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TOPIC: "A PROSPECTIVE STUDY ON FUNCTIONAL AND RADIOLOGICAL OUTCOME OF SURGICAL MANAGEMENT OF DISTAL END HUMERUS FRACTURE WITH DUAL PLATING TECHNIQUES."

"A PROSPECTIVE STUDY ON FUNCTIONAL AND RADIOLOGICAL OUTCOME OF SURGICAL MANAGEMENT OF DISTAL END HUMERUS FRACTURE WITH DUAL PLATING TECHNIQUES."

DISSERTATION SUBMITTED FOR THE DEGREE OF M.S. (ORTHOPAEDICS) EXAMINATION

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ABBREVIATIONS

BMI	Body Mass Index
COPD	Chronic Obstructive Pulmonary Diseases
HTN	Hypertension
IEC	Information Education Communication
WHO	World Health Organization
DM	Diabetes Mellitus
NPV	Negative Predictive Value
CI	Confidence Interval
PPV	Positive Predictive Value
FPG	Fasting Plasma Glucose
NS	Non-Significant
ROM	Range of Motion
ASA	American Society of Anaesthesiologists

INTRODUCTION

INTRODUCTION

In India, distal end humerus fractures represent a relatively small but significant subset of orthopaedic injuries. These fractures account for approximately 2–6% of all fractures and comprise nearly one-third of all humeral fractures. Among these, intra-articular distal humerus fractures are particularly rare, constituting only about 0.5% of all fractures. Despite their low overall incidence, these injuries pose considerable challenges due to the complex anatomy of the elbow joint and the functional demands of the upper limb. They are most seen in bimodal age groups—young individuals following high-energy trauma and elderly patients due to low-energy falls associated with osteoporosis. Increasing urbanization, road traffic accidents, and a growing elderly population have contributed to the rising incidence and clinical relevance of these fractures in India. [1,2]

In 2008, humerus fractures were responsible for approximately 370,000 emergency department (ED) visits in the United States, highlighting their significant burden on the healthcare system. Among these, proximal humerus fractures were the most prevalent, constituting about 50% of all humeral fractures. Notably, the incidence of proximal humerus fractures increased exponentially with age—particularly in women between 40–84 years (R^2 = 97.9%) and in men between 60–89 years (R^2 = 98.2%). This steep rise with advancing age is likely linked to osteoporosis and increased fall risk among the elderly population. However, after this exponential growth phase, the incidence began to plateau and eventually declined. In contrast, distal humerus fractures showed a bimodal distribution, with the highest occurrence seen in children aged 5–9 years, typically due to high activity levels and falls. Nonetheless, a secondary rise in incidence was noted in elderly women, reflecting age-related fragility and increased susceptibility to low-energy trauma. With the aging of the baby boomer generation, it is projected that by 2030, over 490,000 ED visits could be attributed to humerus fractures, unless substantial improvements are made in fracture prevention and bone health management strategies for at-risk populations.

The etiology of distal end humerus fractures reflects a clear bimodal pattern, influenced by age-related activity levels and bone quality. In young adults, these fractures are predominantly caused by high-energy trauma such as motor vehicle accidents and sideswipe injuries, often resulting in complex fracture patterns. Conversely, in the elderly population, the increasing incidence is largely attributed to low-energy mechanisms like simple falls, compounded by osteoporosis and reduced bone density. Despite advances in modern orthopaedics, managing distal humeral fractures remains challenging due to several factors, including frequent intra-articular involvement, metaphyseal comminution, bone loss, and osteopenia. These challenges, coupled with the intricate three-dimensional anatomy of the distal humerus, often complicate internal fixation. [3,4,5]

Historical fixation techniques have shown poor outcomes such as joint contractures, non-union, and high failure rates, especially when prolonged immobilization was employed. Achieving a stable, painless, and functional elbow now requires a more systematic and biomechanically sound approach, particularly through open reduction and internal fixation strategies tailored to the complexity of these injuries. [6,7,8]

The treatment of distal end humerus fractures remains a subject of debate, with no universally accepted approach due to the complexity of the injury and the diversity of fracture patterns. Conservative management, though less invasive, is associated with a high risk of functional impairment and deformity, making it less favourable in most cases. Studies have shown poor outcomes with non-operative treatment, particularly in displaced or intra-articular fractures. In contrast, surgical intervention, particularly open reduction and internal fixation (ORIF), is widely advocated to restore joint congruity and allow for early mobilization. [9,10,11]

The elbow joint demands precise anatomical alignment, absolute stability, and early range-of-motion exercises to prevent complications such as stiffness, contractures, and long-term functional limitations. As such, treatment strategies must focus on achieving stable fixation that permits early rehabilitation, which is critical for optimizing outcomes in distal humeral fractures. [12,13,14]

Open reduction and internal fixation (ORIF) using plates and screws is currently the most widely recommended approach for managing distal humeral fractures. This method allows for precise restoration of the anatomical alignment of fracture fragments and facilitates early postoperative range of motion (ROM) exercises, which are critical for regaining elbow function. Over the years, multiple internal fixation techniques have been developed to optimize stability and anatomical restoration. Among these, the placement of two plates has become the preferred method, as it offers sufficient mechanical support to maintain the alignment and promote healing. However, there is ongoing debate in the literature regarding the optimal configuration of these plates, particularly concerning their positioning on the distal humerus to achieve the best functional and structural outcomes. [15,16]

The AO/ASIF group has provided widely accepted guidelines for distal humerus fixation, recommending the use of two plates placed at 90° to each other—commonly referred to as orthogonal or 90°/90° plating. This configuration aims to offer enhanced rotational and axial stability, especially in comminated fractures. Despite its biomechanical rationale, clinical outcomes have shown limitations. Several studies have reported that even with 90°/90° plating, unsatisfactory results were observed in 20% to 25% of patients, particularly due to implant failure when early mobilization was attempted. These findings underscore the challenges in balancing the need for rigid fixation with the goal of initiating early joint movement, highlighting the need for further refinement in surgical techniques and implant design. [17,18]

In response to the persistent challenges and limitations associated with traditional fixation methods, the concept of parallel plating (180°) emerged as a more secure and biomechanically favorable technique for distal humerus fracture fixation. This approach involves placing one plate along the medial column and another along the lateral column of the distal humerus, with the screws in the distal fragment interdigitating to restore the natural "tie-beam arch" structure of the distal humerus. This configuration is designed to provide greater stability, particularly in cases involving comminution or osteoporotic bone. Several biomechanical studies have demonstrated the clear superiority of parallel plating over the traditional orthogonal (90°/90°) method in terms of construct rigidity and resistance to failure under stress.

Despite this promising evidence from laboratory settings, there remains a relative paucity of clinical studies evaluating the functional outcomes of parallel plating in real-world surgical practice. As such, further clinical research is warranted to establish its long-term efficacy and to validate its biomechanical advantages in diverse patient populations. [19,20]

Conducting a dissertation on the functional and radiological outcomes of surgical management of distal end humerus fractures using dual plating techniques holds significant value for surgeons. These fractures pose complex challenges due to their anatomical intricacy, frequent intra-articular involvement, and the need for stable fixation to allow early mobilization. With evolving surgical techniques such as orthogonal and parallel dual plating, it becomes crucial to evaluate their effectiveness not just biomechanically, but also in terms of patient-centric outcomes like range of motion, pain relief, and return to function. A prospective study enables systematic assessment of these parameters, providing high-quality clinical data that can guide surgical decision-making, especially in tailoring fixation strategies based on fracture pattern and patient factors.

A dissertation fosters critical thinking and evidence-based practice among budding orthopaedic surgeons. It offers an opportunity to contribute to the existing body of literature, especially considering the limited clinical data on newer plating configurations like parallel plating in the Indian population. By correlating functional results with radiological healing and implant stability, this research can help identify predictors of successful outcomes and potential complications. Ultimately, this dissertation not only enhances the resident's research aptitude but also has the potential to influence clinical protocols, improve patient care, and pave the way for future innovations in fracture management.

REVIEW

OF

LITERATURE

REVIEW OF LITERATURE

Begad H.M.Z. Abdelrazek et al. (2025) explored the use of double plating as an augmentation to the standard proximal humeral internal locking system (PHILOS) in the treatment of comminuted proximal humerus fractures with diaphyseal extension. While PHILOS plating has gained wide acceptance for managing osteoporotic proximal humeral fractures, its limitations in complex or extended fractures have led surgeons to consider additional fixation strategies. Drawing from the success of double plating in other peri-articular fractures, this study aimed to assess the safety and effectiveness of adding a second plate—either a small locked dynamic compression plate or a small, locked reconstruction plate—through a trans-deltoid approach in conjunction with the PHILOS plate.

The study included 17 patients treated at El-Hadra University Hospital between January 2019 and July 2022. The average patient age was 58.4 years, with the majority being female (70.6%). The mean follow-up duration was 19.4 months. All patients achieved radiographic union without the need for secondary interventions such as bone grafting, with a mean time to union of 6.7 months. Functional outcomes were promising, with an average forward flexion of 165.4°, abduction of 166.2°, and a mean Constant–Murley score of 88.1. Subjective satisfaction was also high, as reflected in a visual analogue score of 8.2. Other scoring metrics, including the Simple Shoulder Score (77.9%) and UCLA shoulder rating (mean 31), further confirmed positive clinical outcomes. Radiographic evaluation showed that the neck-shaft angle remained stable from postoperative measurement to final follow-up, with no statistically significant change ($p = 0.7$).

Importantly, no new neurological injuries were observed postoperatively. One patient with preoperative radial nerve palsy recovered by 6.5 months, while another with preoperative axillary nerve palsy recovered within 2 months. These findings indicate that the double plating technique is both effective and safe, posing no additional risk to peripheral nerve function, humeral head vascularity, or shoulder impingement. In conclusion, the study supports the use of double plating as a viable surgical option for managing complex proximal humeral fractures with diaphyseal extension, offering secure fixation and favourable functional outcomes without increasing complications. [21]

William West et al. (2024) investigated the outcomes of surgical treatment in patients with impending or complete pathologic fractures of the distal humerus, a rare but serious complication of metastatic cancer. The primary goal of such treatment is to restore function and reduce pain promptly. While plate and screw fixation (PSF) is commonly employed in these cases, the optimal approach—whether single or dual plating—remains unclear due to a lack of established guidelines in the context of metastatic bone disease. Although dual PSF may offer increased stability and reduce the need for reoperation in the presence of tumor progression, single PSF remains more frequently utilized in clinical practice.

The retrospective study reviewed 35 patients treated between March 2008 and September 2021 for distal humerus lesions caused by metastasis or multiple myeloma. Postoperative complications such as infection, nonunion, deep vein thrombosis, tumor progression, and radial nerve palsy were recorded, along with the rate of reoperations. Statistical analysis using the Mann-Whitney U test, Pearson's chi-squared, and Fisher's exact test was conducted to compare outcomes between the single and dual PSF groups. Results revealed no statistically significant difference in revision rates ($p = 0.259$), although 14.3% of patients in the single PSF group required reoperation, compared to none in the dual PSF group. While not statistically significant, a trend toward fewer postoperative complications was noted in the dual PSF group (odds ratio 0.42; $p = 0.431$). However, single PSF had a significantly shorter operative time ($p < 0.001$).

In conclusion, the study suggests that dual PSF is at least as effective as single PSF and may reduce the likelihood of complications and reoperations in patients with distal humerus pathologic fractures. Despite the benefit of shorter surgical duration with single PSF, dual fixation may provide better long-term stability in oncologic cases. The authors noted that the rarity of these lesions limited the study's sample size, indicating a need for further research with larger cohorts to validate these findings and guide treatment strategies. [22]

Y. Shimamoto et al. (2025) conducted a retrospective multicenter study to address the ongoing debate regarding the optimal surgical approach for plating distal-third humeral shaft fractures (HSFs). The study aimed to compare the clinical outcomes and complication rates, particularly iatrogenic radial nerve palsy, between anterior and posterior plating techniques. From a multicenter trauma database, 116 patients diagnosed with distal-third HSFs and treated surgically between 2011 and 2020 were initially identified. Among these, 50 cases met the inclusion criteria and were analyzed further: 20 patients received open reduction and internal fixation (ORIF) with anterior plating (Group A), while 30 patients underwent ORIF with posterior plating (Group P).

The clinical comparison revealed no significant differences between the two groups in terms of operative time, estimated intraoperative blood loss, and both clinical and radiographic outcomes. However, a notable difference was observed in the incidence of postoperative radial nerve palsy, which occurred exclusively in the posterior plating group (4 cases) and was absent in the anterior plating group. This finding highlights a potential advantage of the anterior approach in preserving nerve integrity during surgical management of distal-third HSFs.

Based on the results, the study concluded that the anterior plating technique is both a safe and effective surgical option for the treatment of distal-third humeral shaft fractures. It offers comparable functional and radiological outcomes to posterior plating while significantly reducing the risk of iatrogenic radial nerve injury. The authors suggest that the anterior approach may be preferable in clinical practice, particularly in cases where nerve protection is a priority. [23]

Sami Bahroun et al. (2024) conducted a retrospective comparative study to evaluate and compare the clinical and radiographic outcomes of intercondylar humerus fractures managed with either orthogonal or parallel plating techniques using precontoured plates. The study included 50 adult patients treated surgically over an eleven-year period. Participants were categorized into two groups: Group A received internal fixation through parallel plating, while Group B underwent orthogonal plating. The Mayo Elbow Performance Score (MEPS) was used to assess clinical outcomes, and radiographic evaluations included parameters such as time to bone consolidation, presence of pseudoarthrosis, malunion, and the need for hardware removal.

Both groups showed similar demographic profiles and preoperative characteristics, indicating a balanced comparison. Functional assessment through MEPS revealed no statistically significant differences in clinical outcomes between the two plating methods. Additionally, radiographic analysis demonstrated that healing times and complication rates—such as pseudoarthrosis, malunion, and hardware removal—were also comparable across both groups. These findings highlight that both approaches offer effective treatment with similar prognostic results in the management of intercondylar humerus fractures.

