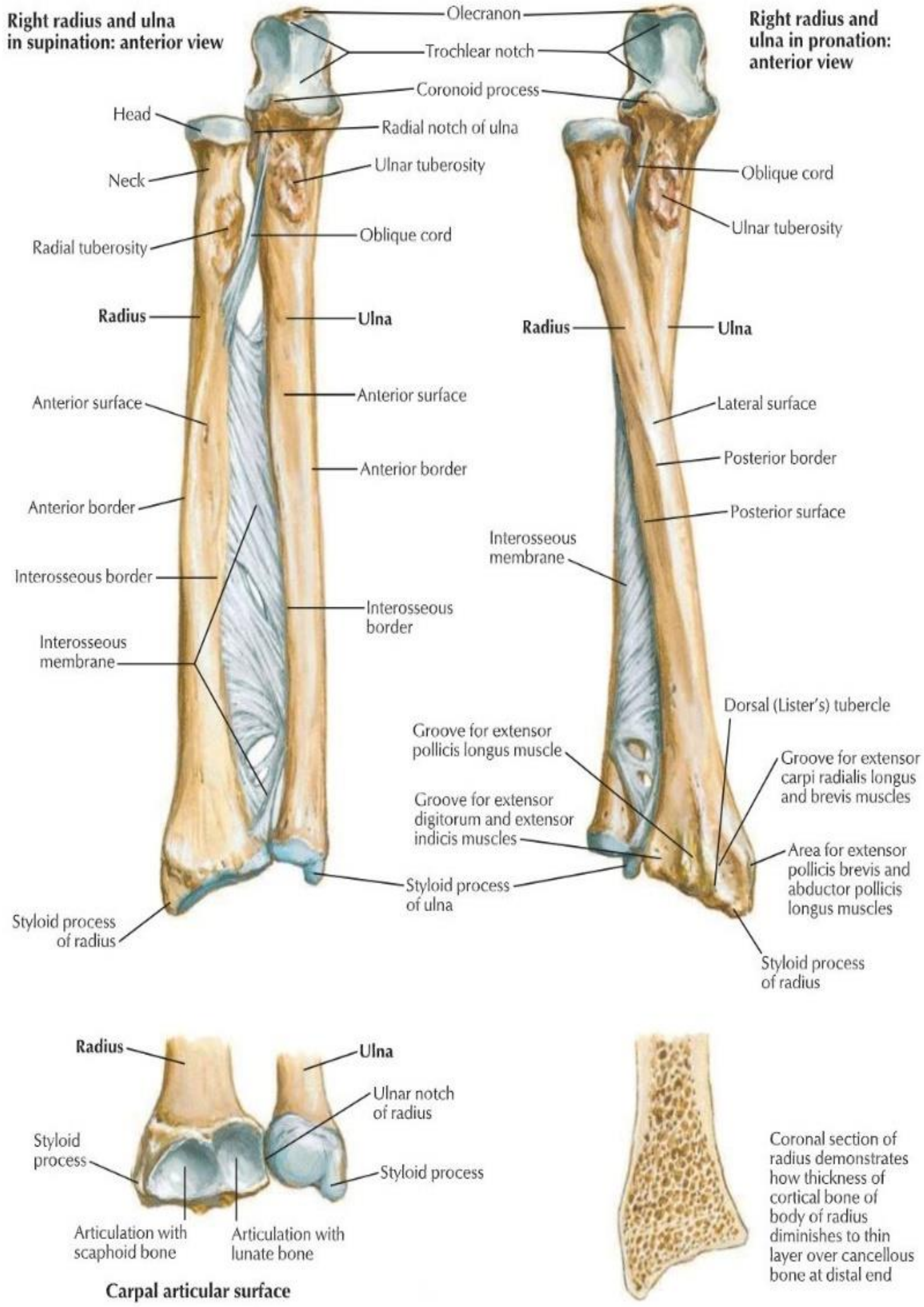


**Figure 3: Osteology of Forearm**[71]

**Table 1: ARTERIES OF FOREARM**[69,87,90]

| Artery | Origin | Course |
|---|---|---|
| Radial | Smaller terminal division of brachial artery in cubital fossa | Runs inferolaterally under cover of brachioradialis and distally lateral to flexor carpi radialis tendon; winds around lateral aspect of radius and crosses floor of anatomical snuff box to pierce fascia; ends by forming deep palmar arch with deep branch of ulnar Artery |
| Ulnar | Larger terminal branch of brachial artery in cubital fossa | Passes infero medially and then directly, deep to pronator teres, palmaris longus, and flexor digitorum superficialis to reach medial side of forearm, passes superficial to flexor retinaculum at wrist and gives a deep palmar branch to deep arch and continues as superficial palmar arch. |
| Radial recurrent | Lateral side of radial, just distal to its Origin | Ascends on supinator and then passes between brachioradialis and brachialis. |
| Anterior and posterior ulnar recurrent | Ulnar, just distal to elbow joint | Anterior ulnar recurrent artery passes superiorly and posteriorly, ulnar collateral artery passes posteriorly to anastomoses with ulnar collateral and interosseous recurrent arteries. |
| Common interosseous | Ulnar, just distal to bifurcation of brachial artery | After a short course, terminates by dividing into anterior and posterior interosseous arteries. |
| Anterior and posterior interosseous | Common interosseous artery | Pass to anterior and posterior sides of interosseous membrane |

**NERVES OF THE FLEXOR COMPARTMENT**[69,87,90]

- Lateral Cutaneous Nerve of the Forearm
  - Continuation of the musculocutaneous nerve.
  - Pierces the deep fascia above the elbow, lateral to the biceps tendon.
  - Supplies the anterolateral surface of the forearm.
- Medial Cutaneous Nerve of the Forearm
  - Innervates the front and back of the medial forearm.
- Superficial Terminal Branch of the Radial Nerve
  - Arises in the cubital fossa and runs along the supinator, pronator teres tendon, and flexor digitorum superficialis.
  - Travels under the brachioradialis in the lateral forearm.
  - In the middle third of the forearm, it lies beside and lateral to the radial artery.
  - Leaves the flexor compartment by passing deep to the brachioradialis tendon and divides into two or three branches.
- Median Nerve
  - Leaves the cubital fossa between the two heads of pronator teres.
  - Passes deep to the fibrous arch of the flexor digitorum superficialis.
  - Just above the wrist, it becomes superficial between the tendons of flexor carpi radialis and flexor digitorum superficialis, lying behind the palmaris longus tendon.

- Motor Supply:
  - Pronator teres, flexor carpi radialis, palmaris longus, and the lateral half of flexor digitorum superficialis.
- Joints Supplied:
  - Elbow and proximal radioulnar joints.
- Anterior Interosseous Branch:
  - Runs alongside the anterior interosseous artery.
  - Supplies flexor digitorum profundus (lateral half), flexor pollicis longus, pronator quadratus, and joints of the inferior radioulnar, wrist, and carpal regions.

- Ulnar Nerve
  - Enters the forearm between the two heads of flexor carpi ulnaris.
  - Travels under the flattened aponeurosis of flexor carpi ulnaris, with the ulnar artery on its radial side.
  - Motor Supply: Flexor carpi ulnaris and the medial half of flexor digitorum profundus.

**NERVE OF THE EXTENSOR COMPARTMENT**[69,87,90]

- Posterior Interosseous Nerve
  - Passes into the extensor compartment through the supinator muscle.
  - Travels downward over the abductor pollicis longus origin.

- Reaches the interosseous membrane and extends toward the wrist joint, ending in a small nodule that gives off branches supplying the wrist.
- Motor Supply:
  - Muscles from the common extensor origin.
  - Deep muscles of the extensor compartment.

**Table 2: Muscles of anterior compartment of forearm**[69,87,90]

**Superficial Compartment**

| Name of Muscle | Origin | Insertion | Nerve Supply | Nerve Root | Action |
|---|---|---|---|---|---|
| Pronator teres<br>a) Humeral head<br>b) Ulnar head | Medial epicondyle of humerus.<br>Medial border of coronoid process of ulna. | Lateral aspect of shaft of radius | Median nerve | C6, C7 | Pronation and flexion of forearm |
| Flexor carpi radialis | Medial epicondyle of humerus. | Base of second and third metacarpal bones | Median nerve | C6, C7 | Flexes and abducts hand at wrist joint. |
| Palmaris longus | Medial epicondyle of humerus | Flexor retinaculam and palmar aponeuosis | Median nerve | C7, C8 | Flexes hand |

| | | | | | |
|---|---|---|---|---|---|
| Flexor carpi Ulnaris<br>a) Humeral head.<br>b) Ulnar head | Medial epicondyle of humerus. Medial aspect of olecranon process and posterior border of ulna. | Pisiform bone, hook of the hammate, Base of fifth metacarpal bone | Ulnar nerve | C8, T1 | Flexes and abducts hand at wrist joint. |
| Flexor digitorium superficials Humeroulnar head. Radial head | Medial epicondyle of humerus Medial border of coronoid process of ulna. Oblique line on anterior surface of shaft of radius. | Bases of Middle phalanx of medial four fingers | Median nerve | C7, C8, T1 | Flexes middle phalanx of fingers and assists in flexing proximal phalanx and hand. |

**Deep Compartment**[69,87,90]

| Name of Muscle | Origin | Insertion | Nerve Supply | Nerve Root | Action |
|---|---|---|---|---|---|
| Flexor-Digitorium profundus | Anteromedial surface of shaft of ulna. | Bases of distal phalanx of medial four fingers | Ulnar (medial half) and median (lateral half) nerves | C8, T1 | Flexes middle phalanx of fingers and assists in flexing proximal phalanx and hand. |
| Pronator quadratus | Anterior surface of shaft of ulna. | Anterior surface of shaft of radius. | Anterior interosseous branch of median nerve | C8, T1 | Pronates forearm |
| Flexor pollicis longus | Anterior surface of shaft of radius. | Base of distal phalanx of thumb | Anterior interosseous branch of median nerve | C8, T1 | Flexes distal phalanx of thumb. |

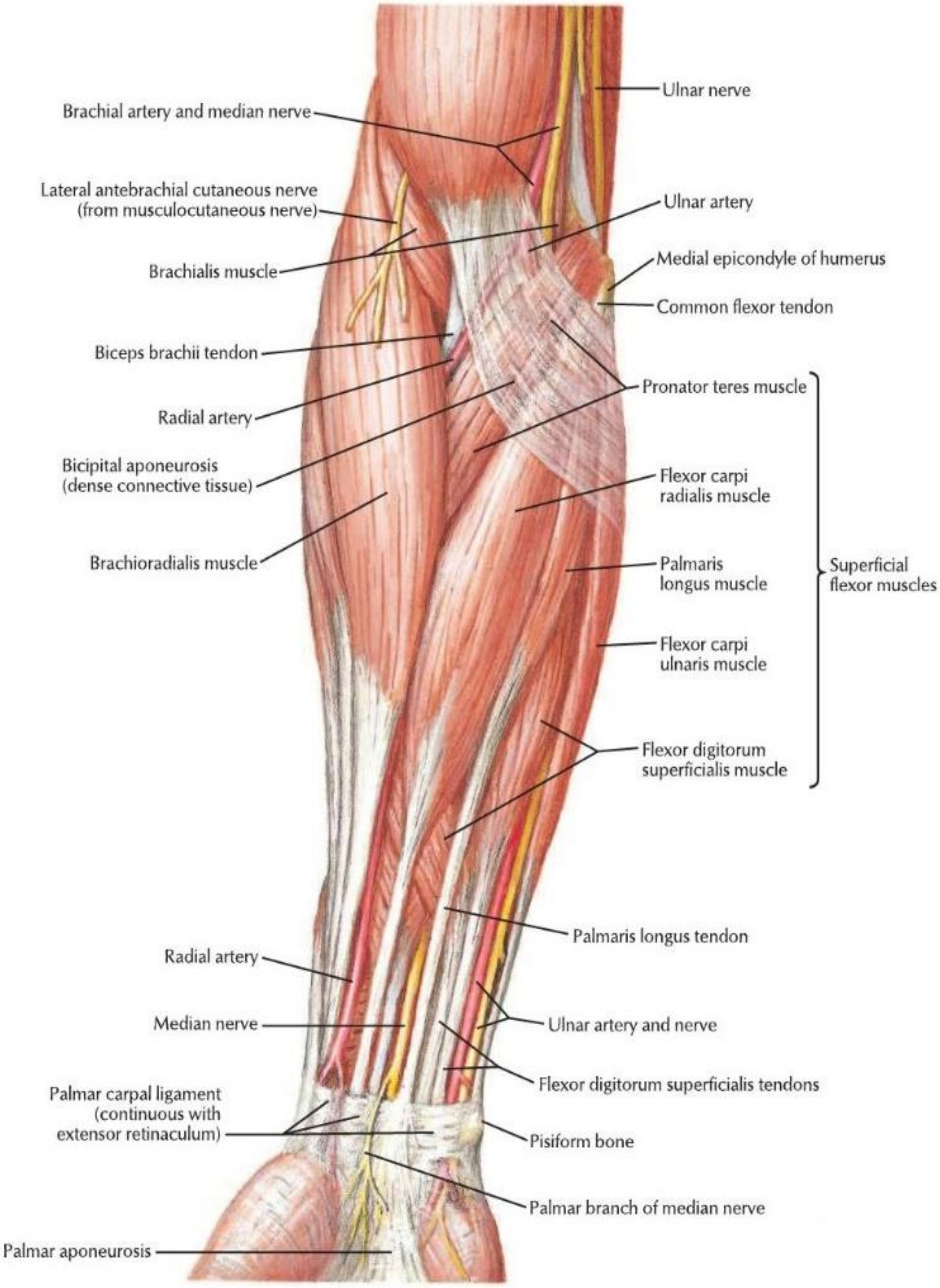


**Figure 4: Superficial Muscles of Forearm**[71]

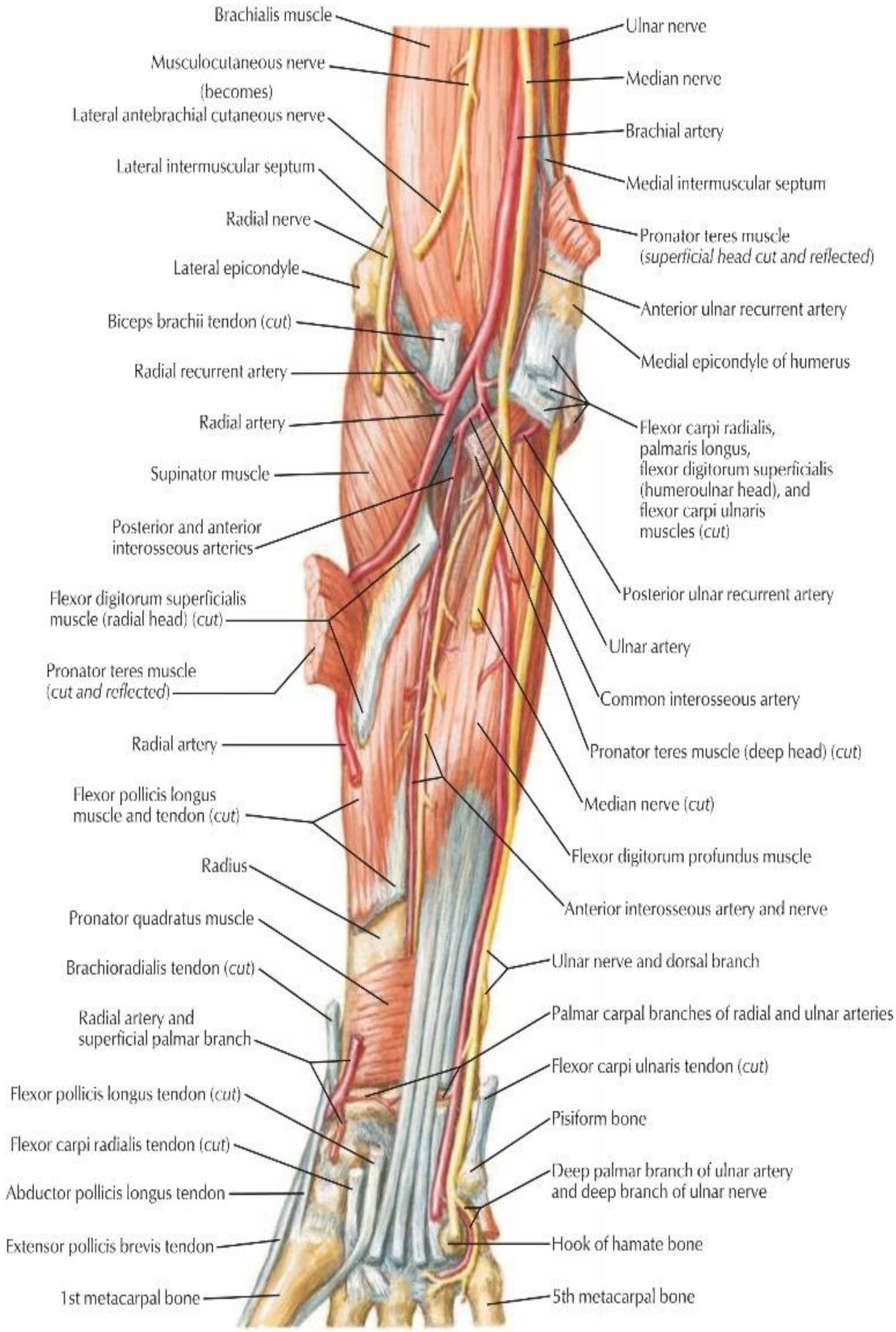


**Figure 5: Deep Muscles of Forearm**[71]

**Table 3: Muscles of posterior compartment of Forearm**[69,87,90]

| Name of Muscle | Origin | Insertion | Nerve Supply | Nerve Root | Action |
|---|---|---|---|---|---|
| Brachioradialis | Lateral supracondylar ridge of humerus. | Base of styloid process of radius. | Radial nerve | C5, C6, C7 | Flexes the forearm at the elbow joint; rotates forearm to the midprone Position |
| Extensor carpi radialis longus | Lateral supracondylar ridge of humerus. | Posterior surface of base of second metacarpal bone. | Radial nerve | C6, C7 | |
| Extensor carpi radialis brevis | Lateral epicondyle of humerus. | Posterior surface of base of third metacarpal Bone | Deep branch of radial nerve | C7, C8 | Extends and abducts hand at wrist joint |
| Extensor Digitorium superficialis | Lateral epicondyle of humerus. | Extensor expansion of middle and distal phalanges of medial four Fingers | Deep branch of radial nerve | C7, C8 | Extend fingers and hands |
| Extensor digiti minimi | Lateral epicondyle of humerus. | Extensor expansion little finger | Deep branch of radial nerve | C7, C8 | Extends meta carpo phalangeal joint of little finger |
| Extensor carpi ulnaris | Lateral epicondyle of humerus | Base of fifth metacarpal bone | Deep branch of radial nerve | C7, C8 | Extends and abducts hand at wrist joint |
| Anconeus | Lateral epicondyle | Lateral surface | Radial nerve | C7, C8, | Extends elbow joint |

| | | | | | |
|---|---|---|---|---|---|
| | of humerus. | of Olecranon | | T1 | |
| Supinator | Lateral epicondyle of humerus, annular ligament of proximal radioulnar joint, and ulna | Neck and shaft of radius | Deep branch of radial nerve | C5, C6 | Supination of forearm |
| Abductor pollicis longus | Posterior surface of shafts of radius and ulna. | Base of 1st metacarpal Bone | Deep branch of radial Nerve | C7, C8, | Abducts and extends thumb |
| Extensor pollicis brevis | Posterior surface of shafts of radius. | Base of proximal phalanx of Thumb | Deep branch of radial nerve | C7, C8 | Extend meta carpo phalangeal joints of thumb. |
| Extensor pollicis longus | Posterior surface of shafts of ulna. | Base of distal phalanx of Thumb | Deep branch of radial Nerve | C7, C8 | Extends distal phalanx of thumb |
| Extensor indicis | Posterior surface of shafts of ulna. | Extensor expansion of index finger. | Deep branch of radial nerve | C7, C8 | Extends meta carpo phalangeal joint index finger. |