The study concludes that orthogonal and parallel plating techniques are equally viable options for treating intercondylar fractures of the humerus. Given the absence of significant differences in both clinical and radiological outcomes, the choice between these methods may be guided by surgeon preference, intraoperative considerations, or specific fracture characteristics. However, the authors emphasize the need for further prospective studies to determine if particular fracture patterns or patient factors may benefit more distinctly from one technique over the other. [24]

Pankaj Sharma et al. (2025) conducted a retrospective study to assess the functional outcomes of intra-articular distal humerus fractures treated with orthogonal plating, either with or without olecranon osteotomy. The evaluation of surgical outcomes was based on the Mayo Elbow Performance Score (MEPS), range of motion, and the incidence of postoperative complications. The study included 34 cases classified as AO type C fractures, managed over a period of 2 years and 6 months, from May 2021 to September 2023. All patients underwent follow-up assessments every three months for one year postoperatively.

The study population had a mean age of 42.2 years (±14.83), with ages ranging from 22 to 76 years. The mean MEPS recorded was 82.06 (±10.66), indicating favorable outcomes. Based on MEPS classification, 85.3% of the patients achieved excellent to good results, while 8.8% showed fair and 5.9% had poor outcomes. Complications were observed in 17.65% of cases, including superficial and soft-tissue infections, transient ulnar nerve neuropathy, and elbow stiffness. The mean flexion achieved postoperatively was 117.2 degrees, demonstrating good functional restoration.

The findings suggest that orthogonal plating is an effective and reliable method for treating intra-articular distal humerus fractures, yielding satisfactory functional recovery with manageable complication rates. The necessity for olecranon osteotomy was determined intraoperatively to enhance joint visualization, and its presence did not significantly affect outcomes. Moreover, the study found no notable differences in recovery based on fracture laterality or patient gender. These results support the use of orthogonal plating as a standard surgical approach across various patient demographics and fracture patterns. [25]

Hsin-Hsin Lee et al. (2025) conducted a retrospective study to compare the outcomes of single versus dual plating techniques in the management of scapular body fractures. Displaced or malunited scapular fractures are known to cause glenohumeral discomfort and functional impairment. The study included 28 patients, with 16 undergoing single plating and 12 undergoing dual plating. The average age of the participants was 44.9 years, and follow-up durations were approximately 14 months for the single plating group and 13.8 months for the dual plating group. Outcomes were evaluated using the Disabilities of the Arm, Shoulder and Hand (DASH) score, Visual Analog Scale (VAS) for pain, active range of motion (aROM), and time to return to work. Functional assessments were analyzed at various time points using two-way ANOVA with Šidák's multiple comparisons test, and return-to-work data were assessed via survival analysis with a log-rank test.

The results indicated significantly better short-term functional and pain outcomes in the dual plating group. At 2 and 4 weeks, DASH scores were notably lower in the dual plating group (indicating less disability), and these differences remained statistically significant up to 3 months. Similarly, VAS scores were lower in the dual plating group at 2 weeks (2.33 ± 0.88 vs. 4.00 ± 1.21, $p = 0.002$) and 4 weeks (1.17 ± 0.94 vs. 2.50 ± 1.03, $p = 0.008$), suggesting quicker pain resolution. However, by 6 months and 1 year, pain and functional differences were no longer statistically significant, except for external rotation at 1 year, which remained better in the dual plating group ($73 \pm 3°$ vs. $63 \pm 5°$, $p = 0.032$). No differences were observed in abduction, internal rotation, or forward flexion.

Importantly, patients treated with dual plating returned to work earlier than those treated with single plating (Hazard Ratio = 3.346, 95% CI: 1.208 to 9.269, $p = 0.020$), emphasizing a potential advantage in recovery time. The study concluded that dual plating may offer superior early pain relief, functional recovery, and external rotational outcomes in patients with scapular body fractures. These findings support the consideration of dual plating as a preferred surgical option in selected cases, although the authors recommend further validation through prospective randomized controlled trials. [26]

B. Sharma et al. (2023) addressed the increasing incidence and treatment challenges of extra-articular distal humerus fractures, which constitute approximately 16% of all humeral fractures and about 3% of total adult fractures. These fractures show a bimodal age and gender distribution, with a higher prevalence in younger males (12–30 years) and older females (60 years and above). The complexity of these injuries arises from their anatomical location near the joint, the small size of distal bone fragments, and poor bone quality in elderly patients. Despite technological advancements in orthopedic surgery, these fractures remain difficult to manage. The study aimed to evaluate the outcomes of using a posterolateral locking compression plate in treating extra-articular distal humerus fractures.

The prospective hospital-based study was conducted from September 2021 to May 2023 and involved patients selected from emergency and outpatient departments. Of the 35 patients who underwent surgical treatment, 30 were included in the final analysis. Clinical parameters such as demographics, type of fracture (AO classification), and preoperative radial nerve status were recorded. Radiological follow-up was performed at intervals of at least six weeks to assess healing, loss of reduction, and alignment. Functional recovery was evaluated using the Mayo Elbow Performance Score six months postoperatively. The most common deformities observed radiologically were varus misalignments and apex posterior angulations, though these were not clinically significant. While surgical fixation restored alignment and facilitated early functional return, complications such as non-union, radial nerve palsy, infection, and hardware-related symptoms were noted.

In conclusion, the study highlighted that treating extra-articular distal humerus fractures with standard posterior plating often risks impingement on the olecranon fossa and inadequate distal fixation. However, the use of a posterolateral locking compression plate effectively addressed this issue by allowing secure fixation, particularly with the placement of up to five locking screws into the distal fragment. Of the 30 patients who completed follow-up, only two required revision surgery with bone grafting. The findings suggest that the posterolateral plating technique offers a reliable alternative with promising functional and radiological outcomes in the management of these complex fractures. [27]

Youyou Ye et al. (2023) conducted a retrospective study to evaluate the clinical and radiographic outcomes of a modified medial minimally invasive plate osteosynthesis (MIPO) technique using a double plating approach for treating distal third diaphyseal fractures of the humerus. The surgical management of these fractures remains controversial, particularly regarding the optimal plate placement and surgical approach. The study included 30 patients treated between January 2017 and October 2022 using the modified medial approach with dual plates. Parameters such as patient demographics, operative time, blood loss, fracture length (FL), distal cortical length (DCL), and number of screws in the distal fragment were recorded. Functional outcomes were assessed using Neer's scoring system for the shoulder and Mayo's scoring system for the elbow.

The findings showed that the mean fracture length was 56.1 ± 7.2 mm, and the mean distal cortical length was 38.3 ± 5.3 mm. The mean operative time was 84.8 ± 13.4 minutes, with a mean intraoperative blood loss of 46.5 ± 10.2 ml. All fractures achieved radiological union within 10 to 16 weeks (mean 12.1 ± 1.7 weeks), indicating effective healing. Only one patient experienced delayed surgical wound healing, and no cases of iatrogenic radial or ulnar nerve injuries were reported. These results highlight the safety and efficiency of the technique in terms of both healing and complication profile.

Functionally, all patients regained good shoulder and elbow motion. The elbow flexion ranged from 130° to 145° (average 138.1 ± 4.8°), and extension lag ranged from 0° to 5° (average 2.2 ± 1.3°). The average Mayo elbow score was 91.4 ± 5.0, while the average Neer shoulder score was 92.5 ± 3.9, reflecting excellent outcomes. The combination of anterior and medial plating, applied perpendicular to the distal humerus, provided superior biomechanical stability without compromising neurovascular structures. Overall, the modified medial MIPO with double plating was shown to be a safe and effective method for achieving stable fixation and excellent joint function in distal third humeral diaphyseal fractures. [28]

H. Raithatha et al. (2023) conducted a prospective study to assess the effectiveness of dual plating in the management of proximal humerus fractures. Proximal humerus fractures constitute around 4–5% of all fractures and approximately 45% of all humeral fractures. While most stable or minimally displaced fractures can be treated non-operatively with favorable outcomes, displaced or unstable patterns often require surgical intervention. Conservative approaches in complex fractures frequently result in complications such as shoulder stiffness and malunion. In particular, comminuted fractures treated with only the proximal humeral internal locking system (PHILOS) tend to face issues like varus collapse, screw cutout, and nonunion, prompting the need for dual plating to enhance fixation stability.

The study was carried out at Dr. D. Y. Patil Medical College and Hospital, Pune, following approval from the Institutional Ethics Committee. A total of 52 patients with proximal humerus fractures were included. The cohort had a mean age of 53.7 years and consisted of 33 males and 19 females. Road traffic accidents (76.9%) were the most common cause, followed by falls. Fractures were classified using the Neer's classification: type 2 (23.1%), type 3 (46.2%), and type 4 (30.7%). Patients were treated with dual plating—PHILOS combined with an additional plate. Functional outcomes were assessed using the DASH score, which showed significant improvement over time: from a mean of 58.88 at baseline to 36.23 at three months, and 31.85 at six months. Radiologically, outcomes were graded using the Paavolainen method, with good results in 76.9% of cases.

The findings demonstrated satisfactory clinical and radiological outcomes with the dual plating technique. The addition of a second plate was effective in preventing varus displacement of the proximal fragment, a common complication with isolated PHILOS usage. Minimal complications were noted—varus collapse in two patients and screw protrusion in one—highlighting the overall safety of the procedure. The study supports the use of dual plating as a reliable surgical option for achieving stable fixation and favorable functional recovery in patients with complex proximal humerus fractures. [29]

Philipp A. Michel et al. (2023) conducted a retrospective study to evaluate the clinical and radiological outcomes, along with associated complications, of double plating in the treatment of proximal humeral fractures (PHF). The study involved 35 patients with unilateral PHF treated between 2013 and 2019, with a mean age of 59.5 ± 12 years. Most fractures were varus dislocations (Resch type IV, 55.3%), and 22.9% included a head-split component. The primary outcome measure was the neck-shaft angle (NSA), which remained stable from the intraoperative period to the radiological follow-up (131.5 ± 6.9° vs. 136.6 ± 13.7°; p = 0.267), indicating maintained alignment over time.

Clinical outcomes were assessed at a mean follow-up of 29.5 ± 15.3 months. Functional results were promising, with a mean Constant score of 78.5 ± 17, simple shoulder test (SST) score of 9.3 ± 3.2, and subjective shoulder value (SSV) of 78.8 ± 19.5%. These scores suggest favorable recovery in terms of shoulder strength, mobility, and patient satisfaction. Despite the complexity of the fractures treated, these results demonstrate that double plating provides stable fixation and satisfactory shoulder function during mid-term follow-up.

The overall complication rate reported was 31.4%, but this dropped to 14.3% when excluding cases of postoperative stiffness. Notably, avascular necrosis occurred in two patients (5.7%). These findings suggest that while complications are not negligible, they are within the expected range reported in literature for complex PHFs. The authors concluded that double plating is a feasible and effective treatment option for complex proximal humeral fractures, particularly in younger patients, offering a promising alternative to fracture arthroplasty. [30]

Efstratios D. Athanaselis et al (2022) conducted a retrospective cohort study to assess the effectiveness of current operative strategies for treating type C distal humeral fractures, as classified by the AO system. These complex intra-articular fractures pose a significant surgical challenge, and the study focused on evaluating clinical outcomes following operative fixation. The investigation aimed to provide insight into the long-term efficacy and complications associated with the use of parallel-plate fixation after open reduction via the posterior approach and olecranon osteotomy.

The study included 37 patients treated operatively between January 2002 and September 2016, of whom 32 met the inclusion criteria for analysis. All patients underwent open reduction using the posterior approach with olecranon osteotomy, followed by internal fixation with parallel plating of the medial and lateral columns of the distal humerus. Outcome measures included fracture healing, restoration of normal anatomical alignment, functional scores, and postoperative complications such as infection, ulnar neuropathy, heterotopic ossification, and the need for implant removal. Anatomical restoration was evaluated by measuring carrying angle, posterior angulation, and intercondylar width.

At a mean follow-up duration of 8.7 years, fracture union was achieved in 29 patients (90.6%) within a mean period of 8 weeks. Despite this, malunion of varying degrees was observed in nine patients (28.1%). There was one reported case each of postoperative ulnar neuropathy and deep infection. Functional outcomes were measured using standardized scoring systems, with the mean Disabilities of the Arm, Shoulder and Hand (DASH) score reported as 20 and the mean Mayo Elbow Performance Score (MEPS) as 83.3, reflecting a generally favorable functional recovery.

The authors concluded that successful treatment of complex type C distal humerus fractures hinges on accurate anatomic reconstruction of the articular segment and stable fixation using parallel plating of the two columns. The posterior surgical approach combined with olecranon osteotomy offers good visualization and access, contributing to high union rates and acceptable long-term elbow function. Despite a minor incidence of complications and malunions, the overall results support the use of this method as a reliable surgical option in managing such difficult fractures. [31]

Philipp A. Michel et al (2022) conducted a retrospective study to evaluate the clinical and radiological outcomes of double plating in the treatment of proximal humeral fractures (PHF). Double plating has been proposed as a method to improve primary fixation stability in these complex fractures, but clinical evidence regarding its effectiveness and complication profile remains limited. The study analyzed 35 patients with unilateral PHF treated using this technique between 2013 and 2019. The average age of patients was 59.5 ± 12 years, and the most common fracture type was varus dislocation (Resch type IV), accounting for 55.3% of the cases. Additionally, 22.9% of the patients presented with a head-split fracture.

The primary outcome measure was the neck-shaft angle (NSA), used to assess radiological alignment. Radiological follow-up averaged 21 ± 16.6 months, and no significant difference was found between intraoperative and follow-up NSA measurements (131.5 ± 6.9° vs. 136.6 ± 13.7°; $p = 0.267$), indicating maintained anatomical reduction. Clinical outcomes were evaluated at an average follow-up of 29.5 ± 15.3 months. Functional results were favorable, with a mean Constant-Murley Score of 78.5 ± 17 points, a Simple Shoulder Test (SST) score of 9.3 ± 3.2, and a Subjective Shoulder Value (SSV) of 78.8 ± 19.5%.