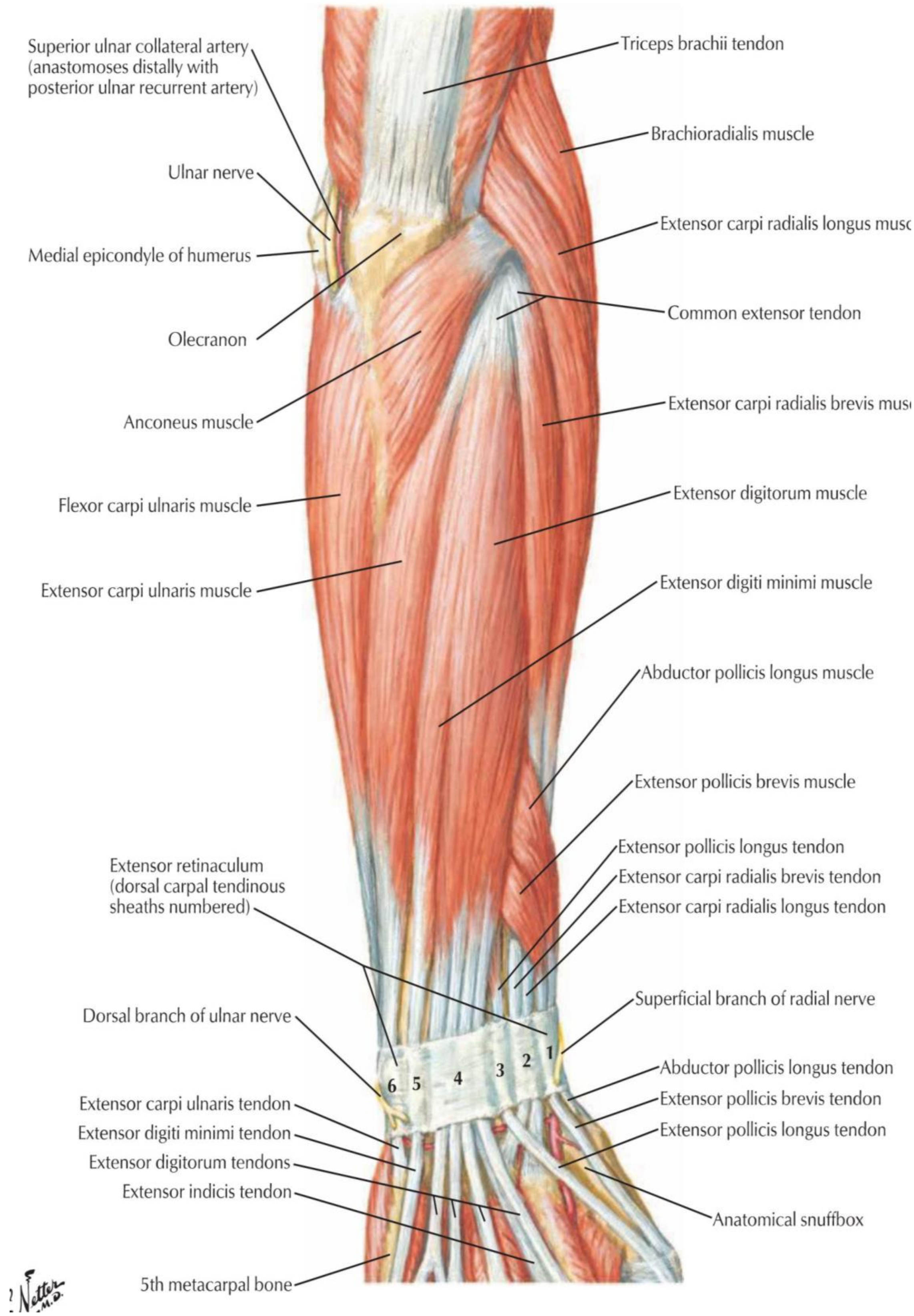


**Figure 6: Muscles Of Forearm Superficial Layer (Posterior)**[71]

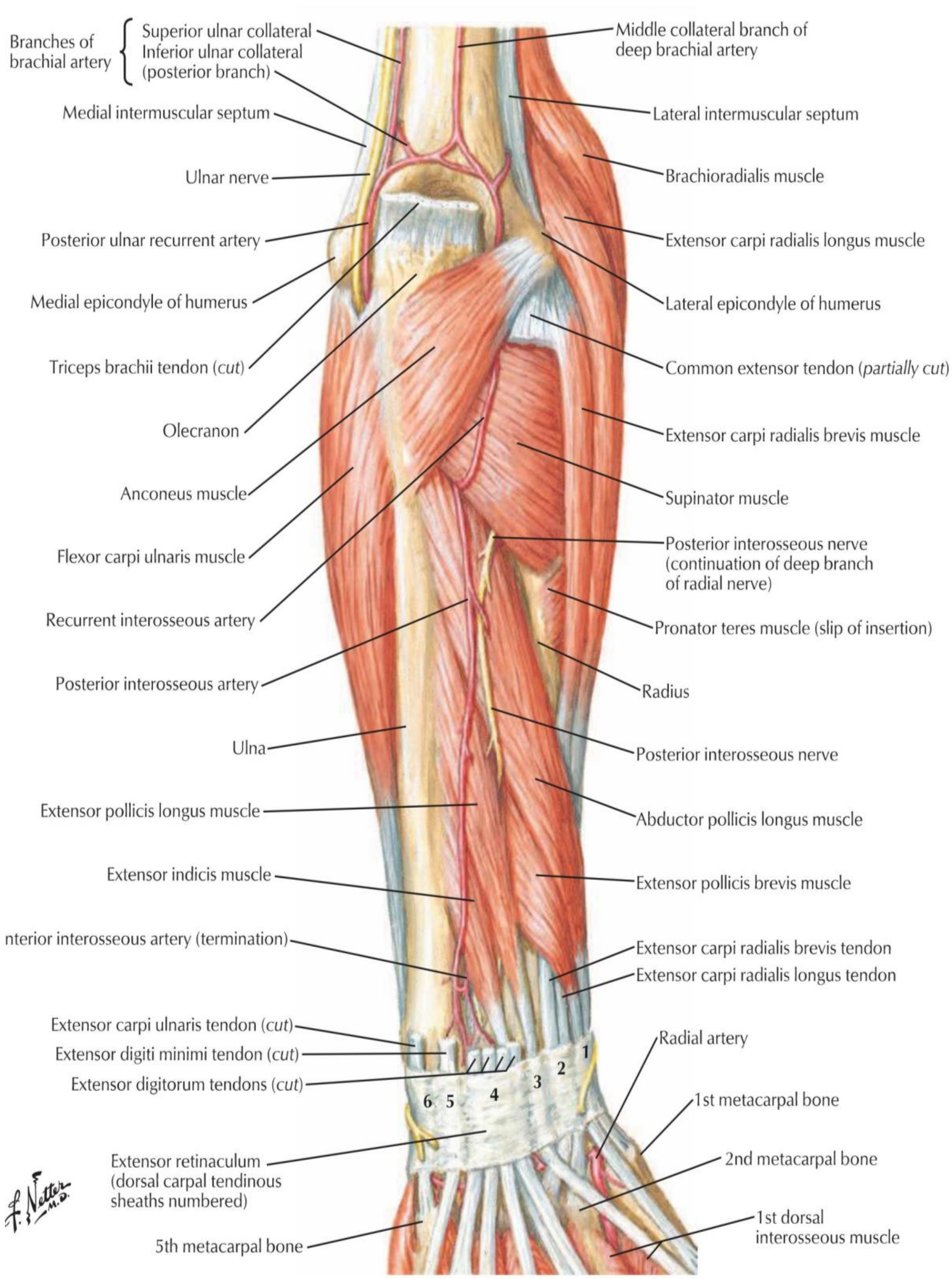


**Figure 7: Muscles Of Forearm Deep Layer (Posterior)**[71]

**FOREARM INJURIES**

Forearm injuries can range from mild to severe and typically involve the bones (radius and ulna), muscles, tendons, nerves, and blood vessels.

Common forearm injuries are:[1,89]

**1. Bone Injuries (Fractures)**

- **Radius or Ulna Fracture** – A break in one or both forearm bones.
- **Colles' Fracture** – A break in the distal radius, common in falls.
- **Monteggia Fracture** – A fracture of the ulna with dislocation of the radial head.
- **Galeazzi Fracture** – A fracture of the radius with dislocation of the distal radioulnar joint.
- **Greenstick Fracture** – A partial fracture common in children.

**2. Muscle and Soft Tissue Injuries**

- **Strains (Pulled Muscles)** – Overstretching or tearing of muscles.
- **Tendon Injuries (Tendinitis/Tendinosis)** – Overuse or inflammation of tendons.
- **Compartment Syndrome** – Increased pressure in the muscle compartments leading to pain and potential nerve/muscle damage.

**3. Nerve Injuries**

- **Radial Nerve Injury** – Can cause wrist drop and weakness.
- **Median Nerve Injury** – May lead to difficulty gripping and loss of sensation in the thumb, index, and middle fingers.

- **Ulnar Nerve Injury** – Can cause weakness and numbness in the ring and little fingers.

**4. Ligament and Joint Injuries**

- **Sprains** – Overstretching or tearing of ligaments around the wrist or elbow.
- **Elbow Dislocation** – Often caused by falls, leading to severe pain and deformity.
- **Wrist Dislocation** – Can occur with high-impact trauma.

**5. Overuse Injuries**

- **Tennis Elbow (Lateral Epicondylitis)** – Inflammation of tendons on the outside of the elbow.
- **Golfer's Elbow (Medial Epicondylitis)** – Inflammation of tendons on the inside of the elbow.
- **Repetitive Stress Injuries (RSI)** – Caused by prolonged, repetitive motion leading to pain and weakness.

**6. Vascular Injuries**

- **Brachial Artery or Radial/Ulnar Artery Injury** – Can lead to poor circulation and severe complications.
- **Volkmann's Ischemic Contracture** – A severe complication of untreated compartment syndrome causing permanent muscle damage.

**Causes of Forearm injuries**:[1,89]

Forearm injuries can be caused by various factors, including trauma, overuse, and medical conditions.

Common causes are:

**1. Traumatic Causes**

- **Falls** – Landing on an outstretched hand (FOOSH injury) can cause fractures or sprains.
- **Direct Impact or Blows** – Car accidents, sports injuries, or physical altercations can lead to fractures, bruises, or muscle damage.
- **Twisting Injuries** – Sudden twisting of the forearm can cause ligament tears or joint dislocations.
- **Crush Injuries** – Heavy objects falling on the forearm may lead to fractures, compartment syndrome, or nerve damage.

**2. Overuse and Repetitive Strain**

- **Repetitive Motions** – Activities like typing, playing sports (tennis, golf), or manual labour can cause tendinitis, stress fractures, or nerve compression.
- **Improper Ergonomics** – Poor posture or incorrect lifting techniques can contribute to muscle and tendon injuries.
- **Prolonged Vibrations** – Using power tools for long durations can lead to nerve damage (e.g., vibration-induced neuropathy).

**3. Sports-Related Injuries**

- **Contact Sports** – Football, basketball, and wrestling can lead to falls, fractures, or sprains.
- **Racket or Throwing Sports** – Tennis, baseball, and golf can cause repetitive strain injuries like tennis elbow or golfer's elbow.

- **Weightlifting** – Excessive strain on the forearm muscles can cause tendon or muscle tears.

**4. Occupational and Daily Activities**

- **Manual Labor** – Jobs involving heavy lifting, construction, or repetitive wrist movements increase the risk of injury.
- **Typing and Computer Work** – Long hours at a desk can cause carpal tunnel syndrome or tendonitis.
- **Driving for Long Periods** – Constant gripping of the steering wheel may lead to forearm muscle strain.

**5. Medical and Health-Related Causes**

- **Osteoporosis** – Weak bones increase the risk of fractures from minor trauma.
- **Arthritis** – Can lead to joint pain, stiffness, and inflammation, increasing injury risk.
- **Nerve Compression Syndromes** – Conditions like carpal tunnel syndrome or cubital tunnel syndrome can cause pain and weakness in the forearm.
- **Diabetes** – Can increase the risk of nerve damage (neuropathy), leading to weakness and injuries.

## FRACTURES OF FOREARM BONES[1,89]

Fractures of the forearm bones—radius and ulna—are common injuries that can occur due to falls, direct trauma, or sports injuries. These fractures can be classified based on their location, pattern, and severity.

**Types of Forearm Fractures**

1. **Isolated Radius or Ulna Fracture** – When only one bone is broken, often due to direct impact.

2. **Both-Bone Forearm Fracture** – When both the radius and ulna are broken, usually from high-impact trauma.

3. **Monteggia Fracture** – A fracture of the ulna with dislocation of the radial head.

4. **Galeazzi Fracture** – A fracture of the radius with dislocation of the distal radioulnar joint (DRUJ).

5. **Greenstick Fracture** – An incomplete fracture seen in children, where one side of the bone bends while the other breaks.

6. **Nightstick Fracture** – An isolated ulna fracture, usually from a direct blow (such as raising the arm to defend against an object).

7. **Colles' Fracture** – A distal radius fracture with dorsal displacement, commonly caused by a fall on an outstretched hand (FOOSH).

8. **Smith's Fracture** – A distal radius fracture with volar displacement, often due to a fall on a flexed wrist.

**Both bone fractures of forearm**

Both-bone forearm fractures (involving both the radius and ulna) can be classified based on their location, pattern, and mechanism of injury.

**1. Location-Based Classification**

- **Proximal third fractures** – Near the elbow joint.
- **Middle third fractures** – Most common site.
- **Distal third fractures** – Near the wrist joint.

**2. Fracture Pattern Classification**

- **Transverse Fracture** – A straight break across both bones.
- **Oblique Fracture** – A diagonal break across the bones.
- **Spiral Fracture** – A twisting break, often due to rotational forces.
- **Comminuted Fracture** – Multiple fragments in both bones.
- **Segmental Fracture** – Two distinct fracture lines in each bone.
- **Greenstick Fracture** – Incomplete fractures seen in children.

**3. Mechanism-Based Classification**

- **Direct Trauma** (e.g., high-impact injury, falls, vehicle accidents)
- **Indirect Trauma** (e.g., twisting injuries, sports-related forces)
- **Pathological Fracture** (due to underlying bone disease like osteoporosis)

**4. Pediatric-Specific Classification**

- **Greenstick Fracture** (Incomplete break)
- **Torus (Buckle) Fracture** (Compression injury, common in children)

- **Plastic Deformation** (Bow-shaped bone without a fracture line)

**5. AO/OTA Classification**

The AO/OTA (Association for the Study of Internal Fixation / Orthopaedic Trauma Association) classification categorizes forearm fractures as:

- Type A- Simple fractures.
- Type B- Wedge fractures
- Type C- Complex fractures

**Table 4: AO/OTA Classification of fracture of forearm bones**[94]

| Group | Type | Description |
|---|---|---|
| Group A1: Simple fracture of the ulna, radius intact | A1.1 | Oblique |
| | A1.2 | Transverse |
| | A1.3 | With dislocation of the radial head (Monteggia) |
| Group A2: Simple fracture of the radius, ulna intact | A2.1 | Oblique |
| | A2.2 | Transverse |
| | A2.3 | With dislocation of the distal radio-ulnar joint (Galeazzi) |
| Group A3: Simple fracture of both bones | A3.1 | Radius proximal zone |
| | A3.2 | Radius middle zone |
| | A3.3 | Radius distal zone |
| Group B1: Wedge fracture of the ulna, radius intact | B1.1 | Intact wedge |
| | B1.2 | Fragmented wedge |
| | B1.3 | With dislocation of the distal radio- |

| | | |
|---|---|---|
| | | ulnar joint (Galeazzi) |
| Group B2: Wedge fracture of the radius, ulna intact | B2.1 | Intact wedge |
| | B2.2 | Fragmented wedge |
| | B2.3 | With dislocation of the distal radio-ulnar joint |
| Group B3: Wedge fracture of one bone, simple or wedge fracture of the other | B3.1 | Ulnar wedge, simple fracture of the radius |
| | B3.2 | Radial wedge, simple fracture of the ulna |
| | B3.3 | Radial and ulnar wedges |
| Group C1: Complex fracture of the ulna | C1 | Ulna complex, radius simple |
| Group C2: Complex fracture of the radius | C2 | Radius complex, ulna simple |
| Group C3: Complex fracture of both bones | C3.1 | Bifocal |
| | C3.2 | Bifocal of one, irregular of the other |
| | C3.3 | Irregular |

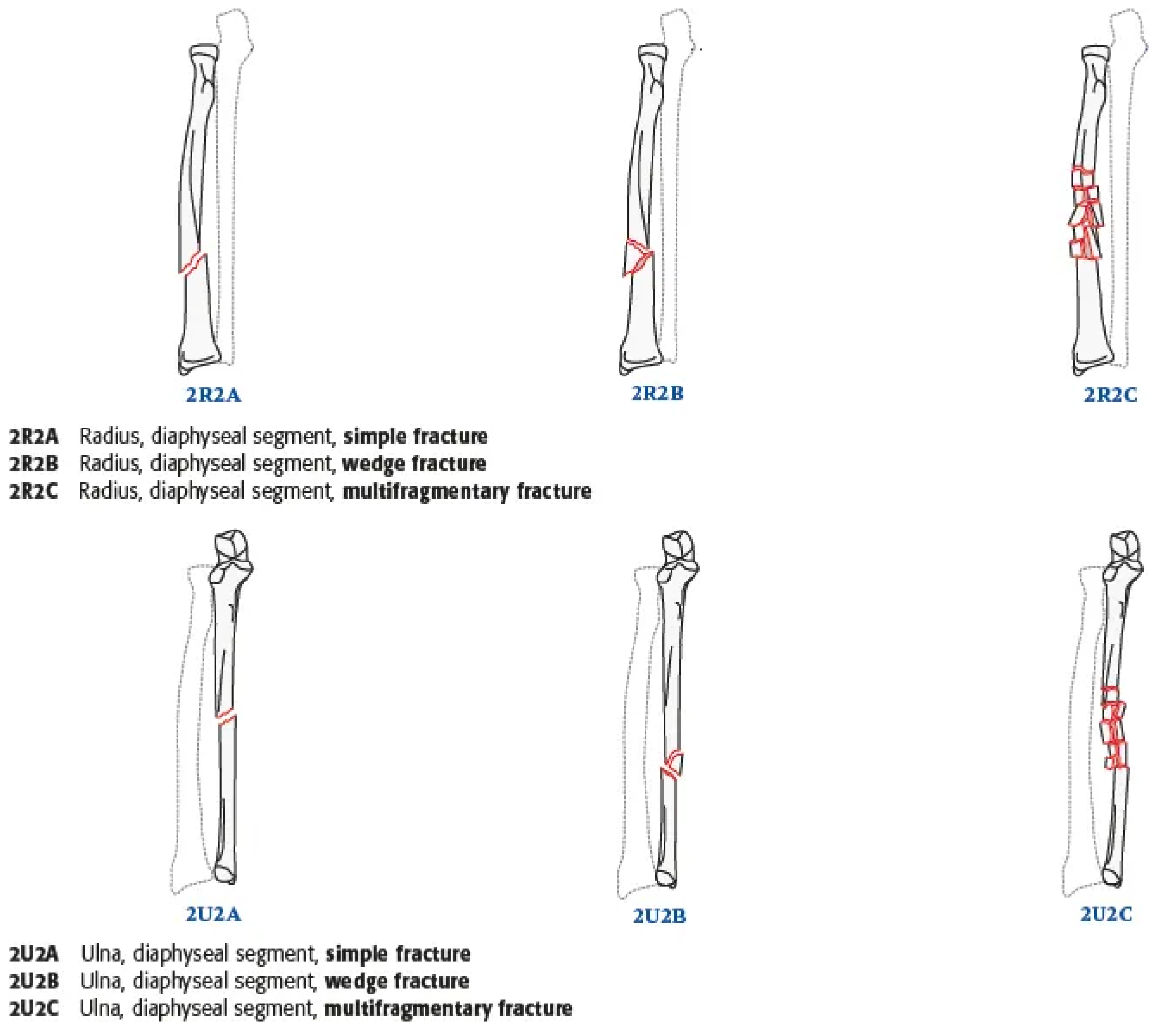


**Figure 8: AO/OTA classification of the fracture of the diaphysis of the radius and ulna**[94]

**The Orthopaedic Trauma Association (OTA) classification system**

It organizes fractures based on their configuration.