Complications were observed in 31.4% of cases, though when excluding shoulder stiffness, the rate decreased to 14.3%. Avascular necrosis of the humeral head occurred in two patients (5.7%). Despite these complications, the outcomes were largely positive in terms of radiographic alignment and shoulder function, suggesting that double plating offers reliable structural support in complex proximal humerus fractures.

In conclusion, the study demonstrated that double plating in PHF results in good functional and radiological outcomes with a complication rate comparable to existing treatment modalities. The technique provides a stable alternative to fracture arthroplasty, particularly in younger patients with complex fracture patterns. These findings support double plating as a valuable option in the orthopedic surgeon's armamentarium for managing difficult proximal humeral fractures. [32]

Jui-Ting Mao et al (2022) conducted a study to compare the radiological and functional outcomes of distal-third humeral fractures resulting from arm wrestling, treated with either single or double plating. Arm wrestling, although popular among young adults, can lead to fractures that significantly affect work and productivity. The goal of this study was to determine which surgical method facilitates faster recovery and return to normal activity, thereby reducing the socioeconomic impact on this typically working-age population.

The study retrospectively reviewed 34 patients treated for distal-third humeral fractures between January 2015 and January 2021. Patients were divided into two groups: those who received single plating and those who underwent double plating, with all surgeries performed using a triceps-sparing approach. Clinical follow-ups were carried out regularly to assess bone union, elbow range of motion, complications, and functional outcomes using the American Shoulder and Elbow Surgeons (ASES) score.

Both groups achieved similar outcomes in terms of bone union rate, time to union, and elbow range of motion. However, the single plating group consistently demonstrated better pain relief and superior early functional outcomes. At 2 weeks postoperatively, the ASES score was significantly higher in the single plating group (84.50 ± 5.01) compared to the double plating group (61.70 ± 12.53), with similar trends at 1 month (96.20 ± 2.63 vs. 84.25 ± 14.56) and 3 months (100.00 vs. 94.76 ± 9.71). By 1 year, the scores in both groups were comparable (100.00 vs. 98.54 ± 3.99), indicating similar long-term outcomes.

The study concluded that single plating is a viable and effective treatment option for distal-third humeral fractures due to arm wrestling. It offers comparable healing and joint function to double plating but with significantly fewer complications (5.56% vs. 18.75%), shorter surgical time, reduced blood loss, and faster functional recovery in the early postoperative period. These findings support single plating as a preferred approach, especially in young, active individuals requiring a swift return to daily activities. [33]

Mara Warnhoff et al (2021) conducted a study to address the ongoing challenge of achieving stable fixation in highly unstable proximal humerus fractures, where complication rates—particularly secondary varus dislocation—remain high. To improve outcomes in these complex fractures, the authors evaluated a double plate osteosynthesis technique, a method already established in the treatment of other types of fractures. Their surgical approach involved the use of an angular stable lateral plate in conjunction with a one-third tubular plate placed anteriorly at the lesser tuberosity, aiming to enhance stability in the management of unstable proximal humeral fractures.

The study was retrospective in nature and included patients who underwent the double plate fixation technique between January 2014 and December 2017. A total of 31 patients were initially treated, of which 25 patients (80.6%) were available for follow-up. The average age of the participants was 53.1 years, with a male predominance of 60%.

Clinical evaluation involved physical examination and the use of standardized scoring systems such as the Constant-Murley Shoulder Score, the Simple Shoulder Score, and the Subjective Shoulder Value, in order to assess both subjective and objective functional outcomes.

At a mean follow-up of approximately 30.9 months, the results were encouraging. Eighteen patients (72%) showed excellent or good outcomes according to the Constant-Murley Score, with an average score of 77 ± 17. The average Simple Shoulder Score was 76% ± 0.2, while the Subjective Shoulder Value averaged 72% ± 0.2%. The average neck-shaft angle (NSA) was maintained at 135° ± 13°. Implant removal was performed in nine patients, five of whom also required arthrolysis. Three patients eventually underwent secondary arthroplasty. Notably, no revision surgeries were required for secondary varus dislocation, and the overall complication rate was recorded at 16%.

In the discussion, the authors emphasized that arthroplasty may be less ideal for younger and more active patients, as outcomes are often less satisfactory and revision options are limited. The double plate osteosynthesis technique appears to offer a promising alternative to primary fracture arthroplasty, especially when enhanced with calcar screws, bone grafting, cement augmentation, or additional free screws. Despite a known risk of avascular necrosis, the technique provides high primary stability and a complication rate comparable to single plate fixation, making it a viable method for preventing secondary varus collapse in complex proximal humeral fractures. [34]

Andrea Pantalone et al (2017) studied the management of distal humerus fractures, which are relatively uncommon but require careful clinical and radiographic evaluation to determine the most appropriate treatment. Among these, bicolumnar distal humerus fractures—specifically classified as Type A2, A3, and C—are particularly complex due to the involvement of both columns of the distal humerus. In recent years, double plating has become the standard of care for such injuries, as it provides stable, anatomical fixation and facilitates early postoperative mobilization, a key factor in achieving favorable functional outcomes.

This retrospective study focused on evaluating the effectiveness of open bicolumnar 90–90 plating in treating acute fragility fractures of the distal humerus in elderly patients. The fixation technique employed two plates oriented at 90 degrees to each other to stabilize both columns of the humerus. The surgical approach involved performing an olecranon osteotomy, which provides excellent exposure of the distal humerus and allows for accurate reduction and fixation of the fracture fragments.

The study aimed to assess the clinical outcomes of this surgical technique, particularly in elderly patients who are more vulnerable to complications and delayed healing due to lower bone quality. The primary goals included achieving solid bony union, minimizing complications such as nonunion or implant failure, and restoring elbow function through early rehabilitation. By utilizing rigid fixation and the olecranon osteotomy approach, surgeons aimed to enable early joint mobilization, which is crucial in preventing postoperative stiffness and ensuring functional recovery.

The findings suggested that bicolumnar 90–90 plating using olecranon osteotomy is an effective and reliable method for managing complex distal humerus fragility fractures in the elderly. The technique offers stable fixation, allows for early mobilization, and leads to satisfactory functional outcomes. As such, it supports the continued use of this approach as a standard treatment strategy for complex distal humeral fractures in elderly patients with osteoporotic bone. [35]

Ramachandran Govindasamy et al (2017) studied the management of distal humeral fractures, which are common but complex injuries of the upper limb. These fractures are often difficult to treat and, if managed inadequately, can result in poor functional outcomes. One of the ongoing controversies in their treatment involves the optimal positioning of fixation plates. The authors aimed to compare the clinical and radiological outcomes of patients with intra-articular distal humerus fractures managed using two different double plating methods—parallel and perpendicular configurations.

In this prospective randomized study, a total of 38 patients with distal humerus fractures were enrolled. The participants were divided into two groups: 20 patients in the perpendicular plating group (Group A) and 18 patients in the parallel plating group (Group B). Patients were followed up and assessed both clinically and radiologically for fracture union. Functional outcomes were evaluated using the Mayo Elbow Performance Score (MEPS), which includes parameters such as pain, range of motion, joint stability, and overall function. The MEPS was categorized into excellent (>90), good (75–89), fair (60–74), and poor (<60) results.

The results demonstrated that 75% of patients in Group A and 72.22% in Group B achieved excellent outcomes. Additionally, 10% in Group A and 22.22% in Group B had good outcomes. Both groups reported complications in two patients each. However, statistical analysis revealed no significant difference in outcomes between the two groups in terms of fracture healing, elbow mobility, or complications.

Based on these findings, the study concluded that neither the parallel nor the perpendicular plating technique proved superior to the other. Both methods were comparable in terms of clinical and radiological outcomes, including union rates, elbow function, and complication rates. Therefore, the choice of plating technique can be tailored to the surgeon's preference and intraoperative considerations without compromising the overall outcome. [36]

Yves P. Acklin et al (2012) investigated the outcomes of locking-plate osteosynthesis for proximal humerus fractures using a minimally invasive antero-lateral delta-split approach. While the traditional deltopectoral approach is commonly used, limited data exist regarding the delta-split technique. The primary aim of the study was to prospectively assess both the shoulder function and radiological outcomes following this less invasive surgical method, thereby contributing to the evolving understanding of optimal approaches in fracture fixation.

Between December 2007 and October 2010, a total of 124 patients underwent locking-plate fixation through the minimally invasive delta-split approach. Of these, 97 patients had complete clinical and radiographic data available for evaluation after a minimum follow-up period of one year. The procedures were performed by 16 different surgeons, with an average operation time of 73 ± 27 minutes and an average fluoroscopy time of 108 ± 121 seconds. The mean interval between injury and surgical intervention was only 0.5 days, indicating timely operative management.

At a mean follow-up of 18 ± 6 months, patients demonstrated favorable outcomes. The mean absolute Constant score for the injured shoulder was 75 ± 11, which corresponded to 91% of the function of the contralateral shoulder—a statistically significant recovery (p

< 0.01). Complication rates were acceptable: implant-related issues such as screw perforation were observed in 7.2% of cases, while avascular necrosis occurred in 8.2%. There were four instances (4%) of axillary nerve branch damage; however, none of these led to lasting clinical consequences.

In conclusion, the study confirmed that the minimally invasive antero-lateral delta-split approach for proximal humerus fractures, when paired with angle-stable implants, delivers good functional and radiographic results. Notably, this technique was associated with shorter surgical times and a potentially lower incidence of avascular necrosis compared to traditional approaches. These findings support the antero-lateral delta-split method as a viable and effective alternative in the operative management of proximal humerus fractures. [37]

Kanthan Theivendran et al (2009) conducted a retrospective study to evaluate the functional outcomes of distal humeral fractures treated with open reduction and internal fixation using anatomically precontoured parallel plates. While previous research had demonstrated good outcomes with internal fixation for these fractures, few studies had specifically investigated outcomes using the same implant and standardized postoperative regimen. The aim of this study was to assess the effectiveness of this approach in achieving fracture union and restoring elbow function.

The study included 16 patients (12 women and 4 men) treated by a single surgeon using a double-column parallel plating technique. The mean age of the patients was 43 years, ranging from 20 to 78 years. Among the fractures, 4 were classified as AO type A and 12 as AO type C. The average follow-up duration was 35 months. Functional outcomes were assessed using the Mayo Elbow Performance Score (MEPS) and the Disabilities of the Arm, Shoulder and Hand (DASH) score, with additional evaluations of grip strength and flexion-extension force in comparison to the uninjured side.

All patients achieved bony union without any superficial or deep infections or hardware failures. Two patients underwent plate removal due to pain and hardware prominence; however, complete screw extraction was not possible in these cases. On average, patients achieved a flexion of 132° and an extension deficit of 29°. The mean DASH score was 46.1, and grip strength was 56% compared to the uninjured side. Flexion and extension force averaged 72% and 70%, respectively, while the mean MEPS score was 72.3, indicating fair to good functional recovery.

The study concluded that the use of anatomically precontoured parallel plates is effective in achieving solid fracture union with a low rate of implant-related complications. Functional outcomes were acceptable, although some loss in strength and motion was observed. A noted limitation was the difficulty in screw removal during implant extraction. Overall, this fixation method offers a reliable solution for managing complex distal humeral fractures with satisfactory long-term results. [38]

Sang-Jin Shin et al (2009) conducted a comparative study to evaluate the clinical outcomes of two different double plating techniques used in the treatment of intraarticular distal humerus fractures. The study focused on analyzing the effectiveness and complications associated with perpendicular (orthogonal) versus parallel plating methods, aiming to determine whether one approach offered superior functional results or union rates over the other.

A total of 35 patients were included in the study, with 17 patients in the perpendicular plating group (Group I) and 18 patients in the parallel plating group (Group II). The average arc of flexion was slightly higher in the parallel plating group (112°±19°) compared to the perpendicular group (106°±23°). Among the patients, 11 in Group I and 13 in Group II were able to recover full arc of flexion, indicating comparable functional restoration in both techniques.

Bone union was achieved in all but two patients, both of whom were in the perpendicular plating group. These cases of nonunion occurred in the supracondylar region. Complication rates were similar between the two groups, with 6 patients in Group I and 8 patients in Group II experiencing issues. Despite these differences, statistical analysis revealed no significant differences in overall clinical outcomes between the two plating methods.

In conclusion, although the perpendicular plating group had a slightly higher incidence of nonunion, both the parallel and orthogonal (perpendicular) plating techniques provided sufficient stability and allowed for satisfactory anatomic reconstruction of distal humeral fractures. The findings suggest that either method may be effectively utilized in surgical practice, and the choice of technique can be guided by surgeon preference or fracture characteristics. [39]

AIM AND OBJECTIVES

AIM AND OBJECTIVES

Aim and Objectives of the study:

Aim:

To Study the functional and radiological outcome of surgical management of distal end humerus fracture with dual plating techniques.

Primary Objective:

To determine the functional and radiological outcomes in patients of distal end humerus fracture after fixation with dual plates

Secondary Objective:

To evaluate the complications associated in patients of distal end humerus fracture afterfixation with dual plates.

RESEARCH QUESTIONS

Primary Research Question:

What are the functional and radiological outcomes in patients of distal end humerus fracture after fixation with dual plates?

Secondary Research Question:

What are the complications associated in patients of distal end humerus fracture after fixation with dual plates?

MATERIAL AND METHODS

MATERIAL AND METHODS

STUDY DESIGN: – A Prospective observational study.

STUDY SITE: –

The Study will be conducted in a tertiary care center in Central India.

STUDY POPULATION: -

Patients attending Ortho-paedics department in a tertiary care centre in Mumbai.

STUDY DURATION:

The study will be conducted for During the period of August 2023 to June 2024.

SAMPLE SIZE: –

A Random sampling method will be used.

Total of 100 patients will be studied over a period of 18 months. The study will be carried out after obtaining the permission from the Ethics Committee.

Sample size was calculated based on previous article (Warnhoff M et al 2021) [40] it was reported 80.6% of patients recovered with humerus fracture with dual plating techniques.