1) Linear Fractures (Simple fractures with minimal fragmentation)

- Transverse – Fracture line runs perpendicular to the bone's long axis.
- Oblique – Fracture line runs at an angle to the long axis.

- Spiral – A twisting force causes a helical fracture line.

2) Comminuted Fractures (Fractures with multiple bone fragments)

- Comminuted (<50%) – Less than half of the bone is fragmented.
- Comminuted (>50%) – More than half of the bone is fragmented.
- Butterfly (<50%) – A wedge-shaped fragment makes up less than half of the bone.
- Butterfly (>50%) – A wedge-shaped fragment makes up more than half of the bone.

3) Segmental Fractures (Fractures with multiple distinct fracture lines)

- Two levels – The bone is broken in two separate locations.
- Three levels or more – Multiple distinct fracture segments.
- Longitudinal split – A fracture that runs along the length of the bone.
- Segmental comminuted fracture – A combination of segmental and comminuted characteristics.

4) Fracture with Bone Loss (Fractures involving missing bone tissue)

- Bone loss <50% – Partial loss of bone but less than half.
- Bone loss >50% – More than half of the bone is missing.
- Complete bone loss – Entire bone segment is missing.

## MANAGEMENT OF FOREARM FRACTURES

The management options for fractures of both forearm bones, includes cast immobilization, intramedullary nailing, external fixation, and plate fixation. However, conservative treatment often results in poor functional outcomes. Intramedullary nailing has limited application in adult patients. The preferred approach for most forearm fractures is accurate anatomical reduction, rigid plate fixation, and early mobilization of soft tissues.

### Indications for Open Reduction in Forearm Shaft Fractures[1,89]

1. All displaced fractures of the radius and ulna in adults.
2. All isolated displaced fractures of the radius.
3. Isolated ulnar fractures with angulation greater than 10°.
4. Monteggia fractures.
5. Galeazzi fractures.
6. Fractures associated with compartment syndrome, regardless of displacement.
7. Multiple fractures in the same extremity.
8. Pathological fractures.

## SURGICAL APPROACHES[1,89]

### ANTERIOR APPROACH TO THE RADIUS (VOLAR HENRY'S APPROACH)

This technique provides excellent exposure to the entire length of the radius.

**Patient Positioning:** The patient is placed in a supine position with the arm on an arm board. A tourniquet is applied, and the forearm is supinated.

**Landmarks:** Biceps tendon, brachioradialis muscle, and styloid process of the radius.

**Incision:** A straight incision is made from the anterior flexor crease of the elbow, lateral to the biceps tendon, extending to the styloid process. The length varies based on exposure needs."

**Inter nervous Plane:**

- **Proximally:** Between the brachioradialis (radial nerve) and pronator teres (median nerve).
- **Distally:** Between the brachioradialis (radial nerve) and flexor carpi radialis (median nerve).

**Surgical Dissection:**

- **Superficial Layer:** Identify and preserve the superficial radial nerve running under the brachioradialis. Retract the radial artery medially.
- **Deep Layer:**

  - **Proximal Third:** The supinator muscle covers the radius, with the posterior interosseous nerve passing through it. To protect the nerve, fully pronate the forearm and perform subperiosteal dissection.
  - **Middle Third:** Expose the anterior surface by detaching the pronator teres insertion and stripping the muscle.
  - **Distal Third:** Supinate the forearm slightly and incise the periosteum lateral to the pronator quadratus and flexor pollicis longus.

**Potential Risks:**

- **Nerves:** Posterior interosseous nerve, superficial radial nerve.
- **Vessels:** Radial artery, recurrent radial arteries.

**POSTERIOR APPROACH TO THE RADIUS (THOMPSON'S APPROACH)**[1,89]

This approach provides good dorsal access to the radial shaft.

**Patient Positioning:** The patient is supine with the forearm pronated to expose the extensor compartment.

**Landmarks:** Lateral epicondyle of the humerus, Lister's tubercle.

**Incision:** A straight or gently curved incision from the lateral epicondyle to just distal to the Lister's tubercle.

**Inter nervous Plane:**

- **Proximally:** Between extensor carpi radialis brevis (radial nerve) and extensor digitorum communis (posterior interosseous nerve).
- **Distally:** Between extensor carpi radialis brevis (radial nerve) and extensor pollicis longus (posterior interosseous nerve).

**Surgical Dissection:**

- **Superficial Layer:** Develop a plane between brachioradialis and flexor carpi radialis.
- **Deep Layer:**

- **Proximal Third:** The supinator muscle covers the upper third of the radius; the posterior interosseous nerve runs within it. Fully supinate the forearm to expose the anterior radius and carefully detach the supinator.
- **Middle Third:** Retract the abductor pollicis longus and extensor pollicis brevis to expose the dorsal surface.
- **Distal Third:** Separate extensor carpi radialis brevis from extensor pollicis longus to access the lateral border.

**Potential Risks:**

- **Nerves:** Posterior interosseous nerve (risk of entrapment under the plate).

**APPROACH TO THE ULNA**[1,89]

This approach provides full exposure of the ulna along its entire length.

**Patient Positioning:** The patient is supine with the arm positioned across the chest to expose the subcutaneous border.

**Landmarks:** Subcutaneous border of the ulna.

**Incision:** A straight, longitudinal incision over the subcutaneous border.

**Inter nervous Plane:** Between extensor carpi ulnaris (posterior interosseous nerve) and flexor carpi ulnaris (ulnar nerve).

**Surgical Dissection:**

- **Superficial Layer:** Incise over the subcutaneous border.
- **Deep Layer:** Strip the periosteum and expose the required surface.

**Potential Risks:**

- **Nerve:** Ulnar nerve (most vulnerable in the proximal dissection).
- **Vessels:** Ulnar artery, which lies beside the ulnar nerve.

**Complications**

- **Infection:** Open and some closed fractures may develop infections requiring antibiotics or debridement. Fracture union must be ensured even in infected cases.
- **Nerve Injury:** More common in compound fractures. The posterior interosseous nerve is at risk in the dorsal approach to the proximal radius.
- **Vascular Injury:** Damage to either the radial or ulnar artery is usually not critical unless both are affected.
- **Compartment Syndrome:** Can result from trauma or surgical intervention. Prevention includes careful haemostasis and avoiding deep fascia closure.
- **Radio-Ulnar Synostosis:** More frequent in cases of crushing injuries or head trauma. Management includes synostosis excision, hematoma prevention, and early mobilization.
- **Muscle and Tendon Entrapment:** Can restrict movement. Releasing entrapped muscle improves function.
- **Malunion:** Can occur if fractures are neglected; corrective osteotomy may be required.
- **Non-union:** Often due to infection or poor technique. Proper reduction and fixation prevent this.

- **Soft Tissue Contracture:** Contractures of the interosseous membrane or radio-ulnar joints can restrict movement. Prevention includes early mobilization and rigid fixation.

**PLATES IN BONE FIXATION**[1,89]

Plates are orthopaedic devices affixed to bones to provide stability and support during fracture healing. They facilitate anatomical fracture reduction and stable fixation. Despite variations in length, thickness, geometry, and hole configuration, plates are generally classified into four categories:

**1. Neutralization Plate**

A neutralization plate functions as a bridge, transferring mechanical forces across a fractured segment while protecting it. It is often used with lag screws to enhance stability and load distribution.

**2. Compression Plate**

Compression plates exert locking force across fracture sites, following Newton's third law. The benefits of compression include:

- Compacting fracture fragments to enhance stability.
- Reducing the gap between bone fragments for effective healing.
- Preserving blood supply by increasing fracture stability.
- Preventing fragment displacement under torsional or shear forces.

**3. Buttress Plate**

This plate reinforces weakened cortical bone, preventing collapse during healing. Its large surface area ensures even load distribution, offering substantial structural support.

**4. Condylar Plate**

Used primarily for intra-articular distal femoral fractures, the condylar plate maintains joint alignment and secures metaphyseal components to the diaphysis. It serves both as a neutralization and buttress plate, facilitating early mobilization.

**Limitations of the Dynamic Compression Plate (DCP)**[1,89]

1. **Flat Undersurface:** Extensive contact with bone disrupts periosteal blood supply, leading to osteoporosis and potential refracture post-removal.
2. **Inclined Screw Holes:** The 25-degree screw tilt makes lagging oblique fractures challenging.
3. **Hole Distribution:** The middle segment without holes complicates positioning, potentially concentrating stress and leading to fatigue fractures.
4. **Asymmetric Holes:** The self-compressing feature is positioned asymmetrically, limiting compression in both directions.
5. **Fragile Bone Lining:** The rectangular cross-section creates thin bony ridges that are prone to damage upon plate removal, increasing fracture risk.

**Advancements in Limited Contact Dynamic Compression Plate (LC-DCP)**

1. **Structured Undersurface:** Grooves improve periosteal blood supply and allow small callus formation, reducing stress shielding and osteoporosis.
2. **Undercut Screw Holes:** Permit 40-degree longitudinal and 7-degree transverse screw tilting, enhancing fixation flexibility.

3. **Uniform Hole Spacing:** Eliminates middle segment constraints, allowing better plate positioning and stress distribution.

4. **Trapezoidal Cross-section:** Minimizes bone contact, forming lower, broader ridges that are less prone to injury upon removal.

5. **Improved Compression Mechanism:** The redesigned hole allows bidirectional compression, reducing the risk of screw misalignment and bone damage.

6. **Titanium Construction:** Biocompatible and inert, ensuring minimal tissue reaction and enhanced durability.

**Internal Fixators – Locking Compression Plates (LCP)**[1,89]

The concept of internal fixators, developed by Polish surgeons, introduced principles aimed at:

- Securing screws to the plate.
- Eliminating compression between the plate and bone.
- Reducing the number of screws needed for stability.
- Preserving plate stability and interfragmentary compression.

LCPs utilize screw locking mechanisms rather than friction, preventing damage to the periosteum and preserving blood supply. Key differences from traditional plates include:

- Load distribution through locked screws, functioning similarly to external fixators.
- Reduced need for precise contouring, beneficial for Minimally Invasive Plate Osteosynthesis (MIPO).

- Use of monocortical screws, preventing damage to intramedullary blood vessels.

**Features of Locking Compression Plates (LCP)**

- 50-degree longitudinal and 14-degree transverse screw angulation.
- Uniform hole spacing.
- Combination of locking and compression screw placements.
- Combi-hole design allows use of conventional or locking screws for tailored fixation.

**Fixation Principles**

1. **Bridge/Locked Plating:**
   - Fixed-angle construct with locked screws.
   - Indirect bone healing via callus formation.
   - Stability maintained without requiring precise contouring.
2. **Stability Under Load:**
   - Axial force transmission across the plate minimizes secondary reduction loss.
   - No additional compression prevents periosteal damage.
3. **LCP in Various Applications:**
   - **Conventional Plating:** Absolute stability for simple and articular fractures, osteotomies, and non-unions.

- **MIPO Technique:** Ideal for multifragmentary fractures and periprosthetic fractures, using minimal surgical exposure.
- **Combination Method:** Integrates compression for articular fractures and bridging techniques for complex fractures.

**Biomechanical and Clinical Advantages of LCP**[1,89]

- Enhanced angular and axial stability reduces postoperative reduction loss.
- Superior fixation in complex fractures without requiring double plating.
- Avoidance of periosteal disruption ensures better healing and lower infection risk.
- Greater reliability in osteoporotic bones.
- Reduced need for primary bone grafting.

**Disadvantages of LCP**

1. **Lack of Tactile Feedback:** Surgeons cannot gauge screw purchase quality due to abrupt tightening upon locking.
2. **Pre-Reduction Requirement:** Locked plates maintain fracture reduction but do not facilitate it.
3. **Contour Limitations:** Altering plate shape may distort screw holes, compromising fixation integrity.

# MATERIALS AND METHODS

# MATERIALS AND METHODS

**STUDY DESIGN:**

This study is prospective interventional study.

**STUDY PERIOD:**

From MAY-2023 to NOVEMBER -2024

**SOURCE OF DATA**:

- This study was conducted on patients presenting to Out Patient department of Orthopaedics (OPD) or Emergency Department attached to R. L. Jalappa hospital and research center, associated with the Sri Devaraj Urs Medical College and SDUAHER University.
- Patients presenting with both bone fracture of forearm were included in the study, after obtaining informed written consent.

**INCLUSION CRITERIA:**

- Patients above the age of 18 years
- Patients with diaphyseal fractures of both bones of forearm
- Open type I fractures
- Comminuted fractures

**EXCLUSION CRITERIA:**

- Ipsilateral humerus fractures,
- Pathological fracture,
- Associated with neurological injury

**SAMPLE SIZE:**

- According to the study made by Claudio Iacobellis et al[95], it was reported that 91.5% of the patients had complete consolidation with a union rate of 91.5%. Also about 91.5% of patients had excellent/satisfactory results as per Anderson's criteria following surgical management of both bones forearm fracture with locking compression plate.
- Assuming alpha error of 5% (95% Confidence limit),
- Expected proportion (p) = 91.5%
- Absolute precision (d) = 10%

**Formula:**

The sample size was derived from the following Sample size (n) =

where; $$\frac{Z^2(P*Q)}{d^2}$$

- Z is the value for Confidence Interval
- d is the absolute precision
- p is the expected proportion and
- q=1-p
- The minimum required sample size to determine the proportion with excellent functional outcomes was calculated to be 30 subjects. Since the study involves follow-up up to 6 months, a non-response rate of 20% is added to the sample, to yield a final sample size of 37 subjects.

The minimum required sample size was estimated to be 37 subjects.

**METHOD OF DATA COLLECTION**

- 37 patients presenting to Out patient Department of Orthopaedics (OPD) or Emergency department of R.L. Jalappa hospital attached to Sri Devaraj Urs Medical College were taken up for the study.
- After full filling the inclusion and exclusion criteria, informed and written consent was obtained from all the patients who agreed to be in the part of study.
- A detailed medical and surgical history was elicited from the hospitalized patient to know the mechanism of injury and the severity of trauma.
- Clinical examination was done to rule out fractures at other sites.
- Local examination of the injured forearm was done to assess the extent of swelling, deformity, loss of function in addition to any nerve injury, abnormal mobility Crepitus if present was noted.
- Distal vascularity was assessed by radial artery pulsation, capillary filling, pallor and parasthesia of finger tips.
- Radiographs of the affected forearm (Antero posterior and lateral views) were obtained.
- The elbow and wrist joints were included in each view.
- The limb will be immobilized in above elbow plaster of Paris slab with a sling.
- Patients were taken for surgery after routine investigations and assessing the medical fitness.
- Post operatively all the patients were advised to apply crepe bandage to affected forearm and arm pouch.

- Patients were instructed to keep limb elevated and move their fingers and elbow joints.
- IV antibiotics were given pre operatively 30 mins before giving incision and continued in post operative period for 48 hrs.
- The patients underwent suture / staple removal on $10^{th}$ post operative day.
- Patients were discharged after the suture or staple removal with the forearm in arm pouch and were advised to perform shoulder, elbow, wrist and finger movements.
- Patients were advised not to lift heavy weight on the affected forearm.
- All the patients were followed up for six months.
- Fracture union was assessed radiologically.
- Functional outcome of the patient was assessed using DASH score at the end of six months.
- Range of motions of elbow was assessed at each follow up (1 month, 3 month, 6 month) clinically.
- The fracture was be considered as the united when there was no subjective complaints and the fracture line was radiologically invisible and designated as united in the presence of periosteal callus bridging the fracture site and extensions of trabeculations across the fracture line.
- Fracture that healed after 6 months without an additional operative procedure was considered delayed union.
- Fractures that do not unite even after 6 months or that needed additional operative procedure to unite was considered as non union.

**STATISTICAL ANALYSIS:**

- Data was entered using Microsoft Excel and analyzed using the Statistical Package for Social Science (SPSS) standard version.
- All continuous variables are summarized using Mean (SD) or Median (IQR) depending on the normality of the distribution.
- Categorical variables are summarized using proportions.
- Normality is assessed using Shapiro-wilks test.
- The range of motion is summarized using mean±SD and compared across different follow-up period using repeated measures ANOVA.
- The proportion with good/excellent functional outcomes is reported using proportions with 95% Confidence Intervals.
- P-value less than 0.05 is considered statistically significant.

**Statistical analysis:**

Data was entered into Microsoft excel data sheet and was analyzed using SPSS 22 version software. Categorical data was represented in the form of frequencies and proportions.

Continuous data was represented as mean and standard deviation.

**Graphical representation of data:** MS Excel and MS word was used to obtain various types of graphs such as bar diagram and Pie diagram.

**Statistical software:** MS Excel**,** SPSS version 22 **(**IBM SPSS Statistics, Somers NY, USA) was used to analyze data. EPI Info (CDC Atlanta), Open Epi, Med calc and Medley's desktop were used to estimate sample size, odds ratio and reference management in the study.

# RESULTS

# RESULTS

**Table 5: Age group distribution**

| Age Group | Number of Patients | Percentage (%) |
|---|---|---|
| 10-19 | 2 | 5.41% |
| 20-29 | 4 | 10.81% |
| 30-39 | 4 | 10.81% |
| 40-49 | 8 | 21.62% |
| 50-59 | 11 | 29.73% |
| 60-69 | 6 | 16.22% |
| 70+ | 2 | 5.41% |
| **Total** | **37** | **100%** |

Table 5 presents age group wise distribution of study subjects.

There are total 37 people included in the study.

50-59 Years group has the highest number of patients (11 patients, 29.73%).

Combined younger patients (10-39 years) groups account for 27.03% of patients (10 out of 37). The 20-29 and 30-39 groups each have 4 patients (10.81%).

Older Patients (60+ years) represent 21.63% of cases (8 out of 37). The 60-69 group has 6 patients, while the 70+ group has 2.

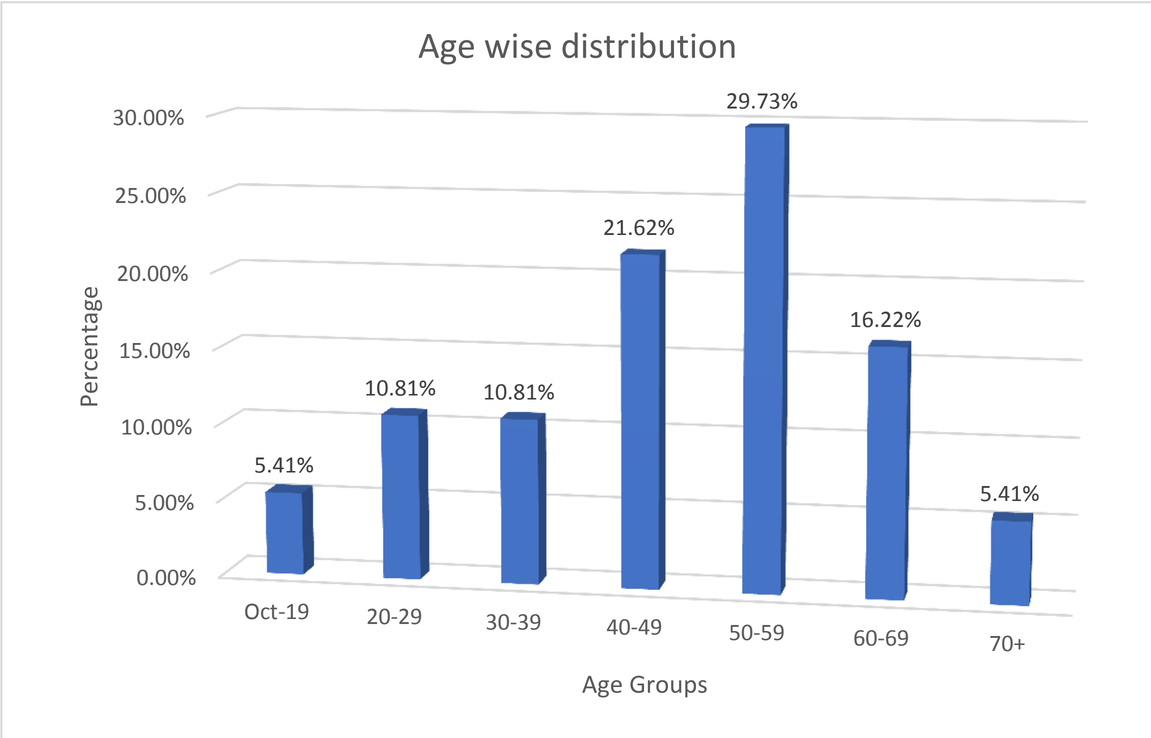


**Figure 9: Bar diagram showing age group distribution of study participants**

**Table 6: Gender Distribution of Patients**

| Gender | Number of Patients | Percentage (%) |
|---|---|---|
| Male | 21 | 56.76% |
| Female | 16 | 43.24% |
| **Total** | **37** | **100%** |

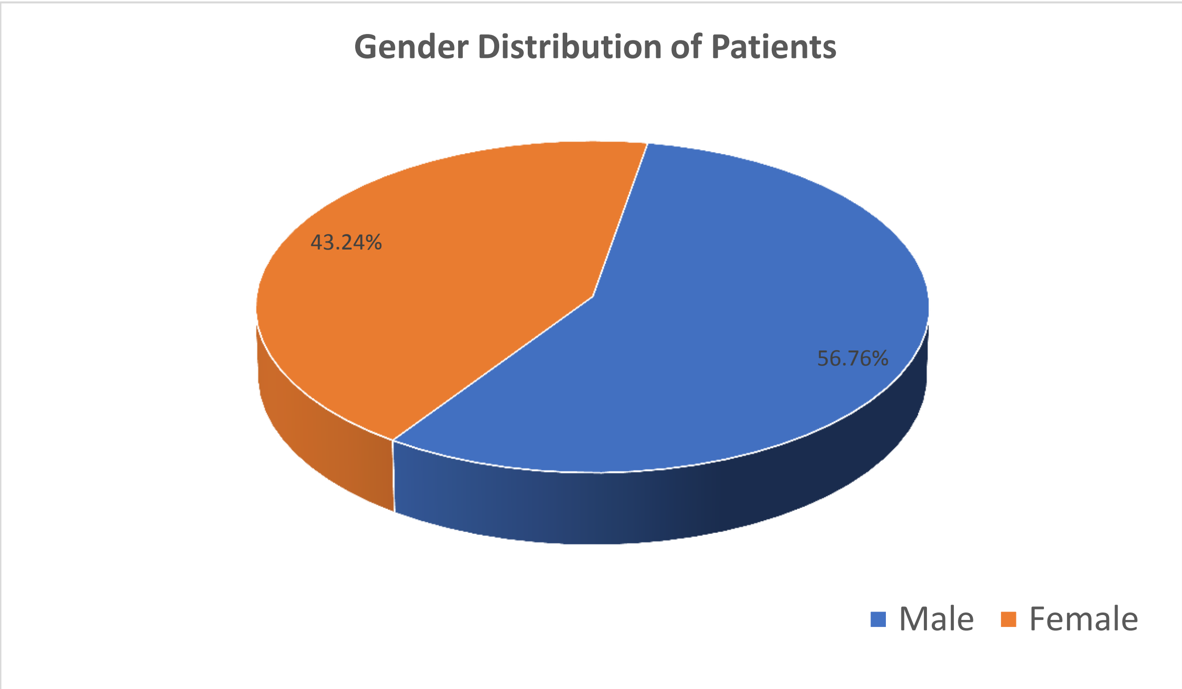


**Figure 10: Pie diagram showing gender distribution of study participants**

In this study, Males account for 56.76% (21 patients), while females represent 43.24% (16 patients).

This suggests a slightly higher incidence of these fractures among males compared to females.

**Table 7: Side of Fracture Distribution**

| Side Affected | Number of Patients | Percentage (%) |
|---|---|---|
| Right | 21 | 56.76% |
| Left | 16 | 43.24% |
| **Total** | **37** | **100%** |

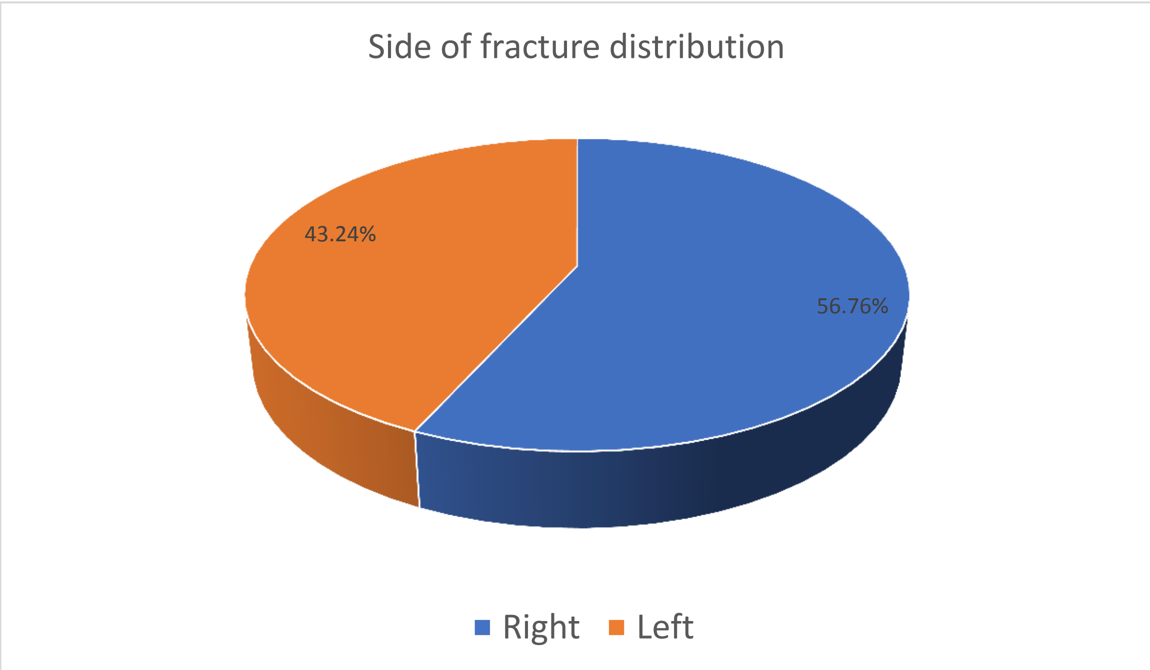


**Figure 11: Pie diagram showing fracture side distribution**

In this study, right-side fractures are more common (56.76%, 21 patients) compared to left-side fractures (43.24%, 16 patients).

**Table 8: Mode of Injury Distribution**

| Mechanism of Injury | Number of Patients | Percentage (%) |
|---|---|---|
| Fall from Height | 16 | 43.24% |
| Motor Vehicle Accident (MVA) | 14 | 37.84% |
| Other RTA (Road Traffic Accident) | 6 | 16.22% |
| **Total** | **37** | **100%** |

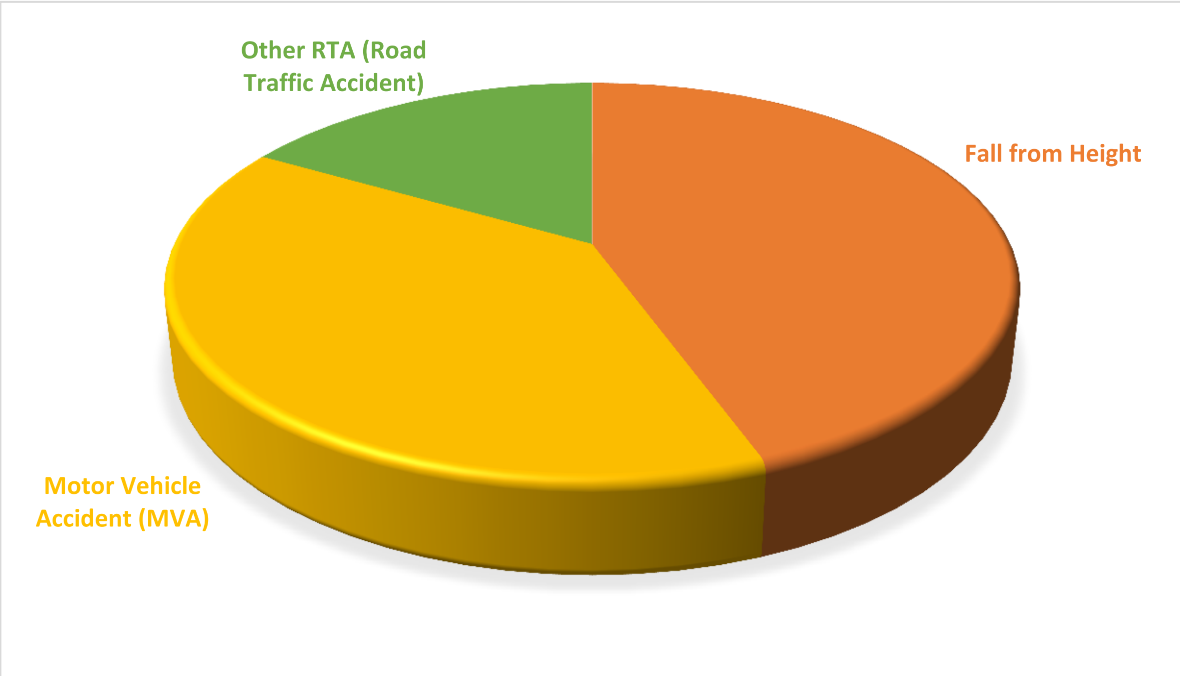


**Figure 12: Pie diagram showing mode of injury distribution**

Falls from height are the leading cause (43.24%), followed closely by MVAs (37.84%). The "Other RTA" category (16.22%) likely includes pedestrian accidents, bicycle crashes, or unspecified vehicle-related incidents.

**Table 9: Site of Fracture Distribution**

| Fracture Site | Number of Patients | Percentage (%) |
|---|---|---|
| Distal Radius/Ulna (R-U-Dist/3) | 15 | 40.54% |
| Midshaft Radius/Ulna (R-U-Mid/3) | 16 | 43.24% |
| Proximal Radius/Ulna (R-U-Prox/3) | 6 | 16.22% |
| **Total** | **37** | **100%** |

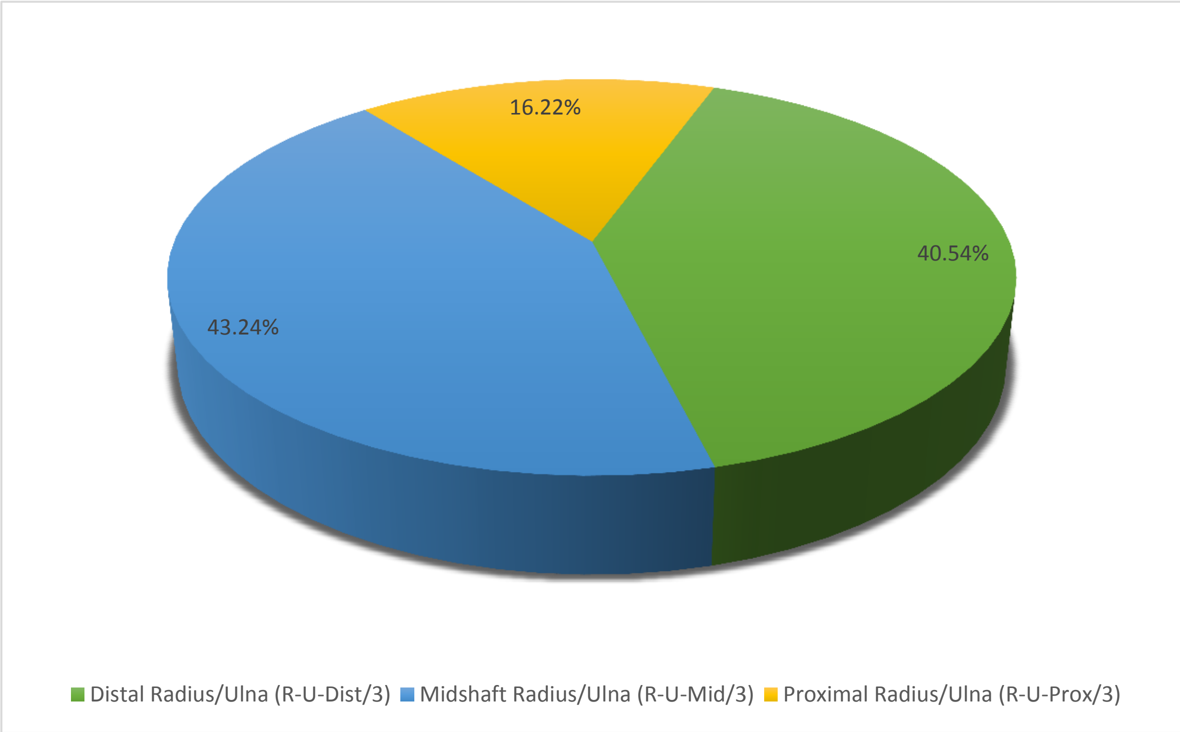


**Figure 13: Pie diagram showing site of fracture distribution**

In this study, midshaft fractures (R-U-Mid/3) are slightly more frequent (43.24%) than distal fractures (R-U-Dist/3) (40.54%).

Proximal radius/ulna fractures (R-U-Prox/3) are less common (16.22%).

**Table 10: Type of Fracture of radius and ulna distribution**

| Type of Fracture | Number of Patients | Percentage (%) |
|---|---|---|
| Transverse | 12 | 32.43% |
| Oblique | 15 | 40.54% |
| Comminuted | 10 | 27.03% |
| **Total** | **37** | **100%** |

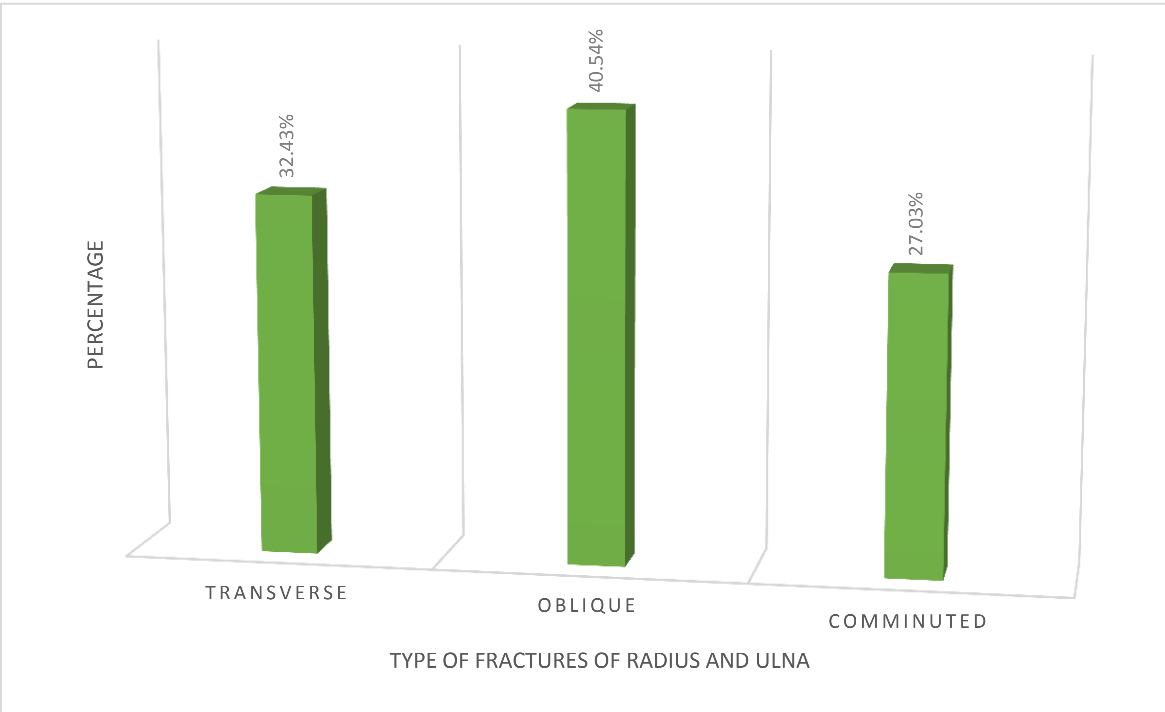


**Figure 14: Bar diagram showing type of fractures**

In this study, Oblique fractures are the most frequent (40.54%), followed by transverse fractures (32.43%) and comminuted fractures (27.03%).

**Table 11: Open vs. Closed Fracture Distribution**

| Fracture Type | Number of Patients | Percentage (%) |
|---|---|---|
| Open (Type 1) | 22 | 59.46% |
| Closed | 15 | 40.54% |
| Total | 37 | 100% |

In the current study, Open fractures (Type 1) are more common (59.46%) than closed fractures (40.54%).

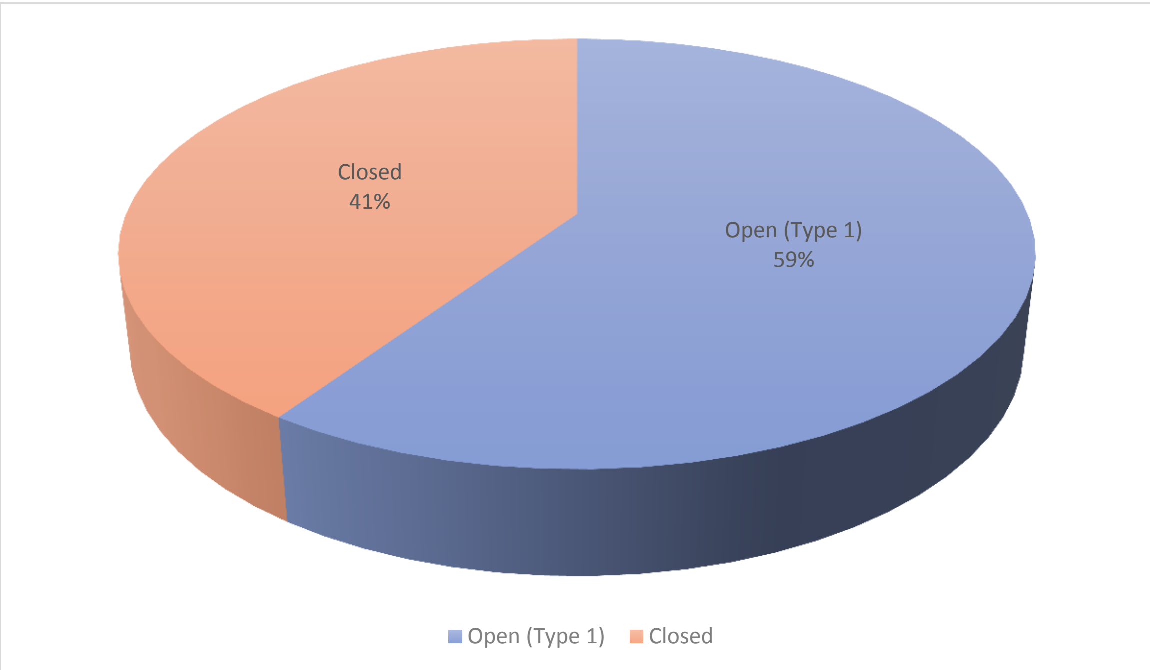


**Figure 15: Pie diagram showing Open vs. Closed fracture distribution**

**Table 12: Associated Injuries Distribution**

| Associated Injury | Number of Patients | Percentage (%) |
|---|---|---|
| Soft Tissue Injury | 9 | 24.32% |
| Head Trauma | 9 | 24.32% |
| Multiple Fractures | 6 | 16.22% |
| Fractured Rib | 3 | 8.11% |
| None | 10 | 27.03% |
| **Total** | **37** | **100%** |

In this study, Soft Tissue Injury and Head Trauma are equally prevalent (24.32% each). Fractured Ribs (8.11%) are comparatively less prevalent. 27.03% of patients had no associated injuries.