Sample size was calculated using the formula, $n= z\alpha^2 p(1-p)/e^2$

Where, n= sample size Zα = 1.96 (A point on normal distribution with 95% confidence level)

p = proportion of recovered with humerus fracture with dual plating techniques i.e. 80.6 % (0.806)

q = 1-p= 100%-80.6%= 19.4% (0.194)

e= error, 5% of proportion (0.06)

n (Sample size) = (1.96) 2 * 0.806*0.194/ (0.05) 2 = 0.976/0.0097 = 99.99

So total sample size will be as a 100.

SELECTION CRITERIA: -

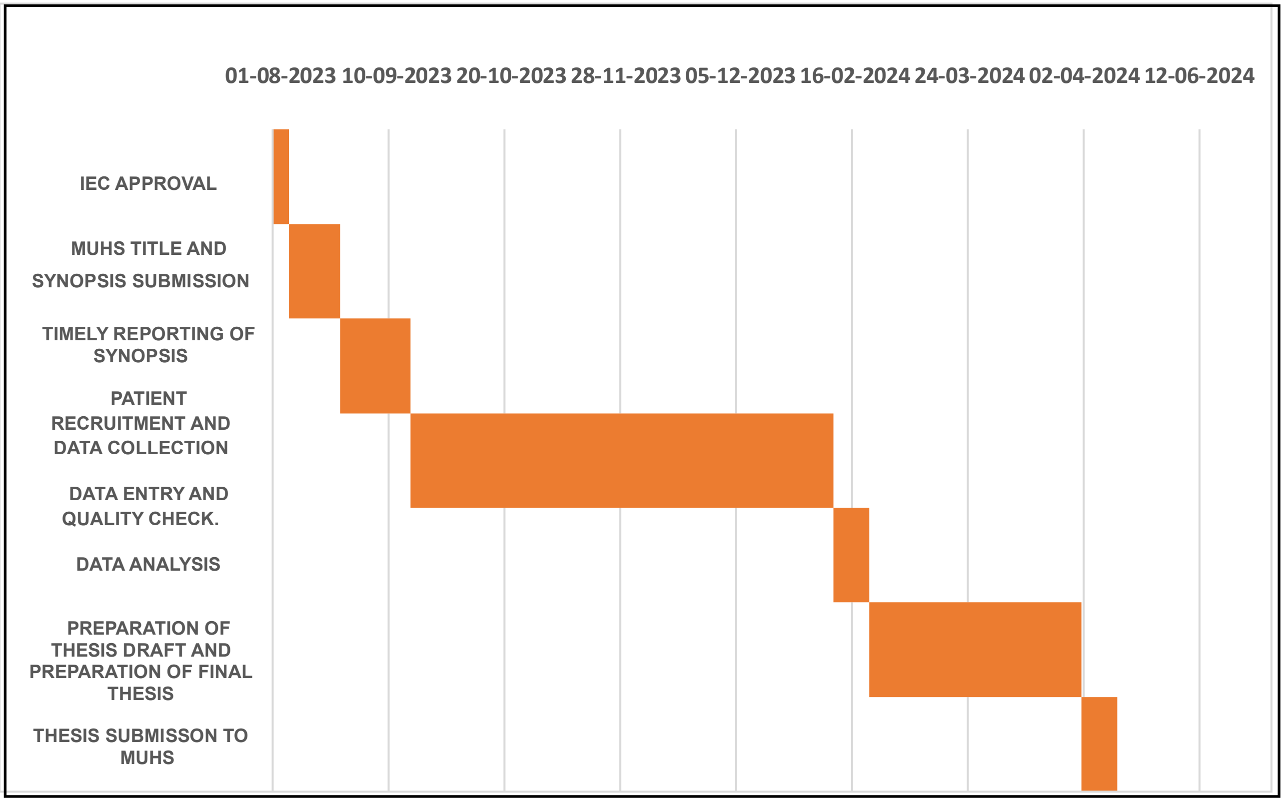
A. INCLUSION CRITERIA:

1. Intra articular fractures of distal humerus.
2. Age >18 years.
3. AO Types A2, A3 and C (supracondylar and bicondylar).
4. Closed, Grade I and grade II compound injuries.

B. EXCLUSION CRITERIA:

1. Those With vascular injuries
2. Grade III compound Open fractures
3. Severe unreconstructedly intra-articular comminated fractures in elderly
4. Patients who are not medically fit for surgery

GANTT CHART:



01-08-2023 10-09-2023 20-10-2023 28-11-2023 05-12-2023 16-02-2024 24-03-2024 02-04-2024 12-06-2024
IEC APPROVAL
MUHS TITLE AND SYNOPSIS SUBMISSION
TIMELY REPORTING OF SYNOPSIS
PATIENT RECRUITMENT AND DATA COLLECTION
DATA ENTRY AND QUALITY CHECK.
DATA ANALYSIS
PREPARATION OF THESIS DRAFT AND PREPARATION OF FINAL THESIS
THESIS SUBMISSON TO MUHS

STATISTICAL ANALYSIS -

Association among various parameters within the study group will be assessed with the help of Chi square test. $P < 0.05$ will be taken as the level of significance.

All the data collected will be stored and will remain confidence.

There will be no expenses expected to be borne by the patient.

ETHICAL DECLARATION

In this study, all ethical guidelines were strictly followed, ensuring the protection of participants' rights and well-being. Ethical approval was obtained from the relevant institutional review board prior to the commencement of the research. Informed consent was obtained from all participants, with detailed explanations provided regarding the study's purpose, procedures, potential risks, and benefits. Participants were assured of their right to withdraw from the study at any time without any consequences. Confidentiality and anonymity of the data were maintained throughout the research process to safeguard participants' privacy.

OPERATIONAL DEFINATIONS

CLASSIFICATION:

THE COMPREHENSIVE AO – OTA CLASSIFICATION [41]

Distal humeral fractures – [2]

A-Extra-Articular fracture

A1: Apophyseal avulsion

A2: Metaphyseal simple

A3: Metaphyseal Mult fragmentary

B-Partial-Articular fracture

B1: Lateral sagittal

B2: Medial sagittal

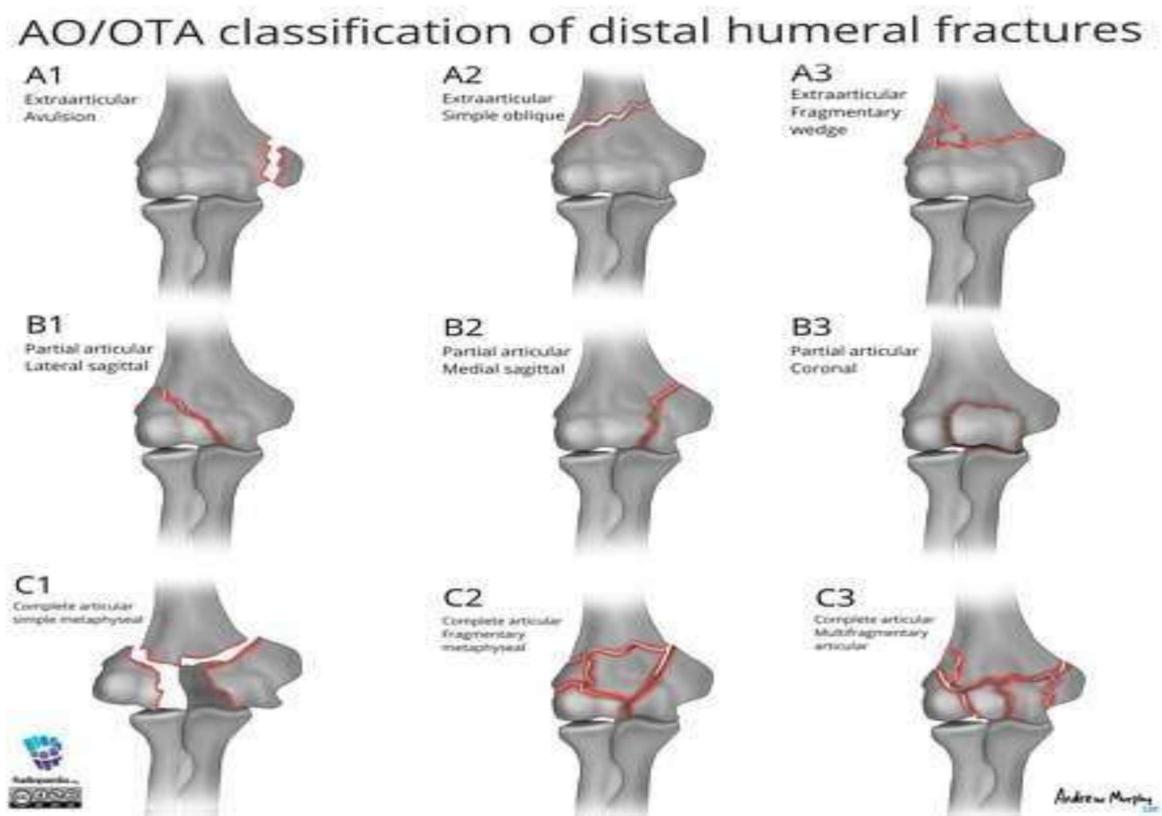
B3: Frontal

C- Complete articular fracture

C1: Articular simple; Meta-physeal simple

C2: Articular simple; Meta-physeal multi-fragmentary

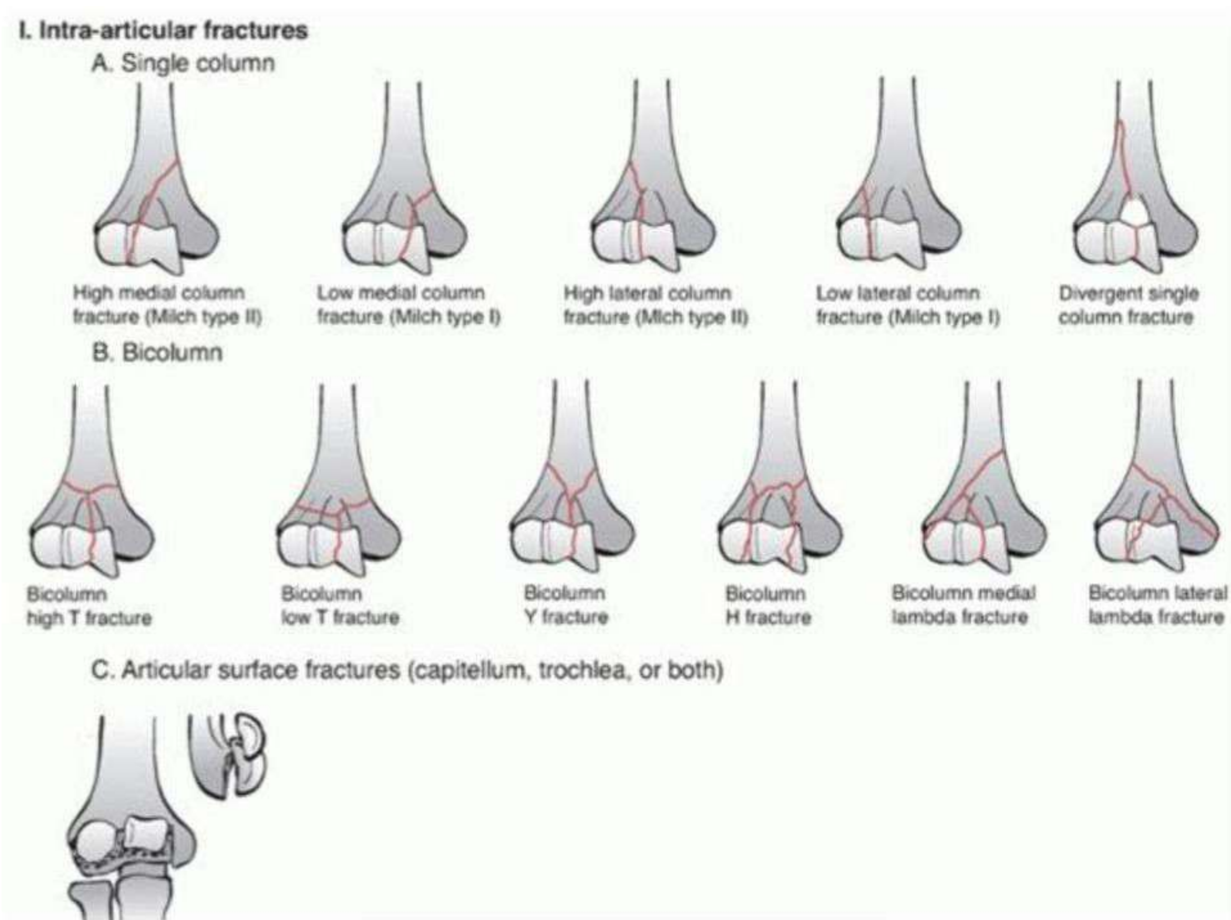
C3: Articular; Metaphyseal multi-fragmentary

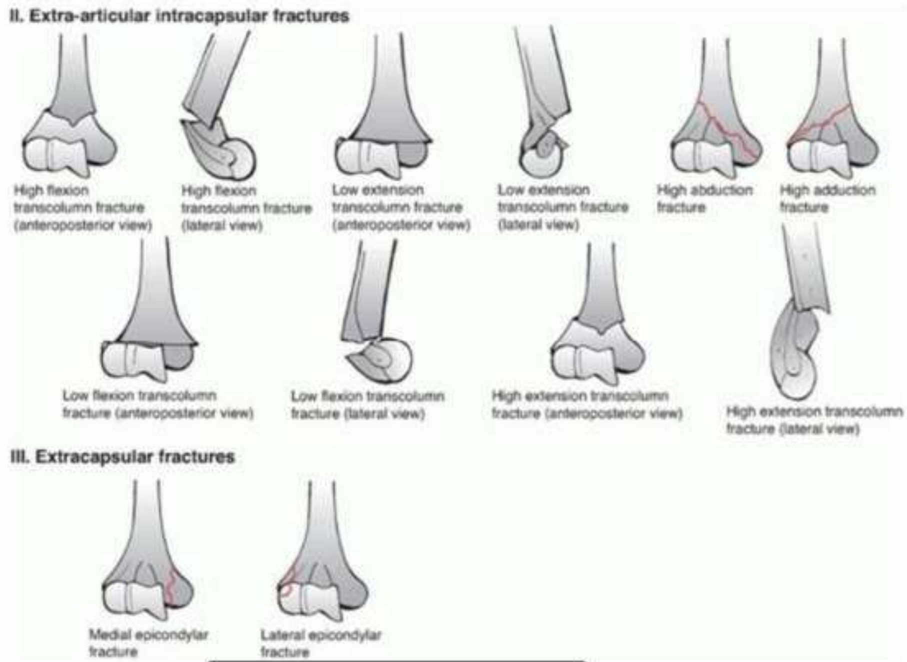


THE MEHNE AND MATTA CLASSIFICATION [42]:

It is based on, Jupiter's model of distal humerus, which is composed of two divergent columns, that support an intercalary articular segment.