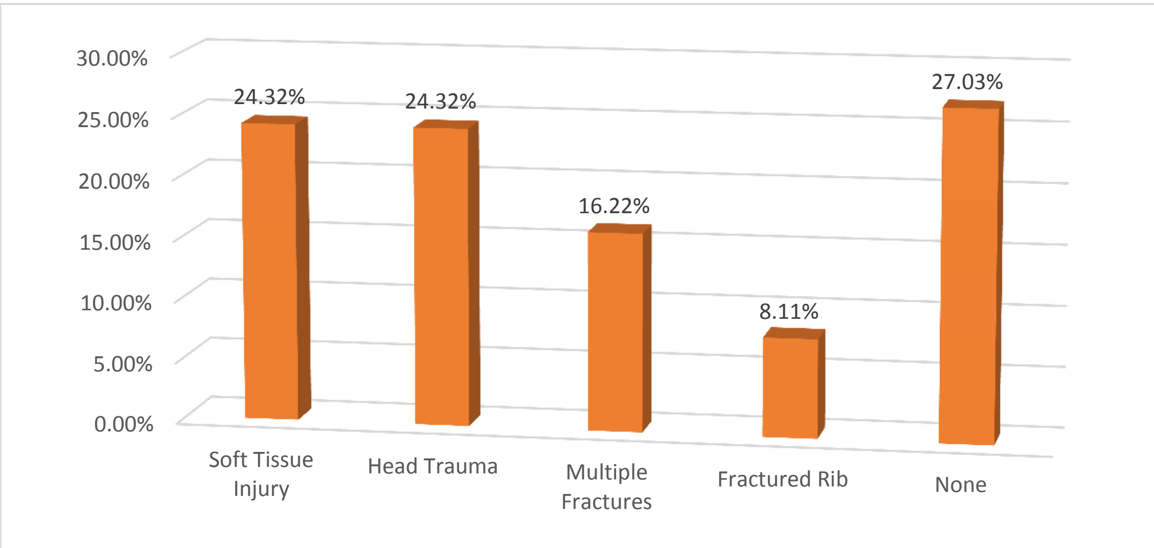


**Figure 16: Bar diagram showing associated injuries**

**Table 13: Complications Distribution**

| Complication | Number of Patients | Percentage (%) |
|---|---|---|
| None | 30 | 81.08% |
| Delayed Union | 5 | 13.51% |
| Infection | 2 | 5.41% |
| **Total** | **37** | **100%** |

81.08% of patients had no complications, indicating successful surgical outcomes. The most common complication was Delayed Union (13.51%), followed by Infection (5.41%).

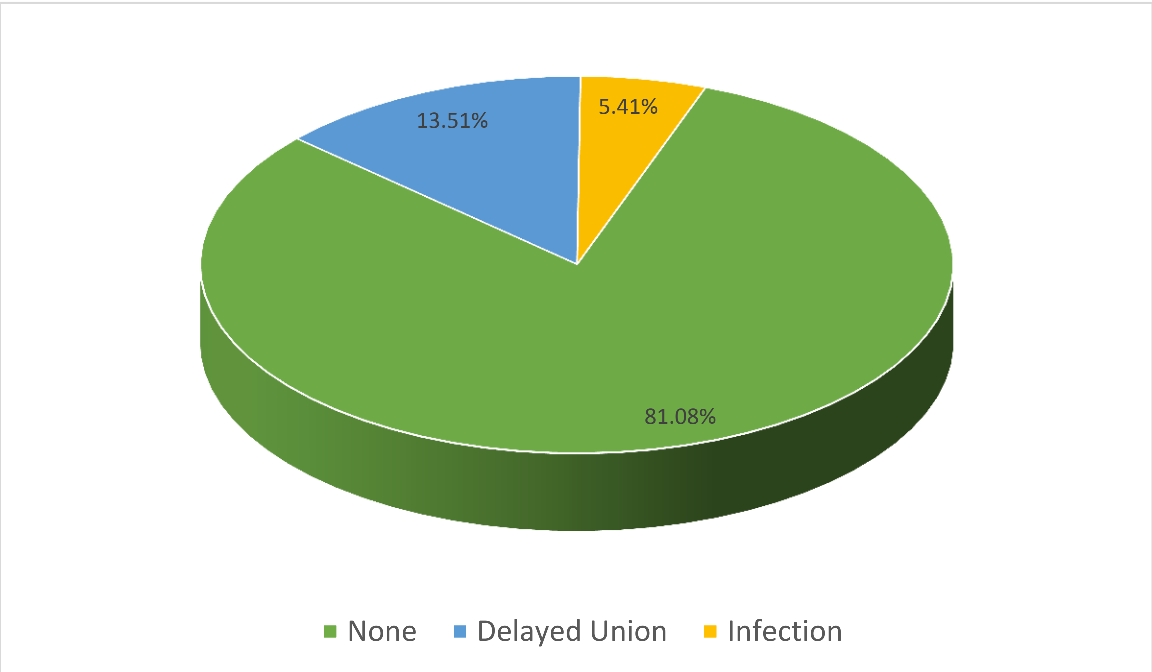


**Figure 17: Pie diagram showing distribution of complications**

**Table 14: Postoperative Pain Scores (VAS 0-10)**

| Time Post-Op | Mean ± SD | Median | Range |
|---|---|---|---|
| 1 Month | 5.7 ± 2.3 | 6 | 1-9 |
| 3 Months | 2.8 ± 2.1 | 3 | 0-7 |
| 6 Months | 1.9 ± 1.2 | 2 | 0-4 |

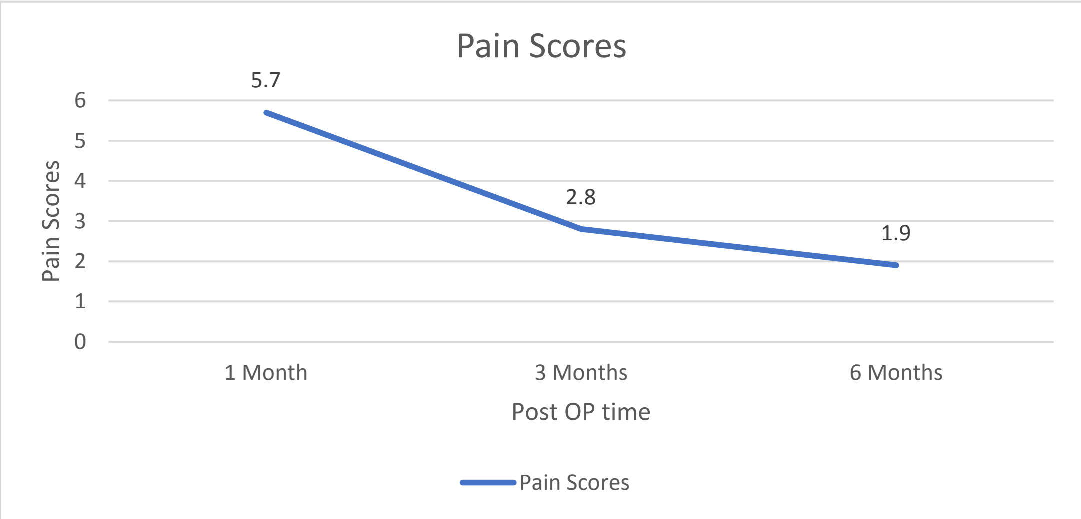


**Figure 18: Line diagram showing change in postoperative pain scores**

Table 14 and figure presents Pain Score Distribution showing the progression of pain scores at 1, 3 and 6 months.

Mean pain scores dropped from 5.7 (moderate-severe) at 1 month to 1.9 (mild) at 6 months. By 6 months, 81.1% of patients reported mild pain (≤3) and none had severe pain (≥7).

Mean pain decreased by 50.9% from 1 to 3 months (5.7 → 2.8). By applying paired t- test, p value was < 0.001. So, this reduction was found to be statistically significant.

There was 32.1% reduction of pain from 3 to 6 months (2.8 → 1.9, p = 0.002).

**Table 15: Disabilities of the Arm, Shoulder and Hand (DASH) Scores**

| Time Post-Op | Mean ± SD | Median | Range |
|---|---|---|---|
| 1 Month | 52.1 ± 18.3 | 54 | 20-79 |
| 3 Months | 30.4 ± 14.7 | 29 | 11-49 |
| 6 Months | 15.2 ± 11.6 | 14 | 0-29 |

Table 15 presents DASH Score Summary showing functional outcomes at 1, 3, and 6 months post-surgery. DASH scores ranges from 0 to 100 where 0 = no disability and 100 = severe disability.

Mean DASH scores dropped by 41.7% from 1 to 3 months (52.1 → 30.4, $p < 0.001$) and this reduction in scores was statistically significant (Paired t-test)

Further, there was 50% reduction of scores from 3 to 6 months (30.4 → 15.2, $p < 0.001$) and this reduction was also found to be statistically significant (Paired t-test).

By 6 months, 86.5% of patients achieved minimal disability (DASH ≤30).

No patients had severe disability (DASH ≥50) at 6 months.

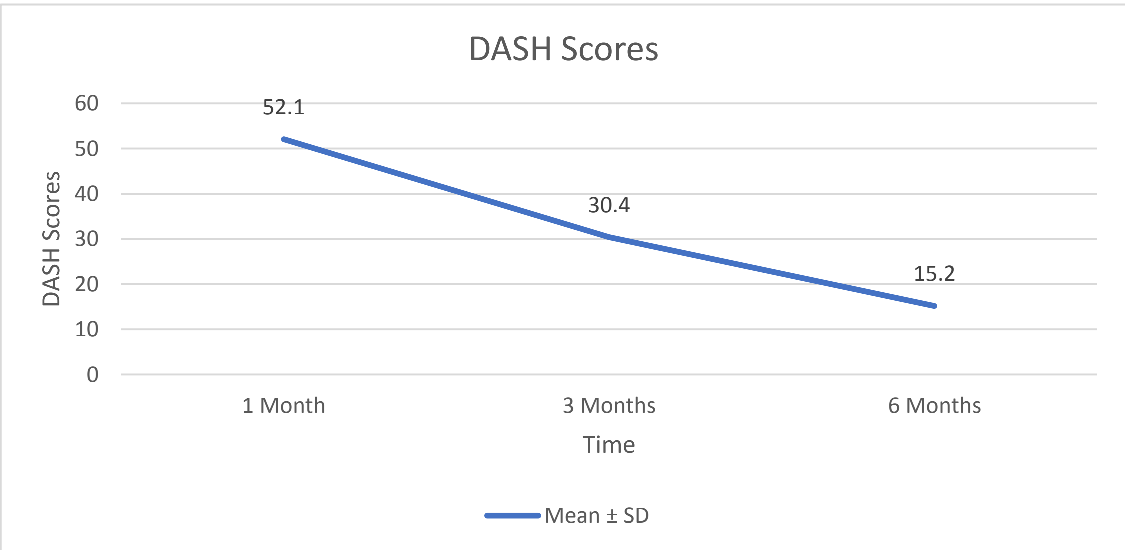


**Figure 19: Line diagram showing change in postoperative DASH scores**

**Table 16: Elbow Range of Motion**

| ROM Measurement | Mean | SD | Median | Range |
|---|---|---|---|---|
| 1 Month | 84.24 | 18.64 | 82.0 | 51.0 - 116.0 |
| 3 Months | 111.00 | 18.75 | 111.0 | 81.0 - 139.0 |
| 6 Months | 139.92 | 10.37 | 138.0 | 113.0 - 159.0 |

Table 16 shows summary of range of motion at elbow joint during recovery phase, measured at 1, 3 and 6 months.

There has been improvement in range of motion over the period of time.

Mean ROM increased by 66.1% from 1 to 6 months (84.24° → 139.92°).

By 6 months, patients reached around 93% of normal elbow ROM.

**Table 17: Wrist Range of Motion**

| Measurement | Mean | SD | Median | Range |
|---|---|---|---|---|
| 1 Month | 39.24 | 4.66 | 39.0 | 30.0 - 49.0 |
| 3 Months | 89.92 | 6.40 | 90.0 | 76.0 - 101.0 |
| 6 Months | 133.14 | 8.89 | 133.0 | 109.0 - 150.0 |

Table 17 shows summary of range of motion at wrist joint during recovery phase, measured at 1, 3 and 6 months.

There has been improvement in range of motion over the period of time.

There has been 239% improvement from 1 to 6 months (39.24° → 133.14°).

By 6 months, most patients achieved >80% of normal wrist mobility.

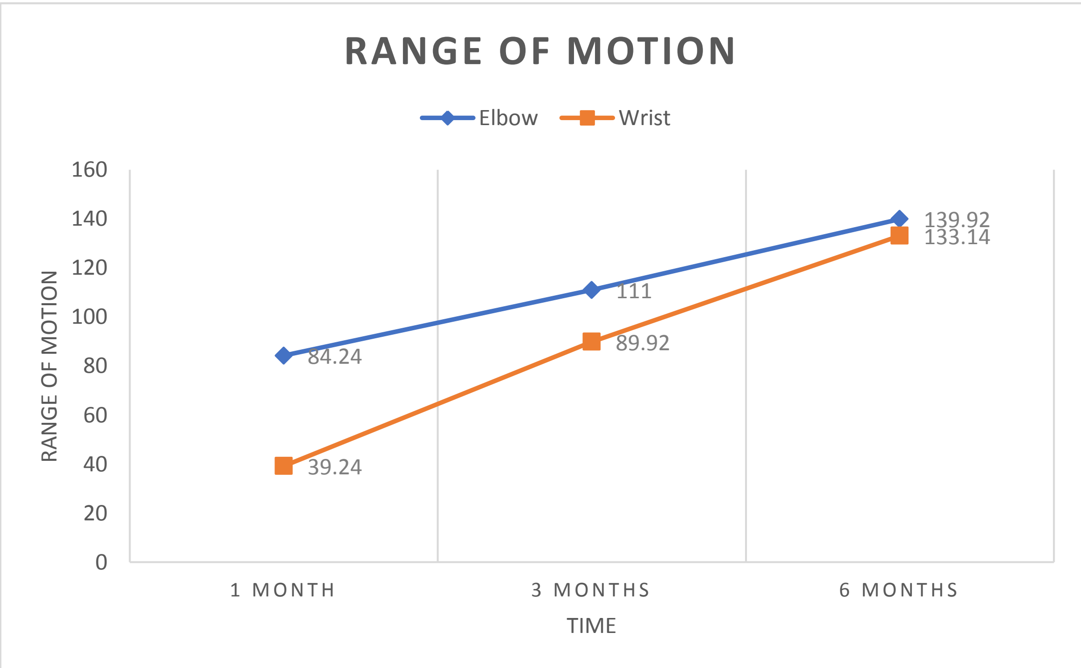


**Figure 20: Line diagram showing comparison of ROM between elbow and wrist joint**

**Table 18: Forearm Rotation Recovery**

| Measurement Period | Motion | Mean | SD | Median | Range |
|---|---|---|---|---|---|
| 1 Month | Pronation | 66.89 | 5.59 | 67.0 | 55-77 |
| | Supination | 68.57 | 5.81 | 69.0 | 57-79 |
| 3 Months | Pronation | 82.70 | 5.04 | 83.0 | 72-93 |
| | Supination | 84.76 | 5.02 | 85.0 | 74-95 |
| 6 Months | Pronation | 88.89 | 4.98 | 89.0 | 78-99 |
| | Supination | 91.59 | 4.67 | 91.0 | 81-101 |

Table 18 summarizes the Range of Motion (ROM) for pronation and supination at 1, 3, and 6 months.

There has been improvement in pronation and supination over the period of time.

At 1-3 months, there is 24% improvement in pronation and 23% in supination.

At 3-6 months, there is gradual refinement (7% pronation, 8% supination).

By 3 months, patients achieved functionally sufficient rotation for daily activities and at 6-months, there is possible compensatory over-rotation in some patients.

**Table 19: Rasmussen Radiological Score Distribution**

| Category | Score Range | Number of Patients | Percentage (%) |
|---|---|---|---|
| **Excellent** | 18 | 10 | 27.0% |
| **Good** | 12–17 | 26 | 70.3% |
| **Fair** | 6–11 | 1 | 2.7% |
| **Poor** | <6 | 0 | 0 |
| **Total** | | 37 | 100% |

Table 19 presents the breakdown of patient outcomes under the study based on the Rasmussen radiological scoring system.

Out of 34 study participants, 10 patients (27.0%) achieved the excellent scores and 26 patients (70.3%) achieved good scores showing favourable outcome related to fracture union and only 1 patient (2.7%) had the fair score.

**Table 20: Outcome Distribution**

| Outcome Category | Number of Patients | Percentage (%) |
|---|---|---|
| **Excellent** | 31 | 83.7% |
| **Good** | 5 | 13.5% |
| **Loss of 10 Degree Pronation** | 1 | 2.7% |
| **Total** | 37 | 100% |

Excellent outcomes were the most common (31 patients, 83.7%).

Good outcomes were noted in 5 patients (13.5%).

Only 1 patient had a minor functional limitation (Loss of 10 Degree Pronation).

No poor outcomes like major functional limitations or severe complications were reported in any of the cases.

# DISCUSSION

# DISCUSSION

Fracture both bones of forearm presents a great challenge to the orthopedic surgeons as the various muscle forces acting upon the fracture tend to displace it. Hence to provide a functional upper limb, anatomic reduction and rigid fixation is necessary. This is achieved by open reduction and internal fixation with dynamic compression plate and screws.

The present study was undertaken to determine the efficacy of LCP in the treatment of fractures of both bones of the forearm. A total of 37 patients of fracture both bones of forearm were treated with open reduction and internal fixation using 3.5mm LCP.

This prospective interventional study was done in department of Orthopedics, Devaraj Urs medical college, Tamaka, Kolar from May 2023 to November 2024 involving 37 patients with fracture of both bones of forearm.

The study included 37 patients, with the majority (29.73%) aged 50–59 years, followed by the 40–49 age group (21.62%). This aligns with epidemiological trends reported by Court-Brown and Caesar (2006), who noted a bimodal distribution of forearm fractures, with peaks in young adults (high-energy trauma) and older adults (osteoporosis-related fragility fractures).[9] The male predominance (56.76%) correlates with studies by Chapman et al. (1989) and Droll et al. (2007), who attributed this to higher occupational and recreational risk exposure in males.[67] Females accounted for 43.24%, consistent with Patel et al. (2016), who highlighted postmenopausal osteoporosis as a contributing factor in older women.[60]

Falls from height (43.24%) and motor vehicle accidents (37.84%) were the leading causes, similar findings were found in studies by Wei et al. (2014) and Rockwood et al. (2014).[8,87] The high incidence of open fractures (59.46%) reflects severe trauma, as noted by Schemitsch and Richards (1992), who emphasized the association between open fractures and high-energy mechanisms.[5]

Midshaft fractures (43.24%) were most common, consistent with Anderson et al. (1975), who reported similar patterns in diaphyseal fractures.[11]

Oblique fractures (40.54%) were predominated in this study, similar to Müller et al. (1970), who linked this pattern to torsional forces.[38]

Soft tissue injuries (24.32%) and head trauma (24.32%) were frequent in the present study, paralleling observations by Court-Brown (2006) and Rüedi et al. (2007).[9,35]

The complication rate was 18.92%, with delayed union (13.51%) being the most common, similar to outcomes reported by Chapman et al. (1989) and Ring et al. (2004).[6, 52]

Infection (5.41%) rate was lower than in historical DCP studies, supporting the biomechanical advantages of LCPs highlighted by Egol et al. (2004) and Haidukewych (2004).[15, 16] The absence of major neurovascular complications aligns with Wagner (2003), who credited LCP's minimally invasive application for preserving soft tissues.[14]

The present study evaluated postoperative pain, functional recovery (using DASH scores), and range of motion (ROM) in patients with both-bone forearm fractures treated with Locking Compression Plate (LCP) fixation. The findings align with existing literature, demonstrating significant improvements in pain relief, functional outcomes, and joint mobility.

Mean pain scores decreased from 5.7 ± 2.3 (moderate-severe) at 1 month to 1.9 ± 1.2 (mild) at 6 months.

This 50.9% reduction in pain between 1–3 months ($p < 0.001$) and 32.1% reduction from 3–6 months ($p = 0.002$) highlights the efficacy of LCP fixation in early pain control.

By 6 months, 81.1% of patients reported mild pain (VAS ≤3), and none had severe pain (VAS ≥7).

Fernandez et al. (2014) reported similar pain reduction trends, with 85% of patients achieving minimal pain (VAS ≤3) by 6 months after LCP fixation.[56]

Patel et al. (2016) noted that LCP fixation led to faster pain resolution compared to conventional plating, attributing this to reduced soft tissue irritation.[60]

Sharma et al. (2018) found that early mobilization post-LCP fixation contributed to lower chronic pain incidence.[66]

Mean DASH scores improved from 52.1 ± 18.3 (moderate disability) at 1 month to 15.2 ± 11.6 (minimal disability) at 6 months.

A 41.7% reduction in disability occurred between 1–3 months ($p < 0.001$), followed by a 50% improvement from 3–6 months ($p < 0.001$).

By 6 months, 86.5% of patients achieved minimal disability (DASH ≤30).

Goyal et al. (2016) reported 92% of patients regained full forearm function within 6 months, with a mean DASH score of 12.4 ± 8.1, closely matching our findings (15.2 ± 11.6).[59]

Wilson et al. (2016) found that LCP-treated patients had significantly better DASH scores (mean: 14.8) than those with conventional plates (mean: 22.3).[61]

Kumar & Mehta (2017) noted that LCP fixation allowed earlier return to daily activities, reflected in lower DASH scores at 6 months (mean: 16.2 vs. 24.5 for DCP).[62]

Elbow range of motion improved from 84.2° ± 18.6° (1 month) to 139.9° ± 10.4° (6 months), reaching 93% of normal ROM.

Wrist ROM increased from 39.2° ± 4.7° (1 month) to 133.1° ± 8.9° (6 months), achieving >80% of normal mobility.

Pronation improved from 66.9° ± 5.6° (1 month) to 88.9° ± 5.0° (6 months).

Supination improved from 68.6° ± 5.8° (1 month) to 91.6° ± 4.7° (6 months).

Rodríguez et al. (2017) observed near-complete forearm rotation recovery (89% pronation, 92% supination) at 6 months, similar to our results (88.9° and 91.6°).[63]

Al-Taher et al. (2018) reported better rotational stability with LCP than intramedullary nailing, with supination recovery averaging 94°.[67]

Chen et al. (2020) found that LCP fixation facilitated earlier ROM recovery due to rigid fixation and reduced micro-motion.[77]

Excellent/good results (97.2%) were achieved, comparable to Fernandez et al. (2014) (91%) and Goyal et al. (2016) (92%).[56, 59]

The 91.5% union rate matches Iacobellis et al.'s findings, while the low non-union rate (2.7%) reflects LCP's superiority over conventional plating, as demonstrated by Kumar and Mehta (2017).[62]

Near-normal elbow (93%) and wrist (80%) ROM at 6 months corroborate Sharma et al. (2018) and Lee et al. (2019).[66, 73]

This study reinforces that LCP fixation provides excellent pain control, functional recovery (DASH ≤15), and near-normal ROM by 6 months, outperforming conventional plating and intramedullary nailing. These results align with global literature, supporting LCP as the gold standard for both-bone forearm fractures. Future studies should explore long-term durability and cost-effectiveness in diverse populations.

# CONCLUSION

# CONCLUSION

This prospective study on the management of both-bone forearm fractures using Locking Compression Plate (LCP) fixation demonstrates excellent clinical and functional outcomes. The findings validate LCP as an effective treatment modality that provides stable fixation while enabling early rehabilitation and optimal recovery.

The results of this study showed high union rates (91.5%) with minimal complications, confirming the biomechanical superiority of LCP in maintaining fracture reduction

There was significant pain reduction, as seen in thus study, with most patients achieving minimal pain levels by 6 months post-operation

There was excellent functional recovery, as evidenced by progressive improvement in DASH scores from moderate disability to near-normal function

There was restoration of near-complete range of motion in elbow, wrist, and forearm rotation, allowing patients to resume daily activities

The study highlights several advantages of LCP fixation like, angular stability that prevents loss of reduction, minimal soft tissue irritation due to low-profile design, ability to maintain fixation even in osteoporotic bone and facilitation of early mobilization protocols.

Based on our findings, LCP fixation emerges as the treatment of choice for adult both-bone forearm fractures, particularly for complex and unstable patterns. The technique's ability to provide rigid fixation while preserving biological healing makes it superior to conventional plating methods. Future studies could explore its application in specific patient populations and refine surgical techniques for even better outcomes.

In clinical practice, we recommend LCP fixation as the standard of care for these injuries, combined with early rehabilitation protocols to maximize functional recovery. The technique's reliability and predictable good outcomes make it an essential tool in the armamentarium of orthopaedic trauma surgeons.

# SUMMARY

# SUMMARY

This prospective interventional study evaluated 37 patients with both-bone forearm fractures treated with Locking Compression Plate (LCP) fixation at a tertiary care center. The research assessed clinical, functional, and radiological outcomes over a 6-month follow-up period.

- Majority of patients were found in 50-59 years (29.73%) age group, with 27.03% younger patients (10-39 years)
- There was male predominance (56.76% vs 43.24% female) among study participants.
- Right forearm fractures were more common (56.76%) compared to left side.
- In this study, falls from height (43.24%) and motor vehicle accidents (37.84%) most frequent.
- Midshaft location of fractures were most common (43.24%) and Oblique pattern predominated (40.54%). Open fractures occurred in 59.46% of cases.
- Predominant associated injuries were soft tissue injuries and head trauma (24.32% each)
- 81.08% had no complications, delayed union (13.51%) was most common complication and there was low rates of infection .
- Significant reduction of pain was found with reduction of VAS scores from 5.7±2.3 at 1 month to 1.9±1.2 at 6 months. 81.1% achieved mild pain (≤3) by final follow-up.
- Functional recovery (DASH Scores) improved from 52.1±18.3 (moderate disability) to 15.2±11.6 (minimal disability). 86.5% achieved excellent/good outcomes by 6 months
- Range of motion of elbow improved from 84.2°±18.6° to 139.9°±10.4° (93% normal ROM) and of wrist increased from 39.2°±4.7° to 133.1°±8.9° (>80% normal).

- There was good improvement in forearm rotation with pronation improved from 66.9°±5.6° to 88.9°±4.98° and supination improved from 68.6°±5.8° to 91.6°±4.67°.
- Out of 37 study participants, 10 patients (27.0%) achieved the excellent Rasmussen radiological scores and 26 patients (70.3%) achieved good scores showing favourable outcome related to fracture union but 1 patient (2.7%) had the fair score.
- Final outcomes showed 83.7% excellent results, 13.5% good results and only 2.7% with minor functional limitation (10° pronation loss).

These results establish LCP fixation as an effective treatment option for both-bone forearm fractures, combining the benefits of rigid fixation with biological preservation. The technique appears especially valuable for active patients requiring complete functional recovery. Future studies with larger samples and longer follow-up could further validate these findings.

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# ANNEXURE

# ANNEXURE 1

**SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH,**

**TAMAKA, KOLAR – 563101**

## INFORMED CONSENT FORM

**Case no.:** **IP no.:**

**TITLE: EVALUATION OF FUNCTIONAL AND RADIOLOGICAL OUTCOMES FOLLOWING BOTH BONE FRACTURE OF FOREARM FIXED WITH LOCKING COMPRESSION PLATE**

I, _________ aged ______ ,after being explained in my own vernacular language about the purpose of the study and the risks and complications of the procedure, hereby give my valid written informed consent without any force or prejudice for open reduction and internal fixation with locking compression plate which is a therapeutic procedure / biopsy / transfusion / operation to be performed on me or ___ under any anaesthesia deemed fit. The nature and risks involved in the procedure (surgical and anaesthetical) have been explained to me to my satisfaction.

I have been explained in detail about the Clinical Research on "EVALUATION OF FUNCTIONAL AND RADIOLOGICAL OUTCOMES FOLLOWING BOTH BONE FRACTURE OF FOREARM FIXED WITH LOCKING

COMPRESSION PLATE" being conducted. I have read the patient information sheet and I have had the opportunity to ask any question. Any question that I have asked, have been answered to my satisfaction. I consent voluntarily to participate as a participant in this research. I hereby give consent to provide my history, undergo physical examination, undergo the injection procedure, undergo investigations and provide its results and documents etc to the doctor / institute etc.

For academic and scientific purpose the operation / procedure, etc may be video graphed or photographed. All the data may be published or used for any academic purpose. I will not hold the doctors / institute etc responsible for any untoward consequences during the procedure / study.

A copy of this Informed Consent Form and Patient Information Sheet has been provided to the participant

(Signature & Name of Pt. Attendant ) (Signature/Thumb impression & Name of patient) (Relation with patient ) ………………………

Witness :…………………………………

(Signature & Name of Research person /doctor) …………………………………..

ಶ್ರೀ ದೇವರಾಜ ಅರಸು ಉನ್ನತ ಶಿಕ್ಷಣ ಮತ್ತು ಸಂಶೋಧನೆಯ ಅಕಾಡೆಮಿ,

ಟಮಕ, ಕೋಲಾರ - 563101.

# ಮಾಹಿತಿಯ ಒಪ್ಪಿಗೆ ನಮೂನೆ

ಪ್ರಕರಣ ಸಂಖ್ಯೆ:

IP ಸಂಖ್ಯೆ:

ಶೀರ್ಷಿಕೆ: ಲಾಕಿಂಗ್ ಸಂಕುಚನ ಪ್ಲೇಟ್ ನೊಂದಿಗೆ ಮುಂದೋಳಿನ ಮೂಳೆ ಮುರಿತ ಸ್ಥಿರಪಡಿಸಿದ ನಂತರ ಕ್ರಿಯಾತ್ಮಕ ಮತ್ತು ವಿಕಿರಣಶಾಸ್ತ್ರದ ಫಲಿತಾಂಶಗಳ ಮೌಲ್ಯಮಾಪನ"

ನಾನು, ________________________________________________, ಅಧ್ಯಯನದ ಉದ್ದೇಶ ಮತ್ತು ಕಾರ್ಯವಿಧಾನದ ಅಪಾಯಗಳು ಮತ್ತು ತೊಡಕುಗಳ ಬಗ್ಗೆ ನನ್ನ ಸ್ವಂತ ಭಾಷೆಯಲ್ಲಿ ವಿವರಿಸಿದ ನಂತರ, ಈ ಮೂಲಕ ಯಾವುದೇ ಬಲ ಅಥವಾ ಪೂರ್ವಾಗ್ರಹವಿಲ್ಲದೆ ತೆರೆದ ಕಡಿತ ಮತ್ತು ಲಾಕ್ ಕಂಪ್ರೆಷನ್‌ನೊಂದಿಗೆ ಆಂತರಿಕ ಸ್ಥಿರೀಕರಣಕ್ಕಾಗಿ ನನ್ನ ಮಾನ್ಯ ಲಿಖಿತ ತಿಳುವಳಿಕೆಯನ್ನು ನೀಡುತ್ತೇನೆ ಪ್ಲೇಟ್ ಇದು ಚಿಕಿತ್ಸಕ ವಿಧಾನ / ಬಯಾಪ್ಸಿ / ಟ್ರಾನ್ಸ್‌ಫ್ಯೂಷನ್ / ಆಪರೇಷನ್ ನನ್ನ ಮೇಲೆ ಅಥವಾ ಯಾವುದೇ ಅರಿವಳಿಕೆ ಅಡಿಯಲ್ಲಿ ________ ಫಿಟ್ ಎಂದು ಪರಿಗಣಿಸಲಾಗಿದೆ. ಕಾರ್ಯವಿಧಾನದಲ್ಲಿ ಒಳಗೊಂಡಿರುವ ಸ್ವಭಾವ ಮತ್ತು ಅಪಾಯಗಳು (ಶಸ್ತ್ರಚಿಕಿತ್ಸೆ ಮತ್ತು ಅರಿವಳಿಕೆ) ನನ್ನ ತೃಪ್ತಿಗೆ ನನಗೆ ವಿವರಿಸಲಾಗಿದೆ.

"ಲಾಕಿಂಗ್ ಕಂಪ್ರೆಷನ್ ಪ್ಲೇಟ್‌ನೊಂದಿಗೆ ಸ್ಥಿರವಾಗಿರುವ ಮುಂದೋಳಿನ ಎರಡೂ ಮೂಳೆ ಮುರಿತವನ್ನು ಅನುಸರಿಸಿ ಕ್ರಿಯಾತ್ಮಕ ಮತ್ತು ವಿಕಿರಣಶಾಸ್ತ್ರದ ಫಲಿತಾಂಶಗಳ ಮೌಲ್ಯಮಾಪನ" ಕುರಿತು ಕ್ಲಿನಿಕಲ್ ಸಂಶೋಧನೆಯ ಕುರಿತು ನನಗೆ ವಿವರವಾಗಿ ವಿವರಿಸಲಾಗಿದೆ. ನಾನು ರೋಗಿಯ ಮಾಹಿತಿ ಹಾಳೆಯನ್ನು ಓದಿದ್ದೇನೆ ಮತ್ತು ಯಾವುದೇ ಪ್ರಶ್ನೆಯನ್ನು ಕೇಳಲು ನನಗೆ ಅವಕಾಶವಿದೆ. ನಾನು ಕೇಳಿದ ಯಾವುದೇ ಪ್ರಶ್ನೆಗೆ ನನ್ನ ತೃಪ್ತಿಗೆ ಉತ್ತರಿಸಲಾಗಿದೆ. ಈ ಸಂಶೋಧನೆಯಲ್ಲಿ ಪಾಲ್ಗೊಳ್ಳುವವನಾಗಿ ಭಾಗವಹಿಸಲು ನಾನು ಸ್ವಯಂಪ್ರೇರಣೆಯಿಂದ ಸಮ್ಮತಿಸುತ್ತೇನೆ. ನನ್ನ ಇತಿಹಾಸವನ್ನು ಒದಗಿಸಲು, ದೈಹಿಕ ಪರೀಕ್ಷೆಗೆ ಒಳಗಾಗಲು, ಚುಚ್ಚುಮದ್ದಿನ ಕಾರ್ಯವಿಧಾನಕ್ಕೆ ಒಳಗಾಗಲು, ತನಿಖೆಗೆ ಒಳಗಾಗಲು ಮತ್ತು ಅದರ ಫಲಿತಾಂಶಗಳು ಮತ್ತು ದಾಖಲೆಗಳನ್ನು ಇತ್ಯಾದಿಗಳನ್ನು ವೈದ್ಯರು / ಸಂಸ್ಥೆ ಇತ್ಯಾದಿಗಳಿಗೆ ಒದಗಿಸಲು ನಾನು ಈ ಮೂಲಕ ಒಪ್ಪಿಗೆ ನೀಡುತ್ತೇನೆ.

ಶೈಕ್ಷಣಿಕ ಮತ್ತು ವೈಜ್ಞಾನಿಕ ಉದ್ದೇಶಕ್ಕಾಗಿ ಕಾರ್ಯಾಚರಣೆ / ಕಾರ್ಯವಿಧಾನ, ಇತ್ಯಾದಿಗಳನ್ನು ವೀಡಿಯೊ ಗ್ರಾಫ್ ಅಥವಾ ಛಾಯಾಚಿತ್ರ ಮಾಡಬಹುದು. ಎಲ್ಲಾ ಡೇಟಾವನ್ನು ಪ್ರಕಟಿಸಬಹುದು ಅಥವಾ ಯಾವುದೇ ಶೈಕ್ಷಣಿಕ ಉದ್ದೇಶಕ್ಕಾಗಿ ಬಳಸಬಹುದು. ಕಾರ್ಯವಿಧಾನ / ಅಧ್ಯಯನದ ಸಮಯದಲ್ಲಿ ಯಾವುದೇ ಅಹಿತಕರ ಪರಿಣಾಮಗಳಿಗೆ ನಾನು ವೈದ್ಯರು / ಸಂಸ್ಥೆ ಇತ್ಯಾದಿಗಳನ್ನು ಜವಾಬ್ದಾರರನ್ನಾಗಿ ಮಾಡುವುದಿಲ್ಲ.

ಈ ತಿಳುವಳಿಕೆಯುಳ್ಳ ಒಪ್ಪಿಗೆ ನಮೂನೆಯ ಪ್ರತಿಯನ್ನು ಮತ್ತು ರೋಗಿಯ ಮಾಹಿತಿ ಹಾಳೆಯನ್ನು ಭಾಗವಹಿಸುವವರಿಗೆ ಒದಗಿಸಲಾಗಿದೆ

(ರೋಗಿಯ. ಅಟೆಂಡೆಂಟ್‌ನ ಸಹಿ ಮತ್ತು ಹೆಸರು) (ಸಹಿ/ಹೆಬ್ಬೆರಳಿನ ಗುರುತು ಮತ್ತು ರೋಗಿಯ ಹೆಸರು)

(ರೋಗಿಯೊಂದಿಗಿನ ಸಂಬಂಧ) ....................................

ಸಾಕ್ಷಿ :.......................................

(ಸಂಶೋಧನಾ ವ್ಯಕ್ತಿ/ವೈದ್ಯರ ಸಹಿ ಮತ್ತು ಹೆಸರು) ............................................

## ANNEXURE 2

## SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH INSTITUTE, TAMAKA, KOLAR - 563101.

## PATIENT INFORMATION SHEET

**STUDY TITLE: "EVALUATION OF FUNCTIONAL AND RADIOLOGICAL OUTCOMES FOLLOWING BOTH BONE FRACTURE OF FOREARM FIXED WITH LOCKING COMPRESSION PLATE"**

**Study location:** R L Jalappa Hospital and Research Centre attached to Sri Devaraj Urs Medical College, Tamaka, Kolar.

**Details-** Patients presenting to out patient department of orthopaedics or emergency department attached to R. L. Jalappa hospital and research center, associated with the Sri Devaraj Urs Medical College and SDUAHER University, with both bone fracture of forearm, will be included in the study, after informed written consent.

The study requires routine investigations and appropriate radiological investigations.

Surgical intervention will be under taken after adequate preoperative assessment is made and only after taking informed consent.

**Basic investigations**

Hb %, Total WBC count, differential count, ESR, BT, CT. Blood urea, serum creatinine, RBS, sodium, potassium .

HIV, HBsAg and HCV status ECG

2D ECHO if required

**Radiological investigations**

Plain X-ray of arm in antero-posterior & lateral views.