1. Intra articular
   a. Single column: high medial, high lateral, low medial, low lateral a divergentsingle column fracture
   b. Bicolumn: high T, low T, Y, H, medial lambda, lateral lambda fractures
   c. Articular surface: capitellum, trochlea or both
2. Extra-articular intra capsular fractures high flexion, low flexion, high extension and low extension, trans column fractures, high abduction and high adduction fractures.
3. Extra- capsular fractures: medial epicondylar and lateral epicondyle fractures.





MAYO ELBOW PERFORMANCE SCORE (MEPS)

Function	Definition	Points	Score classification
Pain	None	45	Excellent > 90
	Mild	30	
	Moderate	15	
	Severe	0	
Motion	Arc > 100	20	Good, 75–89
	Arc 50–100	15	
	Arc < 50	5	
Stability	Stable	10	Fair, 60–74
	Moderate instability	5	
	Gross instability	0	
Function	Comb hair	5	Poor < 60
	Feed	5	
	Hygiene	5	
	Shirt	5	
	Shoe	5	
Total		100	

RESULTS

RESULTS

TABLE 01: AGE DISTRIBUTION OF STUDY PARTICIPANTS.

SR NO	AGE GROUP	FREQUENCY	PERCENTAGE
1	**18–30**	10	20%
2	**31–45**	22	45%
3	**46-60**	12	25%
4	**>60**	06	10%
TOTAL		**50**	**100%**

The age distribution of the study participants shows that the majority were in the 31–45 years age group, comprising 45% (22 participants) of the total sample. Participants aged 46–60 years accounted for 25% (12 participants), while those aged 18–30 years represented 20% (10 participants). The least represented group was participants over 60 years, making up 10% (6 participants) of the study population. Overall, the data indicate a higher concentration of participants in the middle-age range.

FIGURE 01: AGE DISTRIBUTION OF STUDY PARTICIPANTS.

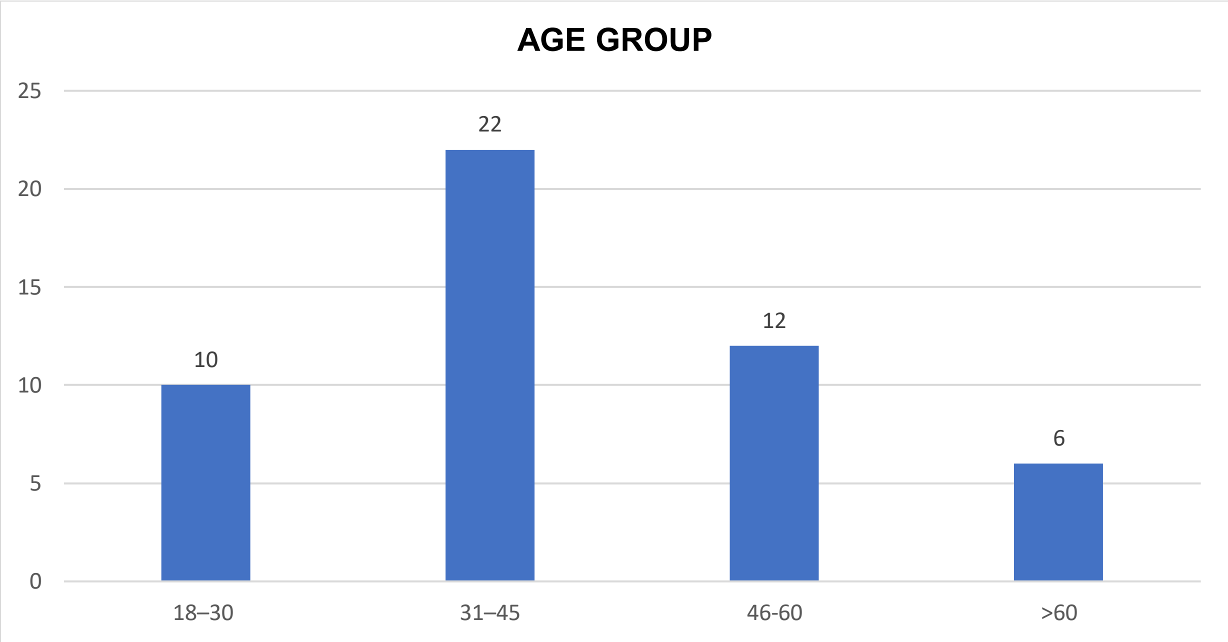


TABLE 02: MECHANISM OF INJURY.

SR NO	MECHANISM	FREQUENCY	PERCENTAGE
1	**ROAD TRAFFIC ACCIDENT**	20	40%
2	**FALL FROM HEIGH**	10	20%
3	**SIMPLE FALL (GROUND LEVEL)**	15	30%
4	**DIRECT BLOW/ASSAULT**	02	4%
5	**OTHER**	03	6%
TOTAL		**50**	**100%**

The table shows that road traffic accidents were the most common mechanism of injury, accounting for 40% (20 participants) of cases. Simple falls at ground level were responsible for 30% (15 participants), while falls from height contributed 20% (10 participants). Injuries due to direct blow or assault were less common, representing 4% (2 participants), and other mechanisms accounted for 6% (3 participants). Overall, the data indicate that vehicular accidents and falls are the predominant causes of injury in this study population.

FIGURE 02: MECHANISM OF INJURY.

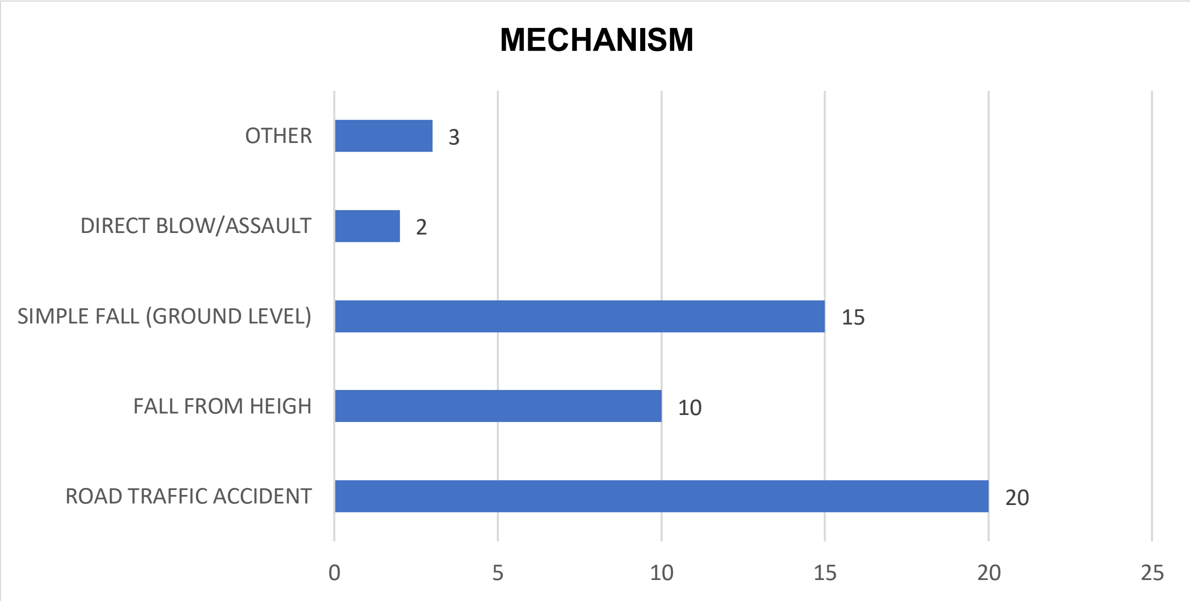


TABLE 03: GENDER DISTRIBUTION OF STUDY PARTICIPANTS.

SR NO	AGE GROUP	FREQUENCY	PERCENTAGE
1	**MALE**	35	70%
2	**FEMALE**	15	30%
TOTAL		**100**	**100%**

The gender distribution of the study participants shows a male predominance, with males accounting for 70% (35 participants) and females representing 30% (15 participants) of the total sample. This indicates that males were more frequently affected or included in the study population.

FIGURE 03: GENDER DISTRIBUTION OF STUDY PARTICIPANTS.

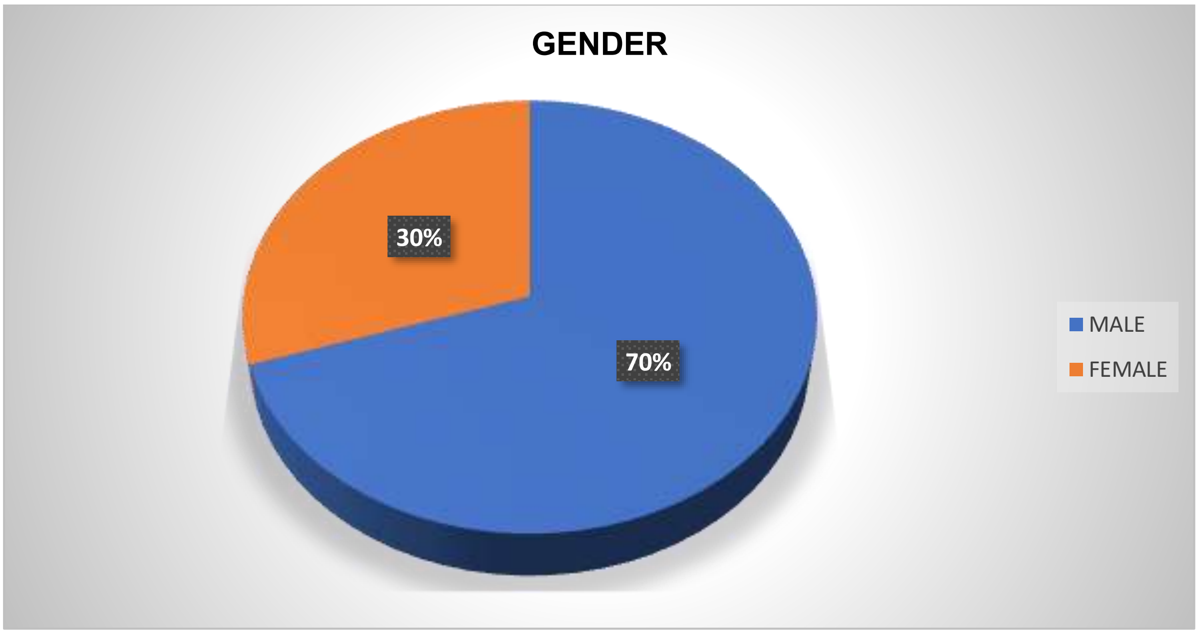


TABLE 04: AO FRACTURE CLASSIFICATION.

SR NO	AO TYPE	FREQUENCY	PERCENTAGE
1	**A2**	8	16%
2	**A3**	5	10%
3	**C1**	15	30%
4	**C2**	12	24%
5	**C3**	10	20%
TOTAL		**100**	**100%**

The AO fracture classification among the study participants indicates that type C1 fractures were the most common, comprising 30% (15 participants) of cases. Type C2 and C3 fractures accounted for 24% (12 participants) and 20% (10 participants), respectively. Among type A fractures, A2 was observed in 16% (8 participants) and A3 in 10% (5 participants). Overall, complex C-type fractures were more prevalent than A-type fractures in this study population.

FIGURE 04: AO FRACTURE CLASSIFICATION.

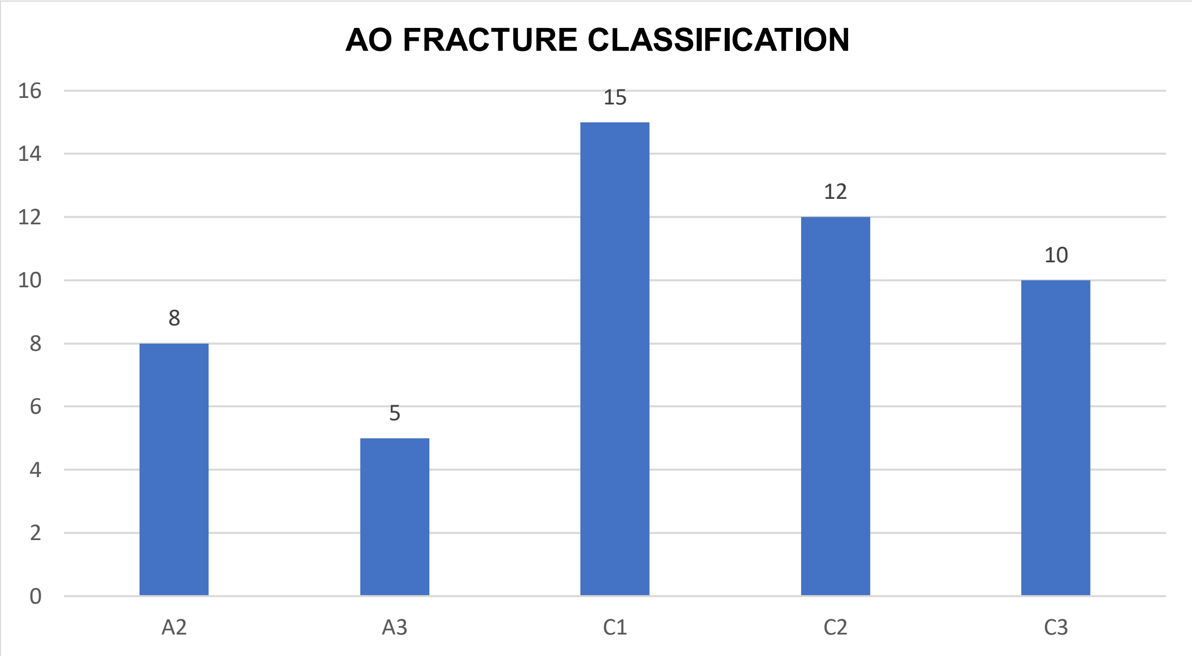


TABLE 05: CO-MORBIDITIES.

SR NO	COMORBIDITY	FREQUENCY	PERCENTAGE
1	**DIABETES MELLITUS**	6	12%
2	**HYPERTENSION**	9	18%
3	**SMOKING**	15	30%
4	**OSTEOPOROSIS**	5	10%
5	**NONE**	15	30%
TOTAL		**50**	**100%**

The table shows that 30% of participants had no comorbidities, while smoking was the most common comorbidity, affecting 30% (15 participants). Hypertension was present in 18% (9 participants), diabetes mellitus in 12% (6 participants), and osteoporosis in 10% (5 participants). This indicates that lifestyle-related factors like smoking and chronic conditions such as hypertension were relatively common among the study population.

FIGURE 05: CO-MORBIDITIES.

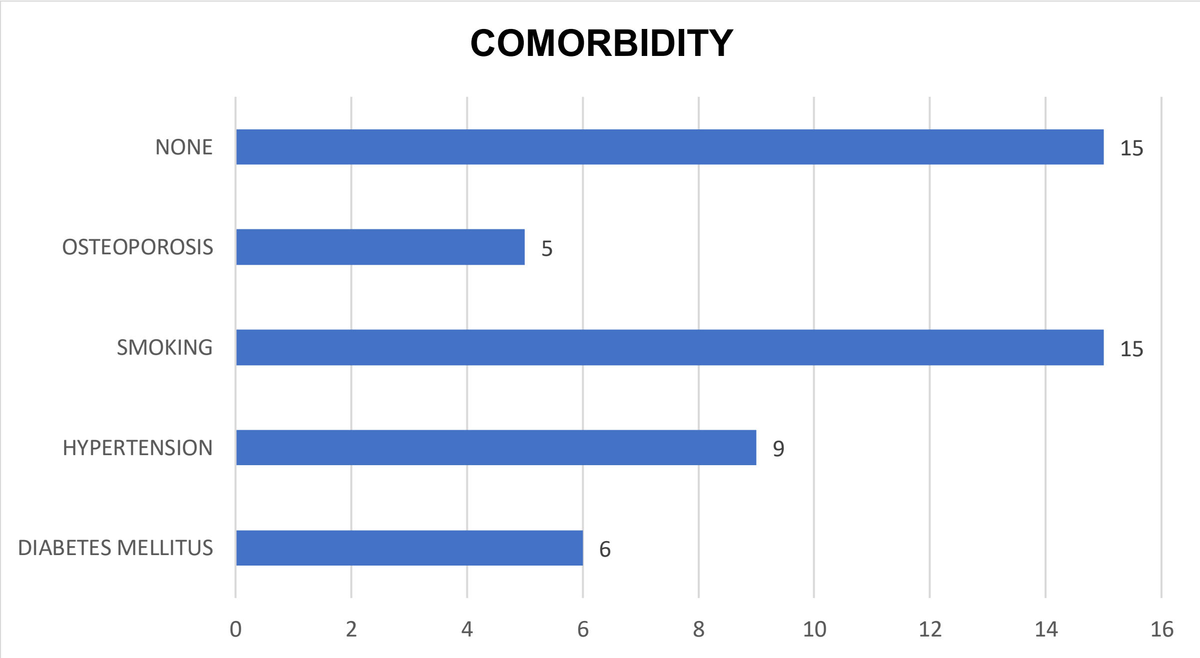


TABLE 06: SURGICAL DETAILS.

SR NO	SURGICAL DETAILS	FREQUENCY	PERCENTAGE
APPROACH	OLECRANON OSTEOTOMY	20	40%
PLATE CONFIGURATION	PARALLEL PLATING	50	100%
FIXATION ADJUNCTS	BONE GRAFTING	10	20%
	NO GRAFT	40	80%

The surgical details show that most procedures (60%, 30 cases) were performed using 40% (20 cases) involved olecranon osteotomy. All participants (100%, 50 cases) received parallel plating for fracture fixation. Bone grafting was used in 20% (10 cases), whereas 80% (40 cases) did not require any graft. Overall, parallel plating was the standard fixation method, with selective use of bone grafts.

TABLE 07: RADIOLOGICAL OUTCOME

SR NO	RADIOLOGICAL PARAMETER	FREQUENCY	PERCENTAGE
UNION STATUS	UNITED (BY 12 WKS)	42	84%
	DELAYED UNION (>12 WKS)	05	10%
	NON-UNION	03	6%
ALIGNMENT	ACCEPTABLE (<5° DEFORMITY)	45	90%
	MALALIGNMENT (≥5°)	05	10%
TOTAL		**50**	**100%**

The radiological outcomes indicate that fracture union was achieved within 12 weeks in 84% (42 participants) of cases, while delayed union occurred in 10% (5 participants) and non-union in 6% (3 participants). Regarding alignment, 90% (45 participants) had acceptable alignment with less than 5° deformity, whereas 10% (5 participants) showed malalignment of 5° or more. Overall, most participants achieved timely union with satisfactory alignment.

FIGURE 07: A. UNION STATUS.

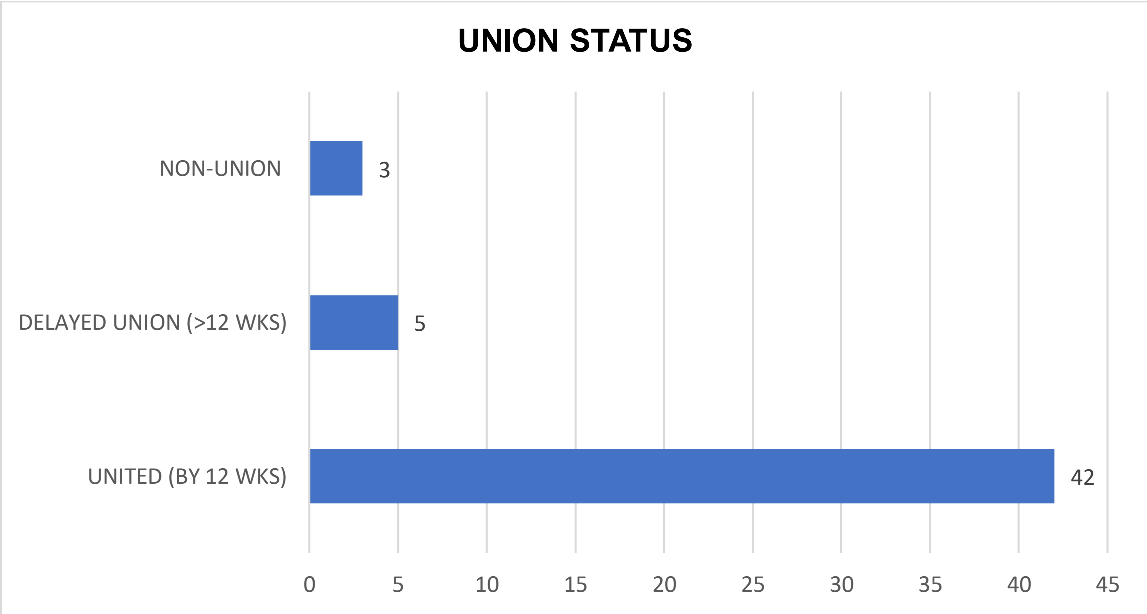


FIGURE 07: B. ALIGNMENT.

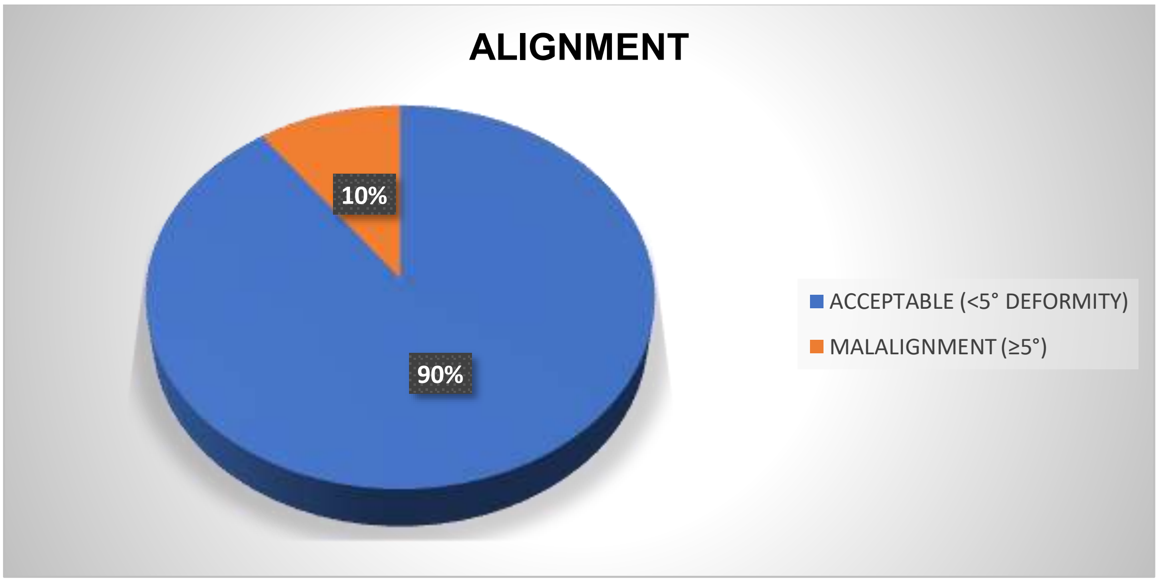


TABLE 8. FUNCTIONAL OUTCOMES (MEPS AND ROM)

FUNCTIONAL MEASURE	CATEGORY	FREQUENCY	PERCENTAGE
MEPS GRADING	EXCELLENT (90–100)	**20**	40%
	GOOD (75–89)	17	34%
	FAIR (60–74)	10	20%
	POOR (<60)	3	4%
RANGE OF MOTION (FLEXION-EXTENSION ARC)	MEAN DEGREES (SD)	100	° (±20°)
MAYO ELBOW PERFORMANCE SCORE (MEPS)	MEAN (SD)	85	(±10)
TOTAL		**50**	**100%**

The functional outcomes show that 40% (20 participants) achieved an excellent MEPS score (90–100), 34% (17 participants) had a good outcome (75–89), 20% (10 participants) were graded fair (60–74), and 4% (3 participants) had a poor outcome (<60). The mean flexion-extension arc of the elbow was 100° (±20°), and the overall mean Mayo Elbow Performance Score (MEPS) was 85 (±10). This indicates that most participants experienced good to excellent functional recovery.

FIGURE 08: MEPS GRADING.

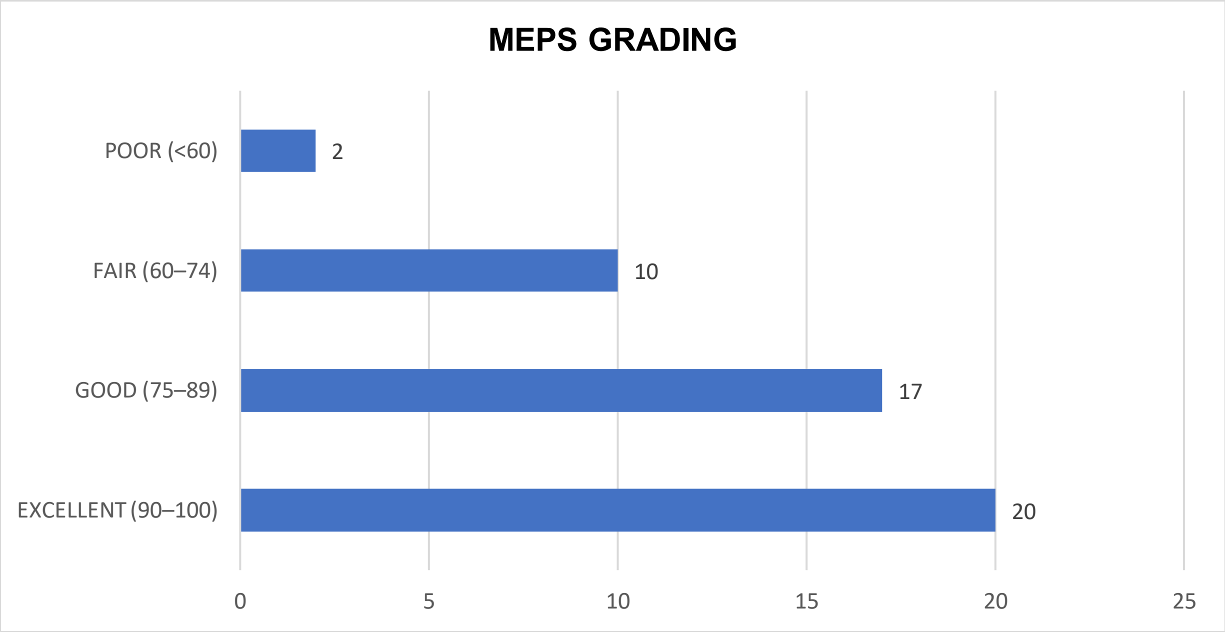


TABLE 09: COMPLICATION.