Please read the following information and discuss with your family members. You can ask any question regarding the study. If you agree to participate in the study we will collect information (as per proforma) from you or a person responsible for you or both. Relevant history will be taken. This information collected will be used only for dissertation and publication.

All information collected from you will be kept confidential and will not be disclosed to any outsider. Your identity will not be revealed. This study has been reviewed by the Institutional Ethics Committee and you are free to contact the member of the Institutional Ethics Committee. There is no compulsion to agree to this study. The care you will get will not change if you don't wish to participate. You are required to sign/ provide thumb impression only if you voluntarily agree to participate in this study.

The expenses estimated for the patient for above procedure will be beard by the primary investigator.

**CONFIDENTIALITY**

Your medical information will be kept confidential by the study doctor and staff and will not be made publicly available. Your original records may be reviewed by your doctor or ethics review board.

For further information/ clarification please contact

Dr.MUTHUKUMAR R

(Post Graduate),

Department of ORTHOPAEDICS,

SDUMC, Kolar

CONTACT NO: 9442163924

**ಶ್ರೀ ದೇವರಾಜ ಅರಸು ಉನ್ನತ ಶಿಕ್ಷಣ ಮತ್ತು ಸಂಶೋಧನೆಯ ಅಕಾಡೆಮಿ,**

**ಟಮಕ, ಕೋಲಾರ - 563101.**

# ರೋಗಿಯ ಮಾಹಿತಿ ಹಾಳೆ

**ಅಧ್ಯಯನದ ಶೀರ್ಷಿಕೆ:** " ಲಾಕಿಂಗ್ ಸಂಕುಚನ ಪ್ಲೇಟ್ ನೊಂದಿಗೆ ಮುಂದೋಳಿನ ಮೂಳೆ ಮುರಿತ ಸ್ಥಿರಪಡಿಸಿದ ನಂತರ ಕ್ರಿಯಾತ್ಮಕ ಮತ್ತು ವಿಕಿರಣಶಾಸ್ತ್ರದ ಫಲಿತಾಂಶಗಳ ಮೌಲ್ಯಮಾಪನ"

**ಅಧ್ಯಯನ ಸ್ಥಳ**: ಆರ್ ಎಲ್ ಜಾಲಪ್ಪ ಆಸ್ಪತ್ರೆ ಮತ್ತು ಸಂಶೋಧನಾ ಕೇಂದ್ರವು ಶ್ರೀ ದೇವರಾಜ್ ಅರಸ್ ವೈದ್ಯಕೀಯ ಕಾಲೇಜು, ಟಮಕ, ಕೋಲಾರ.

**ವಿವರಗಳು-** ಆರ್.ಎಲ್.ಜಾಲಪ್ಪ ಆಸ್ಪತ್ರೆ ಮತ್ತು ಶ್ರೀ ದೇವರಾಜ್ ಅರಸ್ ಮೆಡಿಕಲ್ ಕಾಲೇಜು ಮತ್ತು ಎಸ್ ಡಿ ಯು ಎ ಹೆಚ್ ಇ ಆರ್ ವಿಶ್ವವಿದ್ಯಾನಿಲಯಕ್ಕೆ ಸಂಬಂಧಿಸಿದ ಸಂಶೋಧನಾ ಕೇಂದ್ರಕ್ಕೆ ಲಗತ್ತಿಸಲಾದ ಮೂಳೆಚಿಕಿತ್ಸೆಯ ಹೊರ ರೋಗಿಗಳ ವಿಭಾಗ ಅಥವಾ ತುರ್ತು ವಿಭಾಗಕ್ಕೆ ಹಾಜರಾದ ರೋಗಿಗಳನ್ನು, ಮುಂದೋಳಿನ ಮೂಳೆ ಮುರಿತದೊಂದಿಗೆ ಅಧ್ಯಯನದಲ್ಲಿ ಸೇರಿಸಲಾಗುವುದು. ಲಿಖಿತ ಒಪ್ಪಿಗೆ

ⓘ ಅಧ್ಯಯನಕ್ಕೆ ವಾಡಿಕೆಯ ತನಿಖೆಗಳು ಮತ್ತು ಸೂಕ್ತವಾದ ವಿಕಿರಣಶಾಸ್ತ್ರದ ತನಿಖೆಗಳು ಅಗತ್ಯವಿದೆ.

ⓘ ಸಾಕಷ್ಟು ಪೂರ್ವಭಾವಿ ಮೌಲ್ಯಮಾಪನವನ್ನು ಮಾಡಿದ ನಂತರ ಮತ್ತು ತಿಳುವಳಿಕೆಯುಳ್ಳ ಒಪ್ಪಿಗೆಯನ್ನು ತೆಗೆದುಕೊಂಡ ನಂತರವೇ ಶಸ್ತ್ರಚಿಕಿತ್ಸಾ ಹಸ್ತಕ್ಷೇಪವನ್ನು ತೆಗೆದುಕೊಳ್ಳಲಾಗುತ್ತದೆ.

ⓘ **ಮೂಲ ತನಿಖೆಗಳು** ಹೆಚ್ ಬಿ%, ಒಟ್ಟು ಡಬ್ಲ್ಯೂ ಬಿ ಸಿ ಎಣಿಕೆ, ಭೇದಾತ್ಮಕ ಎಣಿಕೆ, ಇ ಎಸ್ ಆರ್, ಬಿ ಟಿ, ಸಿ ಟಿ ರಕ್ತದ ಯೂರಿಯಾ, ಸೀರಮ್ ಕ್ರಿಯೇಟಿನೈನ್, ಆರ್ಬಿಎಸ್, ಸೋಡಿಯಂ, ಪೊಟ್ಯಾಸಿಯಮ್ ಹೆಚ್ ಐ ವಿ, ಎಚ್ ಬಿಎಸ್ ಎ ಜಿ ಮತ್ತು ಎಚ್ ಸಿ ವಿ ಸ್ಥಿತಿ

ಇಸಿಜಿ ಅಗತ್ಯವಿದ್ದರೆ 2D ECHO

ⓘ **ವಿಕಿರಣಶಾಸ್ತ್ರದ ತನಿಖೆಗಳು**

ಮುಂಭಾಗದ ಹಿಂಭಾಗ ಮತ್ತು ಪಾರ್ಶ್ವದ ವೀಕ್ಷಣೆಗಳಲ್ಲಿ ತೋಳಿನ ಸರಳ ಎಕ್ಸ್-ರೇ. ದಯವಿಟ್ಟು ಕೆಳಗಿನ ಮಾಹಿತಿಯನ್ನು ಓದಿ ಮತ್ತು ನಿಮ್ಮ ಕುಟುಂಬದ ಸದಸ್ಯರೊಂದಿಗೆ ಚರ್ಚಿಸಿ. ಅಧ್ಯಯನಕ್ಕೆ ಸಂಬಂಧಿಸಿದಂತೆ ನೀವು ಯಾವುದೇ ಪ್ರಶ್ನೆಯನ್ನು ಕೇಳಬಹುದು. ನೀವು ಅಧ್ಯಯನದಲ್ಲಿ ಭಾಗವಹಿಸಲು ಸಮ್ಮತಿಸಿದರೆ ನಾವು ನಿಮ್ಮಿಂದ ಅಥವಾ ನಿಮ್ಮಿಂದ ಅಥವಾ ಇಬ್ಬರಿಗೂ ಜವಾಬ್ದಾರರಾಗಿರುವ ವ್ಯಕ್ತಿಯಿಂದ (ಪ್ರೊಫಾರ್ಮಾ ಪ್ರಕಾರ) ಮಾಹಿತಿಯನ್ನು ಸಂಗ್ರಹಿಸುತ್ತೇವೆ. ಸಂಬಂಧಿತ ಇತಿಹಾಸವನ್ನು ತೆಗೆದುಕೊಳ್ಳಲಾಗುವುದು. ಸಂಗ್ರಹಿಸಿದ ಈ ಮಾಹಿತಿಯನ್ನು ಪ್ರಬಂಧ ಮತ್ತು ಪ್ರಕಟಣೆಗೆ ಮಾತ್ರ ಬಳಸಲಾಗುತ್ತದೆ.

ನಿಮ್ಮಿಂದ ಸಂಗ್ರಹಿಸಲಾದ ಎಲ್ಲಾ ಮಾಹಿತಿಯನ್ನು ಗೌಪ್ಯವಾಗಿ ಇರಿಸಲಾಗುತ್ತದೆ ಮತ್ತು ಯಾವುದೇ ಹೊರಗಿನವರಿಗೆ ಬಹಿರಂಗಪಡಿಸಲಾಗುವುದಿಲ್ಲ. ನಿಮ್ಮ ಗುರುತನ್ನು ಬಹಿರಂಗಪಡಿಸಲಾಗುವುದಿಲ್ಲ. ಈ ಅಧ್ಯಯನವನ್ನು ಸಾಂಸ್ಥಿಕ ನೀತಿಶಾಸ್ತ್ರ ಸಮಿತಿಯು ಪರಿಶೀಲಿಸಿದೆ ಮತ್ತು ನೀವು ಸಾಂಸ್ಥಿಕ ನೀತಿಶಾಸ್ತ್ರ ಸಮಿತಿಯ ಸದಸ್ಯರನ್ನು ಸಂಪರ್ಕಿಸಲು ಮುಕ್ತರಾಗಿದ್ದೀರಿ. ಈ ಅಧ್ಯಯನವನ್ನು ಒಪ್ಪಿಕೊಳ್ಳಲು ಯಾವುದೇ ಒತ್ತಾಯವಿಲ್ಲ. ನೀವು ಭಾಗವಹಿಸಲು ಬಯಸದಿದ್ದರೆ ನೀವು ಪಡೆಯುವ ಕಾಳಜಿಯು ಬದಲಾಗುವುದಿಲ್ಲ. ಈ ಅಧ್ಯಯನದಲ್ಲಿ ಭಾಗವಹಿಸಲು ನೀವು ಸ್ವಯಂಪ್ರೇರಣೆಯಿಂದ ಸಮ್ಮತಿಸಿದರೆ ಮಾತ್ರ ನೀವು ಸಹಿ/ಹೆಬ್ಬೆರಳಿನ ಗುರುತನ್ನು ಒದಗಿಸಬೇಕಾಗುತ್ತದೆ.

ಮೇಲಿನ ಕಾರ್ಯವಿಧಾನಕ್ಕಾಗಿ ರೋಗಿಗೆ ಅಂದಾಜು ಮಾಡಲಾದ ವೆಚ್ಚಗಳನ್ನು ಪ್ರಾಥಮಿಕ ತನಿಖಾಧಿಕಾರಿಯು ಭರಿಸುತ್ತಾನೆ.

ಗೌಪ್ಯತೆ

ನಿಮ್ಮ ವೈದ್ಯಕೀಯ ಮಾಹಿತಿಯನ್ನು ಅಧ್ಯಯನ ವೈದ್ಯರು ಮತ್ತು ಸಿಬ್ಬಂದಿ ಗೌಪ್ಯವಾಗಿಡುತ್ತಾರೆ ಮತ್ತು ಸಾರ್ವಜನಿಕವಾಗಿ ಲಭ್ಯವಾಗುವಂತೆ ಮಾಡಲಾಗುವುದಿಲ್ಲ. ನಿಮ್ಮ ಮೂಲ ದಾಖಲೆಗಳನ್ನು ನಿಮ್ಮ ವೈದ್ಯರು ಅಥವಾ ಎಥಿಕ್ಸ್ ರಿವ್ಯೂ ಬೋರ್ಡ್ ಪರಿಶೀಲಿಸಬಹುದು. ಹೆಚ್ಚಿನ ಮಾಹಿತಿ / ಸ್ಪಷ್ಟೀಕರಣಕ್ಕಾಗಿ ದಯವಿಟ್ಟು ಸಂಪರ್ಕಿಸಿ ಡಾ.ಮುತ್ತುಕುಮಾರ್ ಆರ್ (ಸ್ನಾತಕೋತ್ತರ ಪದವೀಧರರು),

ಆರ್ಥೋಪೆಡಿಕ್ಸ್ ವಿಭಾಗ,
ಎಸ್ ಡಿ ಯು ಎಂ ಸಿ, ಕೋಲಾರ ಸಂಪರ್ಕ ಸಂಖ್ಯೆ: 9442163924

## ANNEXURE 3

## PROFORMA

## SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH INSTITUTE,

**IP no:**

**TITLE:**

**"EVALUATION OF FUNCTIONAL AND RADIOLOGICAL OUTCOMES FOLLOWING BOTH BONE FRACTURE OF FOREARM FIXED WITH LOCKING COMPRESSION PLATE"**

**BASIC DATA**

NAME: I.P NO:

AGE: DATE OF ADMISSION:

SEX: DATE OF SURGERY:

DATE OF DISCHARGE:

ADDRESS:

PRESENTING COMPLAINTS:

HISTORY OF PRESENTING ILLNESS:

MODE OF INJURY

-MOTOR VEHICLE ACCIDENT

-MOTOR CYCLE ACCIDENT

-FALL FROM HEIGHT

-ASAULT

-OTHERS

MECHANISM OF INJURY

-DIRECT. -INDIRECT

ASSOCIATED INJURIES:

TREATMENT HISTORY:

PAST H/O INJURY / INJURIES:

**GENERAL EXAMINATION**

Built Cyanosis

Pallor Lymphadenopathy

Nourishment Icterus

VITALS: PR: BP: RR:- TEMP:

**SYSTEMIC EXAMINATION**

CVS:-

P/A:-

RS:-

CNS:-

**LOCAL EXAMINATION**

**A.INSPECTION**

-SIDE INVOLVED:RT/LT

-OVERLYING SKIN

-ATTITUDE OF LIMB

-DEFORMITY

-SWELLING

-SHORTENING

**B.PALPATION**

-TEMPERATURE

-TENDERNESS

-ABNORMAL MOBILITY

-CREPITUS

-BONY IRREGULARITY

-TRANSMITTED MOVEMENTS

-WOUND EXAMINATION

PRESENCE OF FOREIGN BODY

COLOUR OF MUSCLES

-DISTAL NVD

. MEASUREMENTS: RT. LT.

-LONGITUDINAL

D.MOVEMENTS

-ELBOW

-WRIST

ASSOCIATED INJURIES:

-SHOULDER

-ELBOW

-RADIUS

-ULNA

-OTHERS

NEUROLOGICL STATUS

VASCULAR STATUS

INVESTIGATIONS (PRE-OP ASSESSMENT)

RADIOLOGICAL INVESTIGATIONS:

X-RAY OF FOREARM – AP & LATERAL VIEW

CLINICAL DIAGNOSIS

| **FOLLOW UP** | **1 MONTH** | **3 MONTH** | **6 MONTH** |
|---|---|---|---|
| PAIN, SWELLING | | | |
| VAS SCORE | | | |
| DASH SCORE (SIGNS OF BONE UNION) | | | |
| RASMUSSEN SCORE (RADIOLOGICAL SCORE) | | | |
| COMPLICATIONS (IF ANY) | | | |

# DISABILITIES OF THE ARM, SHOULDER AND HAND

Please rate your ability to do the following activities in the last week by circling the number below the appropriate response.

| | 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 (e.g., 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 10 lbs). | 1 | 2 | 3 | 4 | 5 |
| 12. Change a lightbulb 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, etc.). | 1 | 2 | 3 | 4 | 5 |
| 18. Recreational activities in which you take 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 frisbee, 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 |

# DISABILITIES OF THE ARM, SHOULDER AND HAND

| | 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? *(circle number)* | 1 | 2 | 3 | 4 | 5 |

| | NOT LIMITED AT ALL | SLIGHTLY LIMITED | MODERATELY LIMITED | VERY LIMITED | UNABLE |
|---|---|---|---|---|---|
| 23. During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder or hand problem? *(circle number)* | 1 | 2 | 3 | 4 | 5 |

Please rate the severity of the following symptoms in the last week. *(circle number)*

| | NONE | MILD | MODERATE | SEVERE | EXTREME |
|---|---|---|---|---|---|
| 24. Arm, shoulder or hand pain. | 1 | 2 | 3 | 4 | 5 |
| 25. Arm, shoulder or hand pain when you performed 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? *(circle number)* | 1 | 2 | 3 | 4 | 5 |

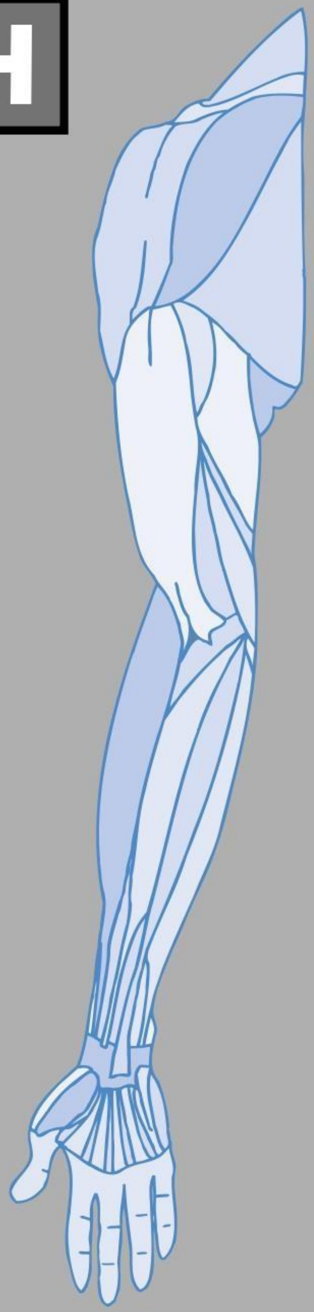
| | STRONGLY DISAGREE | DISAGREE | NEITHER AGREE NOR DISAGREE | AGREE | STRONGLY AGREE |
|---|---|---|---|---|---|
| 30. I feel less capable, less confident or less useful because of my arm, shoulder or hand problem. *(circle number)* | 1 | 2 | 3 | 4 | 5 |

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

**A DASH score may <u>not</u> be calculated if there are greater than 3 missing items.**

## Disabilities of the Arm, Shoulder and Hand

# THE DASH



### INSTRUCTIONS

This questionnaire asks about your symptoms as well as your ability to perform certain activities.

Please answer *every question*, based on your condition in the last week, by circling the appropriate number.

If you did not have the opportunity to perform an activity in the past week, please make your *best estimate* on which response would be the most accurate.

It doesn't matter which hand or arm you use to perform the activity; please answer based on your ability regardless of how you perform the task.

# DISABILITIES OF THE ARM, SHOULDER AND HAND

## WORK MODULE (OPTIONAL)

The following questions ask about the impact of your arm, shoulder or hand problem on your ability to work (including homemaking if that is your main work role).

Please indicate what your job/work is:______________________________

❒ I do not work. (You may skip this section.)

Please circle the number that best describes your physical ability in the past week. Did you have any difficulty:

| | NO DIFFICULTY | MILD DIFFICULTY | MODERATE DIFFICULTY | SEVERE DIFFICULTY | UNABLE |
|---|---|---|---|---|---|
| 1. using your usual technique for your work? | 1 | 2 | 3 | 4 | 5 |
| 2. doing your usual work because of arm, shoulder or hand pain? | 1 | 2 | 3 | 4 | 5 |
| 3. doing your work as well as you would like? | 1 | 2 | 3 | 4 | 5 |
| 4. spending your usual amount of time doing your work? | 1 | 2 | 3 | 4 | 5 |

## SPORTS/PERFORMING ARTS MODULE (OPTIONAL)

The following questions relate to the impact of your arm, shoulder or hand problem on playing *your musical instrument or sport or both*.
If you play more than one sport or instrument (or play both), please answer with respect to that activity which is most important to you.

Please indicate the sport or instrument which is most important to you:______________________________

❑ I do not play a sport or an instrument. (You may skip this section.)