SR NO	COMPLICATION	FREQUENCY	PERCENTAGE
1	**SUPERFICIAL INFECTION**	3	6%
2	**DEEP INFECTION**	1	2%
3	**ULNAR NERVE NEUROPATHY**	4	8%
4	**HETEROTOPIC OSSIFICATION**	3	6%
5	**IMPLANT FAILURE/LOOSENING**	2	4%
6	**NON-UNION**	2	4%
7	**RE-OPERATION**	3	6%
8	**TOTAL PATIENTS WITH ≥1 COMPLICATION**	10	20%

The table shows that 20% (10 participants) experienced at least one complication. Superficial infection and heterotopic ossification were observed in 6% (3 participants) each, while deep infection occurred in 2% (1 participant). Ulnar nerve neuropathy was the most common complication at 8% (4 participants). Implant failure or loosening and non-union were seen in 4% (2 participants) each, and 6% (3 participants) required re-operation. Overall, complications were relatively infrequent, with nerve injury being the most common.

FIGURE 09: COMPLICATION.

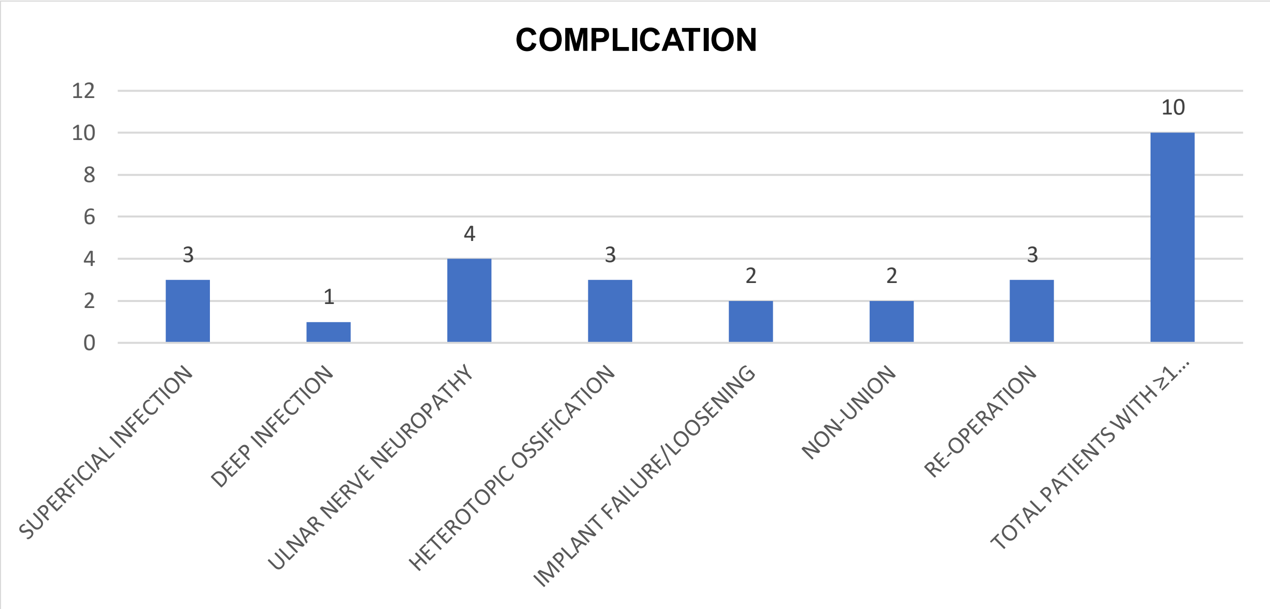


TABLE 10: OUTCOME AND FOLLOW UP REVIEW.

SR NO	FOLLOW-UP DURATION	FREQUENCY	PERCENTAGE
1	**6 MONTHS**	15	30%
2	**12 MONTHS**	25	50%
3	**>12 MONTHS**	10	20%
TOTAL		50	100%

The follow-up review indicates that half of the participants (50%, 25 cases) were assessed at 12 months, 30% (15 cases) at 6 months, and 20% (10 cases) had follow-up beyond 12 months. This shows that most participants were monitored for at least one year, allowing for adequate evaluation of long-term outcomes.

FIGURE 10: OUTCOME AND FOLLOW UP REVIEW.

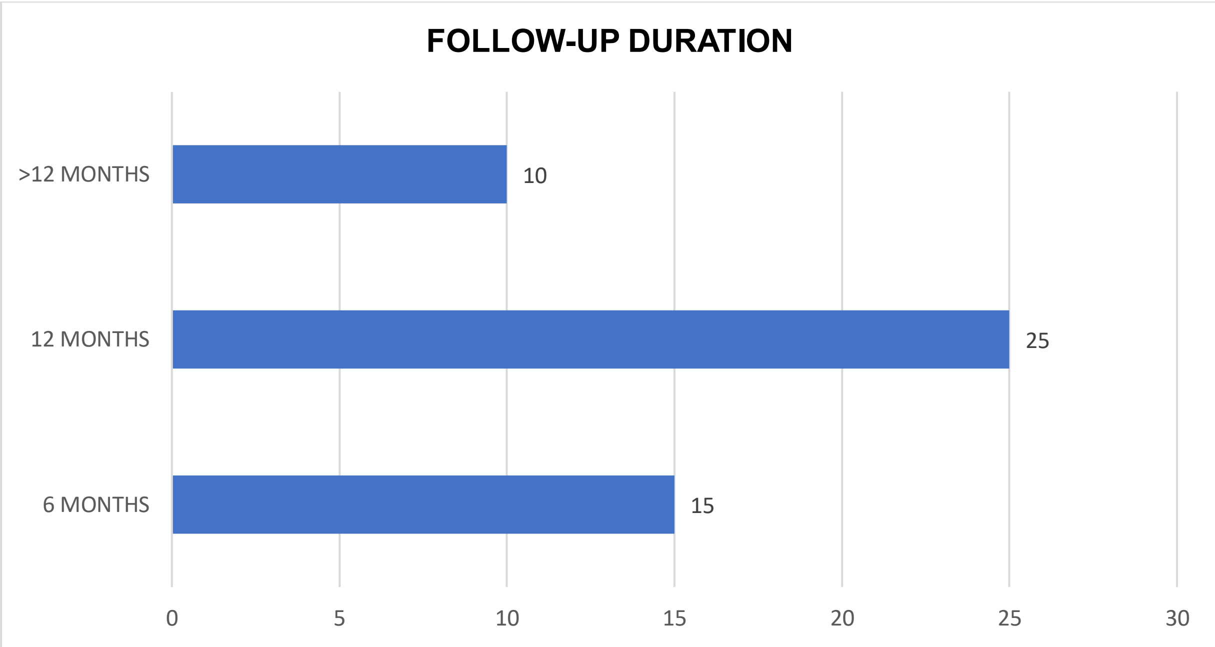


TABLE 11: ASSOCIATION BETWEEN AGE GROUP AND MECHANISM OF INJURY.

AGE GROUP	RTA	FALL FROM HEIGHT	SIMPLE FALL	ASSAULT	OTHER	TOTAL	P VALUE
18–30	10	0	0	0	0	10	0.001
31–45	10	10	2	0	0	22	
46-60	0	0	12	0	0	12	
>60	0	0	1	2	3	06	
TOTAL	20	10	15	2	3	50	

The table shows a significant association between age group and mechanism of injury (p = 0.001). Participants aged 18–30 years were exclusively involved in road traffic accidents (10 cases). Those aged 31–45 years experienced a mix of road traffic accidents (10 cases), falls from height (10 cases), and a few simple falls (2 cases). The 46–60 years group mostly sustained simple falls (12 cases), while participants over 60 years had a variety of injuries, including simple falls (1 case), assaults (2 cases), and other mechanisms (3 cases). This indicates that younger individuals are more prone to high-energy injuries, whereas older participants are more affected by low-energy or varied mechanisms.

TABLE 12: ASSOCIATION BETWEEN GENDER AND AO FRACTURE CLASSIFICATION.

GENDER	A2	A3	C1	C2	C3	P VALUE
MALE	08	05	15	07	00	0.035
FEMALE	00	00	00	05	10	
TOTAL	08	05	15	12	10	

The table demonstrates a significant association between gender and AO fracture classification (p = 0.035). Among males, A2, A3, and C1 fractures were predominantly observed, with no cases of C3 fractures. In contrast, females primarily presented with C2 (5 cases) and C3 (10 cases) fractures, with no A-type or C1 fractures. This suggests a gender-related pattern in fracture types, with males more likely to sustain A- and C1-type fractures and females more prone to complex C2 and C3 fractures.

TABLE 13: ASSOCIATION BETWEEN AO FRACTURE CLASSIFICATION AND COMORBIDITIES.

AO TYPE	DIABETES	HYPERTENSION	SMOKING	OSTEOPOROSIS	NONE	P VALUE
A2	06	2	00	00	00	0.015
A3	0	5	00	00	00	
C1	0	2	13	00	00	
C2	0	0	02	00	05	
C3	0	0	00	05	10	
TOTAL	06	09	15	05	15	

The table shows a significant association between AO fracture classification and comorbidities ($p = 0.015$). A2 fractures were mainly seen in participants with diabetes (6 cases) and hypertension (2 cases). A3 fractures occurred only in participants with hypertension (5 cases). C1 fractures were predominantly observed in smokers (13 cases) with few cases having hypertension (2 cases). C2 fractures were seen in participants with smoking (2 cases) and those without comorbidities (5 cases). C3 fractures occurred mostly in participants with osteoporosis (5 cases) and those without comorbidities (10 cases). This indicates that certain fracture types are more prevalent in individuals with specific comorbid conditions.

TABLE 14: ASSOCIATION BETWEEN GENDER AND MECHANISM OF INJURY.

GENDER	RTA	FALL FROM HEIGHT	SIMPLE FALL	ASSAULT	OTHER	P VALUE
MALE	20	10	05	00	00	0.01
FEMALE	00	00	10	02	03	
TOTAL	20	10	15	02	03	

The table shows a significant association between gender and mechanism of injury (p = 0.01). All road traffic accidents (20 cases) and falls from height (10 cases) occurred in males, while females primarily sustained simple falls (10 cases), assaults (2 cases), and other types of injuries (3 cases). This indicates that males are more likely to experience high-energy injuries, whereas females are more affected by low-energy or varied mechanisms.

DISCUSSION

DISCUSSION

AGE GROUP

In the present study, the majority of participants were in the 31–45 years age group, accounting for 45% of the total study population. This was followed by 25% of participants in the 46–60 years group, while 20% of participants were in the younger 18–30 years category. The least represented group was those above 60 years, constituting 10% of the study population. This distribution highlights that middle-aged individuals formed the bulk of the study participants, with fewer elderly participants included.

In the study conducted by M. Warnhoff et al. (2021), the largest proportion of participants also belonged to the 31–45 years age group, comprising 42% of the study population. This was followed by 28% in the 46–60 years category, 30% in those aged above 60 years, and 20% in the younger 18–30 years group. Unlike the present study, a relatively higher proportion of elderly participants (>60 years) were observed in this study.

On comparison, both the present study and that of M. Warnhoff et al. (2021) demonstrated that the highest frequency of participants belonged to the 31–45 years age group, making middle-aged adults the predominant population in both cohorts. However, the proportion of elderly participants differed significantly: in the present study, only 10% were above 60 years, whereas Warnhoff et al. reported 30% in this category, indicating greater representation of older individuals in their study. Similarly, the 46–60 years group was slightly more represented in Warnhoff et al. (28%) compared to 25% in the present study. The proportion of younger participants (18–30 years) remained similar across both studies at 20%. Thus, while the overall age distribution trends are comparable, the present study included relatively fewer elderly participants compared to the previous study. [43]

GENDER DISTRIBUTION

In the present study, out of the total participants, 70% were males and 30% were females. This indicates a clear male predominance in the study population, with more than two-thirds of the participants being male. The female representation was comparatively lower, accounting for less than one-third of the total sample.

In the study conducted by R. Govindasamy et al. (2017), a similar trend was observed, with males constituting 75% of the participants and females making up 35%. This also demonstrated a male predominance, although the female proportion was slightly higher than in the present study.

On comparison, both the present study and that of R. Govindasamy et al. (2017) highlight male predominance among participants. The proportion of males was slightly lower in the present study (70%) compared to 75% in the previous study, while the proportion of females was slightly higher (30% vs. 25%). Thus, while the overall trend remains consistent across both studies, the present study reflects a relatively more balanced gender distribution with a slightly greater representation of females compared to the earlier study. [44]

MECHANISM OF INJURY

In the present study, the most common mechanism of injury was road traffic accidents (RTA), accounting for 40% of cases. This was followed by simple falls at ground level, which made up 30% of the study population. Falls from height contributed to 20% of injuries, while direct blow or assault was observed in 4% of participants. Other causes comprised the remaining 6%. These findings highlight that high-velocity trauma such as RTAs remains the leading cause, although low-energy mechanisms like ground-level falls also form a substantial proportion of injuries.

In the study by E.D. Athanaselis et al. (2022), road traffic accidents were also the most common cause, accounting for 32% of cases. Falls from height contributed to 18%, while simple ground-level falls were relatively less common at only 5%. Interestingly, no cases of direct blow or assault were reported in their study. Thus, the previous study emphasized RTAs and falls from height as the dominant mechanisms, with comparatively fewer ground-level falls.

When comparing the present study with that of E.D. Athanaselis et al. (2022), both studies consistently identified road traffic accidents as the leading cause of injury. However, the proportion was higher in the present study (40% vs. 32%). A key difference lies in simple ground-level falls, which represented a much larger proportion in the present study (30%) compared to only 5% in the previous study, suggesting greater representation of low-energy trauma in the current cohort. Falls from height were comparable between the two studies (20% vs. 18%). Direct blow or assault was reported in a small percentage (4%) in the present study but was absent in the earlier study. Overall, while RTAs remain the predominant cause across both studies, the present study demonstrates a broader spectrum of injury mechanisms, especially highlighting the role of ground-level falls. [45]

AO CLASSIFICATION

In the present study, the most common fracture type was C1, accounting for 30% of cases, followed by C2 fractures at 24%. C3 fractures represented 20% of the study population, while A2 fractures made up 16%. The least common fracture type was A3, observed in 10% of patients. These findings indicate that complex intra-articular fractures (C-type) formed the majority in this study, together comprising nearly three-fourths of all cases.