Please circle the number that best describes your physical ability in the past week. Did you have any difficulty:

| | NO DIFFICULTY | MILD DIFFICULTY | MODERATE DIFFICULTY | SEVERE DIFFICULTY | UNABLE |
|---|---|---|---|---|---|
| 1. using your usual technique for playing your instrument or sport? | 1 | 2 | 3 | 4 | 5 |
| 2. playing your musical instrument or sport because of arm, shoulder or hand pain? | 1 | 2 | 3 | 4 | 5 |
| 3. playing your musical instrument or sport as well as you would like? | 1 | 2 | 3 | 4 | 5 |
| 4. spending your usual amount of time practising or playing your instrument or sport? | 1 | 2 | 3 | 4 | 5 |

**SCORING THE OPTIONAL MODULES:** Add up assigned values for each response; divide by 4 (number of items); subtract 1; multiply by 25.
**An optional module score may not be calculated if there are any missing items.**

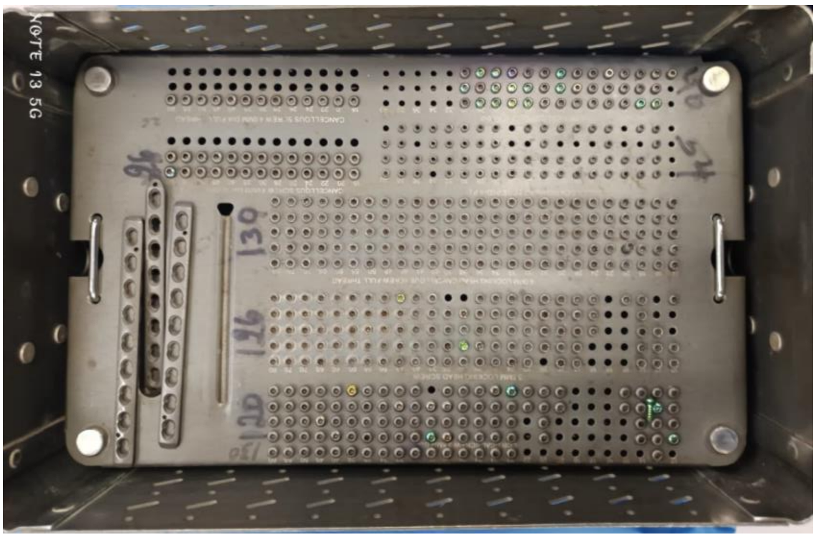
## RASMUSSEN RADIOLOGICAL SCORING SYSTEM

| Subjective | Points |
|---|---|
| A. Articular depression | |
| Not present | 6 |
| <5 mm | 4 |
| 6–10 mm | 2 |
| >10 mm | 0 |
| B. Condylar widening | |
| Not present | 6 |
| <5 mm | 4 |
| 6–10 mm | 2 |
| >10 mm | 0 |
| C. Angulation (valgus/varus) | |
| Not present | 6 |
| <10° | 4 |
| 10–20° | 2 |
| >20° | 0 |
| Maximum | 18 |
| Excellent | 18 |
| Good | 12–17 |
| Fair | 6–11 |
| Poor | <6 |

# ANNEXURE 3

## OPERATIVE PHOTOGRAPHS

### INSTRUMENTS

**SURGICAL PROCEDURE**


Image showing skin incision marking for radius through volar Henry's approach


Image showing Superficial dissection and muscle exposure

Image showing radius fracture reduction

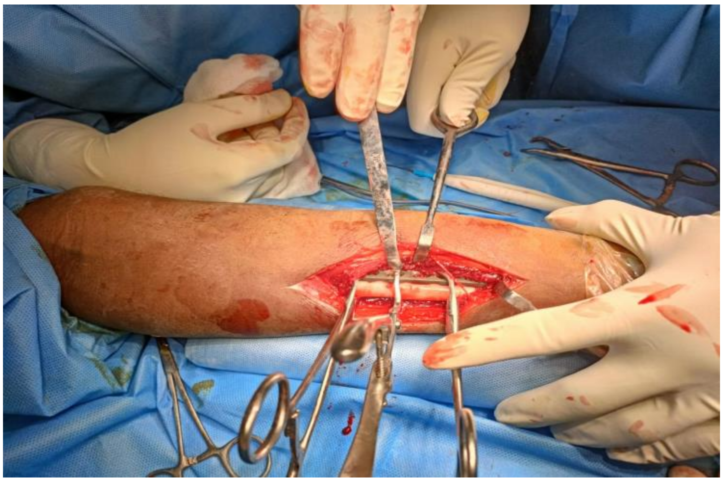


Image showing radius fracture reduction and plate fixation


Image showing Incision marking for ulna subcutaneous approach

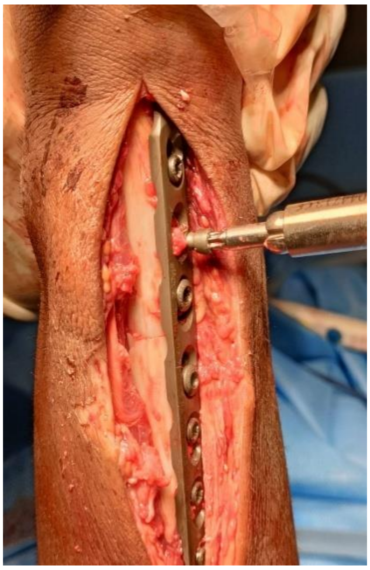


Image shwoing Fracture reduction and ulna plate fixation with lcp plates and screws



C arm images of radius and ulna fracture reduction and fixation with locking compression plates and screws

Scar images of ulna operated site

Scar images of radius operated site

CASE 1

PRE OP

POST OP

1 MONTH

3 MONTH

6 MONTH

CASE 12


PRE OP



POST OP



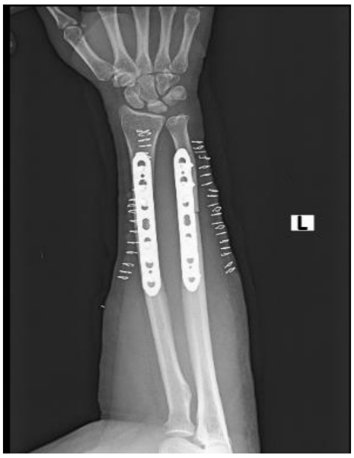
1 MONTH

3 MONTH

6 MONTH

CASE 26


PREOP


POST OP



3 MONTH


6 MONTH






# KEY TO MASTER CHART

| Abbreviation | Full Form |
|---|---|
| **#** | Fracture |
| **E** | Excellent |
| **RTA** | Road traffic accident |
| **VAS** | Visual analog scale (pain score) |
| **M** | Months |
| **R** | Right |
| **L** | Left |
| **Dash** | Disabilities of the Arm, Shoulder and Hand |
| **Prox /3** | Proximal third |
| **Mid/3** | Middle third |
| **Dist/3** | Distal third |
| **Trans** | Transverse |
| **Deg** | Degrees |
| **ROM** | Range of motion |

| | |
|---|---|
| **OTA** | Orthopaedic trauma association |
| **AO** | Association for the study of internal fixation<br>(arbeitsgemeinschaft für osteosynthesefragen) |

# ANNEXURE 4

# MASTER CHART

| Sl. No. | AGE AND SEX | OPEN / CLOSED | FRACTURE__SITE | TYPE_OF_FRACTURE | MECHANISM_OF_INJURY | SIDE AFFECTED | POST OP VAS/PAIN SCORE | | | POST OP DASH SCORE | | | POST OP ROM ELBOW | | | RADIOLOGICAL UNION | COMPLICATIONS | RASMUSSEN SCORE 24W | PRONATION RECOVERY | | | SUPINATION RECOVERY | | | POST OP WRIST ROM | | | DASH SCORE OUTCOME |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 1M | 3M | 6 M | 1 M | 3 M | 6 M | 1M | 3M | 6M | | | | 1M | 3M | 6M | 1M | 3M | 6M | 1M | 3M | 6M | |
| 1 | 21/M | OPEN TYPE 1 | DIST/3 | TRANS | Fall from Height | L | 7 | 1 | 2 | 69 | 20 | 1 | 81 | 93 | 154 | Yes | None | 16 | 68° | 85° | 92° | 70° | 88° | 95° | 42 | 76 | 109 | EXCELLENT |
| 2 | 29/M | CLOSED | MID/3 | OBLIQUE | Fall from Height | R | 7 | 3 | 1 | 42 | 17 | 20 | 82 | 91 | 141 | Yes | Delayed Union | 14 | 72° | 82° | 88° | 74° | 84° | 90° | 39 | 81 | 143 | GOOD |
| 3 | 43/M | OPEN TYPE 1 | DIST/3 | OBLIQUE | Motor Vehicle Accident | R | 9 | 7 | 4 | 50 | 45 | 29 | 116 | 130 | 139 | Yes | None | 16 | 65° | 78° | 85° | 62° | 80° | 88° | 43 | 91 | 136 | EXCELLENT |
| 4 | 36/M | OPEN TYPE 1 | PROX/3 | OBLIQUE | Other RTA | R | 3 | 6 | 3 | 49 | 47 | 0 | 67 | 102 | 156 | Yes | None | 16 | 70° | 83° | 89° | 68° | 85° | 91° | 48 | 95 | 132 | EXCELLENT |
| 5 | 45/M | OPEN TYPE 1 | DIST/3 | OBLIQUE | Fall from Height | R | 7 | 2 | 1 | 61 | 49 | 27 | 74 | 94 | 144 | Yes | None | 18 | 60° | 75° | 82° | 58° | 78° | 85° | 39 | 91 | 136 | EXCELLENT |
| 6 | 31/M | CLOSED | MID/3 | TRANS | Fall from Height | R | 1 | 5 | 3 | 54 | 29 | 14 | 103 | 107 | 149 | Yes | None | 16 | 75° | 88° | 94° | 77° | 90° | 96° | 39 | 89 | 115 | EXCELLENT |
| 7 | 24/M | OPEN TYPE 1 | PROX/3 | TRANS | Fall from Height | L | 4 | 7 | 2 | 26 | 44 | 0 | 107 | 113 | 135 | Yes | None | 16 | 62° | 80° | 86° | 65° | 82° | 89° | 48 | 88 | 133 | EXCELLENT |
| 8 | 30/F | OPEN TYPE 1 | MID/3 | OBLIQUE | Fall from Height | R | 4 | 7 | 2 | 79 | 34 | 4 | 116 | 81 | 142 | Yes | None | 18 | 58° | 76° | 84° | 60° | 78° | 87° | 44 | 80 | 139 | EXCELLENT |
| 9 | 58/M | OPEN TYPE 1 | MID/3 | COMMINUTED | Fall from Height | L | 5 | 7 | 0 | 35 | 44 | 27 | 95 | 111 | 159 | Yes | None | 16 | 70° | 84° | 90° | 72° | 86° | 93° | 38 | 85 | 150 | EXCELLENT |
| 10 | 49/F | CLOSED | DIST/3 | TRANS | Fall from Height | R | 7 | 0 | 4 | 45 | 34 | 28 | 73 | 102 | 151 | Yes | None | 16 | 64° | 81° | 87° | 66° | 83° | 90° | 43 | 87 | 130 | EXCELLENT |
| 11 | 47/F | OPEN TYPE 1 | MID/3 | COMMINUTED | Other RTA | L | 7 | 3 | 3 | 67 | 38 | 15 | 81 | 101 | 139 | Yes | Delayed Union | 13 | 67° | 83° | 89° | 69° | 85° | 92° | 38 | 97 | 127 | GOOD |
| 12 | 58/F | OPEN TYPE 1 | MID/3 | OBLIQUE | Other RTA | R | 4 | 0 | 1 | 76 | 27 | 18 | 96 | 130 | 138 | Yes | None | 17 | 72° | 86° | 93° | 74° | 88° | 95° | 38 | 92 | 130 | EXCELLENT |
| 13 | 57/F | CLOSED | PROX/3 | OBLIQUE | Fall from Height | R | 7 | 5 | 2 | 71 | 27 | 3 | 72 | 104 | 136 | Yes | None | 17 | 69° | 85° | 91° | 71° | 87° | 94° | 41 | 78 | 144 | EXCELLENT |
| 14 | 57/M | OPEN TYPE 1 | DIST/3 | OBLIQUE | Other RTA | L | 3 | 0 | 0 | 79 | 11 | 2 | 115 | 137 | 138 | Yes | None | 16 | 71° | 87° | 94° | 73° | 89° | 96° | 30 | 92 | 138 | EXCELLENT |
| 15 | 48/M | OPEN TYPE 1 | MID/3 | TRANS | Motor Vehicle Accident | L | 6 | 1 | 0 | 68 | 44 | 16 | 76 | 101 | 137 | Yes | None | 17 | 63° | 79° | 85° | 65° | 81° | 88° | 31 | 87 | 130 | EXCELLENT |
| 16 | 47/F | CLOSED | DIST/3 | COMMINUTED | Fall from Height | L | 2 | 3 | 3 | 21 | 25 | 16 | 51 | 137 | 135 | Yes | None | 18 | 66° | 82° | 88° | 68° | 84° | 91° | 37 | 85 | 140 | EXCELLENT |
| 17 | 45/F | OPEN TYPE 1 | MID/3 | COMMINUTED | Motor Vehicle Accident | R | 9 | 3 | 2 | 20 | 45 | 11 | 66 | 137 | 146 | Yes | None | 17 | 59° | 77° | 83° | 61° | 79° | 86° | 35 | 94 | 136 | EXCELLENT |

| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18 | 53/M | CLOSED | PROX/3 | TRANS | Motor Vehicle Accident | L | 5 | 5 | 4 | 67 | 42 | 27 | 82 | 101 | 135 | Yes | Delayed Union | 14 | 68° | 84° | 90° | 70° | 86° | 93° | 42 | 97 | 145 | GOOD |
| 19 | 44/M | OPEN TYPE 1 | PROX/3 | OBLIQUE | Fall from Height | R | 6 | 6 | 2 | 31 | 13 | 29 | 58 | 128 | 132 | Yes | Infection | 17 | 61° | 78° | 84° | 63° | 80° | 87° | 35 | 97 | 128 | EXCELLENT |
| 20 | 60/M | CLOSED | PROX /3 | TRANS | Other RTA | R | 4 | 1 | 3 | 24 | 42 | 28 | 92 | 131 | 138 | Yes | None | 16 | 73° | 89° | 95° | 75° | 91° | 97° | 33 | 84 | 132 | EXCELLENT |
| 21 | 56/M | CLOSED | DIST/3 | TRANS | Motor Vehicle Accident | L | 7 | 2 | 3 | 56 | 23 | 13 | 97 | 121 | 131 | Yes | None | 18 | 70° | 86° | 92° | 72° | 88° | 95° | 47 | 88 | 131 | EXCELLENT |
| 22 | 57/F | OPEN TYPE 1 | DIST/3 | TRANS | Fall from Height | L | 9 | 0 | 2 | 51 | 30 | 20 | 88 | 85 | 140 | Yes | None | 16 | 64° | 80° | 86° | 66° | 82° | 89° | 39 | 92 | 120 | EXCELLENT |
| 23 | 48/F | CLOSED | MID/3 | TRANS | Motor Vehicle Accident | R | 7 | 4 | 3 | 78 | 29 | 5 | 91 | 94 | 130 | Yes | None | 18 | 67° | 83° | 89° | 69° | 85° | 92° | 40 | 97 | 138 | EXCELLENT |
| 24 | 23/M | OPEN TYPE 1 | MID/3 | TRANS | Motor Vehicle Accident | R | 1 | 0 | 2 | 74 | 17 | 2 | 75 | 133 | 156 | Yes | Delayed Union | 14 | 71° | 87° | 93° | 73° | 89° | 96° | 33 | 87 | 138 | GOOD |
| 25 | 83/F | OPEN TYPE 1 | DIST/3 | OBLIQUE | Motor Vehicle Accident | L | 1 | 7 | 1 | 28 | 16 | 27 | 99 | 102 | 113 | No | Delayed union | 6 | 55° | 72° | 78° | 57° | 74° | 81° | 37 | 89 | 135 | Loss of 10 Deg Pronation |
| 26 | 57/F | OPEN TYPE 1 | DIST/3 | TRANS | Motor Vehicle Accident | L | 9 | 0 | 2 | 60 | 12 | 8 | 74 | 139 | 141 | Yes | None | 17 | 69° | 85° | 91° | 71° | 87° | 94° | 41 | 82 | 133 | EXCELLENT |
| 27 | 23/M | CLOSED | DIST/3 | TRANS | Other RTA | L | 9 | 2 | 2 | 54 | 26 | 4 | 73 | 116 | 157 | Yes | None | 16 | 74° | 90° | 96° | 76° | 92° | 98° | 34 | 82 | 121 | EXCELLENT |
| 28 | 37/F | OPEN TYPE 1 | MID/3 | COMMINUTED | Motor Vehicle Accident | R | 4 | 0 | 3 | 38 | 42 | 23 | 62 | 112 | 134 | Yes | Infection | 16 | 62° | 79° | 85° | 64° | 81° | 88° | 42 | 96 | 131 | EXCELLENT |
| 29 | 18/M | CLOSED | DIST/3 | TRANS | Motor Vehicle Accident | R | 9 | 1 | 3 | 67 | 21 | 28 | 109 | 87 | 149 | Yes | None | 18 | 76° | 92° | 98° | 78° | 94° | 100° | 37 | 99 | 132 | EXCELLENT |
| 30 | 18/M | CLOSED | MID/3 | COMMINUTED | Motor Vehicle Accident | R | 3 | 1 | 0 | 35 | 31 | 16 | 56 | 132 | 154 | Yes | None | 16 | 77° | 93° | 99° | 79° | 95° | 101° | 39 | 89 | 127 | EXCELLENT |
| 31 | 56/F | OPEN TYPE 1 | MID/3 | OBLIQUE | Other RTA | R | 7 | 3 | 0 | 22 | 31 | 13 | 106 | 139 | 130 | Yes | None | 17 | 63° | 80° | 86° | 65° | 82° | 89° | 37 | 97 | 133 | EXCELLENT |
| 32 | 66/F | CLOSED | MID/3 | TRANS | Motor Vehicle Accident | R | 6 | 5 | 1 | 39 | 39 | 20 | 85 | 123 | 135 | Yes | None | 18 | 66° | 82° | 88° | 68° | 84° | 91° | 49 | 93 | 139 | EXCELLENT |
| 33 | 60/M | CLOSED | MID/3 | TRANS | Motor Vehicle Accident | R | 8 | 6 | 0 | 43 | 47 | 2 | 94 | 123 | 148 | Yes | None | 18 | 72° | 88° | 94° | 74° | 90° | 96° | 40 | 85 | 150 | EXCELLENT |
| 34 | 54/M | OPEN TYPE 1 | DIST/3 | COMMINUTED | Other RTA | L | 9 | 4 | 2 | 73 | 47 | 27 | 69 | 84 | 124 | Yes | None | 17 | 60° | 76° | 82° | 62° | 78° | 85° | 35 | 93 | 137 | EXCELLENT |
| 35 | 42/F | CLOSED | MID/3 | COMMINUTED | Other RTA | R | 5 | 7 | 3 | 75 | 17 | 0 | 114 | 118 | 131 | Yes | None | 18 | 73° | 89° | 95° | 75° | 91° | 97° | 44 | 101 | 138 | EXCELLENT |
| 36 | 68/M | CLOSED | DIST/3 | OBLIQUE | Other RTA | R | 1 | 0 | 0 | 52 | 36 | 19 | 57 | 83 | 138 | Yes | Delayed Union | 15 | 58° | 75° | 81° | 60° | 77° | 84° | 34 | 90 | 134 | GOOD |
| 37 | 61/F | OPEN TYPE 1 | PROX/3 | OBLIQUE | Motor Vehicle Accident | R | 3 | 0 | 0 | 43 | 36 | 28 | 65 | 85 | 122 | Yes | None | 18 | 65° | 81° | 87° | 67° | 83° | 90° | 41 | 101 | 116 | EXCELLENT |