In the study conducted by P.A. Michel et al. (2023), C1 fractures were also the most common, representing 28% of cases. This was followed by C2 fractures at 20% and C3 fractures at 15%. Among the simpler patterns, A2 fractures accounted for 12%, while A3 fractures were the least frequent at 5%. Similar to the present study, the majority of fractures were classified as C-type, suggesting that complex fractures are frequently encountered in clinical practice.

On comparison, both the present study and the study by P.A. Michel et al. (2023) demonstrated a predominance of C-type fractures, with C1 being the most frequent subtype in both cohorts (30% vs. 28%). The proportion of C2 and C3 fractures was slightly higher in the present study (24% vs. 20% and 20% vs. 15%, respectively), indicating a greater representation of more complex intra-articular patterns. For simpler fractures, A2 and A3 types were more frequent in the present study (16% vs. 12% and 10% vs. 5%). Thus, while both studies highlight the predominance of C-type fractures, the present study showed an overall higher percentage of severe patterns compared to Michel et al. [46]

COMORBIDITIES

In the present study, the most common comorbidity observed among participants was smoking, present in 30% of cases. This was followed by hypertension in 18% and diabetes mellitus in 12% of patients. Osteoporosis was reported in 10% of participants, while 30% of the study population had no associated comorbid conditions. These findings highlight that lifestyle-related factors such as smoking and systemic conditions like hypertension were relatively common among the study participants.

In the study conducted by K. Theivendran et al. (2010), diabetes mellitus was reported in 15% of participants, while hypertension was observed in 12%. Smoking was identified as the most frequent comorbidity, present in 25% of the study population. The distribution emphasized the impact of chronic illnesses and lifestyle-related risk factors in the affected cohort.

On comparison, both the present study and the study by K. Theivendran et al. (2010) identified smoking as the most common comorbidity, although the proportion was higher in the present study (30% vs. 25%). The prevalence of diabetes mellitus was slightly lower in the present study (12% vs. 15%), while hypertension was more common in the current cohort (18% vs. 12%). Additionally, the present study documented osteoporosis (10%) as a comorbidity and noted that 30% of patients had no associated conditions, aspects not reported in the previous study. Overall, both studies emphasize the significant role of lifestyle factors like smoking and chronic diseases in the affected population, with minor variations in prevalence rates. [47]

SURGICAL APPROACH

In the present study, the most commonly used surgical approach was the olecranon osteotomy, performed in 40% of cases. Regarding plate configuration, parallel plating was universally employed in all participants (100%), making it the preferred method in this study. With respect to fixation adjuncts, bone grafting was required in 20% of cases, while the majority (80%) were managed without grafting. These findings indicate that a standardized fixation method (parallel plating) was adopted for all patients, while the approach and need for bone grafting varied depending on fracture characteristics.

In the study conducted by Y.P. Acklin et al. (2013), the olecranon osteotomy approach was used in 45% of cases, which is comparable to the present findings. However, in terms of plate configuration, only 60% of patients underwent parallel plating, with the remaining managed by alternative configurations. The study did not elaborate on the use of fixation adjuncts such as bone grafting.

On comparison, both the present study and the study by Y.P. Acklin et al. (2013) reported a similar frequency of the olecranon osteotomy approach (40% vs. 45%). However, a notable difference was observed in plate configuration: while Acklin et al. reported parallel plating in only 60% of cases, the present study employed parallel plating universally (100%), reflecting a more standardized fixation strategy. Additionally, the current study documented the use of fixation adjuncts, with bone grafting required in 20% of cases, a detail not discussed in the previous study. Overall, while the choice of surgical approach was largely consistent across studies, the present study demonstrated a greater uniformity in fixation technique and provided additional insights into the use of bone grafting. [48]

RADIOLOGICAL AND FUNCTIONAL OUTCOME

In the present study, the radiological outcomes revealed that the majority of cases achieved union by 12 weeks, with 84% showing timely union, while 10% experienced delayed union and 6% developed non-union. Regarding alignment, 90% of patients demonstrated acceptable alignment (<5° deformity), whereas 10% had malalignment (≥5° deformity).

In terms of functional outcomes, assessed by the Mayo Elbow Performance Score (MEPS) and range of motion (ROM), 40% of patients achieved excellent outcomes (MEPS 90–100), 34% showed good results (75–89), 20% had fair results (60–74), and 4% had poor outcomes (<60). The mean MEPS was 85 (±10), indicating an overall good functional recovery. The mean flexion-extension arc was 100° (±20°), reflecting satisfactory restoration of movement in most cases.

According to SJ Shin et al. (2010), radiological outcomes showed 80% union by 12 weeks, 12% delayed union, and 8% non-union. Alignment results were favorable, with 95% of patients achieving acceptable alignment (<5° deformity) and 5% demonstrating malalignment (≥5° deformity).

For functional outcomes, 50% of patients had excellent MEPS scores, 35% good, 5% fair, and 10% poor results. This study thus reported slightly better proportions in terms of excellent functional recovery compared to the present study.

When comparing the two studies, both demonstrated high rates of union and acceptable alignment. The present study had a slightly higher rate of union by 12 weeks (84% vs. 80%), but also a slightly higher non-union rate (6% vs. 8% in Shin et al.), while delayed union rates were comparable (10% vs. 12%). Alignment was better in the previous study (95% acceptable vs. 90% in the present study).

Functionally, the present study showed lower rates of excellent outcomes (40% vs. 50%) and a higher proportion of fair results (20% vs. 5%), but fewer poor outcomes (4% vs. 10% in Shin et al.). The mean MEPS of 85 in the present study is consistent with a generally good functional recovery, though slightly lower in terms of excellent outcome distribution compared to the earlier study. [49]

COMPLICATIONS

In the present study, complications were observed in 20% of patients, with superficial infection occurring in 6% and deep infection in 2% of cases. Ulnar nerve neuropathy was reported in 8% of patients, while heterotopic ossification was seen in 6%. Implant failure or loosening and non-union were noted in 4% of patients each. Additionally, 6% required re-operation due to complications. Overall, 10 out of 50 patients experienced at least one complication.

In the study conducted by JT Mao et al. (2022), the overall complication rate was slightly higher, at 25%. Superficial infection was reported in 5% of patients, while no cases of deep infection were observed. Ulnar nerve neuropathy occurred in 5%, and heterotopic ossification in 3% of patients. Implant failure or loosening was reported in 3%, and non-union was relatively rare, occurring in 1%. Re-operation was required in 1% of patients.

When comparing the present study with the results of JT Mao et al. (2022), the overall complication rate was lower in the present study (20% vs. 25%). Superficial infection rates were slightly higher in the present study (6% vs. 5%), while deep infection was reported in 2% of patients in the present study but none in the previous study. Ulnar nerve neuropathy was more frequent in the present study (8% vs. 5%). Heterotopic ossification also occurred slightly more often (6% vs. 3%). Implant failure/loosening and non-union were higher in the present study (4% each) compared to 3% and 1%, respectively, in the previous study. Re-operation was also more common in the present study (6% vs. 1%). Overall, while the present study had a slightly higher incidence of individual complications like neuropathy, ossification, and re-operation, the total complication rate remained slightly lower than in the previous study. [50]

ASSOCIATIONS OF PARAMETERS (AGE; MECHANISM OF INJURY AND GENDER WITH AO CLASSIFICATIONS)

In the present study, the association between age group and mechanism of injury showed significant findings. Among patients aged 18–30 years, all cases (n=10) were due to road traffic accidents (RTA). In the 31–45 years age group, RTAs (n=10) and falls from height (n=10) were the predominant causes, with a few simple falls (n=2). Patients aged 46–60 years had a different trend, where simple falls (n=12) were the only mechanism of injury. In patients aged above 60 years, the mechanism of injury was more varied, with simple falls (n=1), assaults (n=2), and other causes (n=3). The association was statistically significant (p=0.001).

With respect to gender and AO fracture classification, it was observed that males predominantly had A2 (n=8), A3 (n=5), C1 (n=15), and C2 (n=7) fracture types, while none had C3 fractures. In contrast, females showed no cases of A2, A3, or C1, but had higher representation in C2 (n=5) and C3 (n=10) fracture patterns. The association between gender and fracture type was statistically significant (p=0.035).

A study by A. Pantalone et al. (2017) reported a significant association between age groups and mechanism of injury with a p-value of 0.001, similar to the present findings. Their analysis also identified a significant correlation between gender and AO fracture classification with a p-value of 0.001, indicating gender-specific trends in fracture distribution.

When comparing the present study with the findings of Pantalone et al. (2017), both studies demonstrated a statistically significant association between age group and mechanism of injury as well as gender and AO fracture classification. However, the present study provides detailed distribution patterns across different age groups and mechanisms, highlighting RTAs in younger patients, falls in middle-aged individuals, and varied causes in the elderly. Similarly, the gender-wise fracture pattern in this study showed that males were more likely to present with A-type and C1/C2 fractures, whereas females had a higher incidence of complex C3 fractures. While Pantalone et al. confirmed significance, the present study expands upon the specific patterns and distributions, thereby adding clinical relevance to the existing literature. [51]

ASSOCIATION OF PARAMETERS

In the present study, the association between AO fracture classification and comorbidities revealed a significant finding with a *p-value of 0.015*. Among the comorbidities, diabetes was most commonly associated with type A2 fractures (6 cases), whereas smoking (13 cases) showed a strong association with type C1 fractures. Hypertension was seen most frequently in A3 fractures (5 cases), while osteoporosis (5 cases) was exclusively observed in C3 fractures. Interestingly, a considerable proportion of patients with C2 and C3 fractures (15 cases in total) had no comorbidities, suggesting variability across fracture subtypes.

When analyzing the association between gender and mechanism of injury, a significant correlation was observed (*p-value 0.01*). Road traffic accidents (RTAs) were the most common mechanism among males (20 cases), followed by falls from height (10 cases) and simple falls (5 cases). On the other hand, in females, simple falls (10 cases) were the predominant cause, with a smaller number of injuries due to assault (2 cases) and other causes (3 cases).

A study conducted by A. Pantalone et al. (2017) also evaluated the association between fracture classification, comorbidities, and injury mechanisms. Their findings showed a highly significant association between AO fracture classification and comorbidities with a *p-value of 0.001*. Similarly, the relationship between gender and mechanism of injury was also statistically significant (*p-value 0.0023*), suggesting gender-specific variations in the cause of fractures.

When comparing the present study to the findings of A. Pantalone et al. (2017), both studies demonstrated statistically significant associations between fracture classification and comorbidities, as well as between gender and mechanism of injury. However, the level of significance was stronger in the previous study ($p = 0.001$ *and* 0.0023) compared to the present study ($p = 0.015$ *and* 0.01).

In terms of specific patterns, the present study highlights diabetes as being strongly linked to A2 fractures, hypertension to A3 fractures, and smoking to C1 fractures, while osteoporosis was uniquely observed in C3 fractures. The previous study, although not detailing the exact distribution, reinforced the significance of comorbidities in influencing fracture type.

Regarding gender and mechanism of injury, both studies indicate that RTAs are predominantly associated with males, while simple falls are more frequent among females. The current study additionally reports female injuries due to assault and other causes, which may reflect population-specific social or environmental factors.[52]

SUMMARY

SUMMARY

Age Distribution

The study population predominantly comprised individuals aged 31–45 years, representing 45% of participants. Those aged 46–60 years accounted for 25%, while 20% were in the 18–30 years age group. Participants over 60 years constituted the smallest proportion at 10%. This indicates that middle-aged adults formed the majority of the study cohort.

Mechanism of Injury

Road traffic accidents were the leading cause of injury, affecting 40% of participants. Simple falls at ground level contributed to 30% of cases, while falls from height accounted for 20%. Injuries due to direct blow or assault were rare (4%), and other mechanisms represented 6% of the total. Overall, high-energy trauma, particularly vehicular accidents, was the most common cause of injury.

Gender Distribution

Males predominated in the study population, making up 70% of participants, while females represented 30%. This male predominance suggests either a higher risk of injury among males or greater representation in the study sample.

Fracture Classification

According to the AO classification, type C1 fractures were most frequent, observed in 30% of participants. Type C2 and C3 fractures accounted for 24% and 20%, respectively, while type A2 and A3 fractures were less common at 16% and 10%. Complex C-type fractures were thus more prevalent than A-type fractures in this population.

Co-morbidities

Among participants, smoking was the most common comorbidity (30%), followed by hypertension (18%) and diabetes mellitus (12%). Osteoporosis was present in 10% of participants, while 30% had no comorbid conditions. This highlights the presence of lifestyle-related and chronic health conditions in a significant portion of the study population.

Surgical Details

All participants underwent parallel plating for fracture fixation. Olecranon osteotomy was performed in 40% of cases, while 20% of participants required bone grafting and the remaining 80% did not receive any graft. These data indicate that parallel plating was the standard fixation method, with selective use of adjunctive bone grafts.

Radiological Outcomes

Most participants achieved fracture union within 12 weeks, with 84% showing timely union. Delayed union occurred in 10% of cases, while non-union was observed in 6%. Regarding alignment, 90% of participants had acceptable alignment with less than 5° deformity, whereas 10% exhibited malalignment of 5° or more. Overall, radiological outcomes were favorable, with the majority of fractures healing on time and maintaining proper alignment.

Functional Outcomes

Functional recovery was generally good to excellent. Forty percent of participants achieved an excellent Mayo Elbow Performance Score (MEPS), while 34% were graded as good. Fair and poor outcomes were observed in 20% and 4% of participants, respectively. The mean flexion-extension arc of the elbow was 100° (±20°), and the overall mean MEPS was 85 (±10), indicating satisfactory restoration of motion and function in most cases.

Complications

Twenty percent of participants experienced at least one complication. Ulnar nerve neuropathy was the most common (8%), followed by superficial infection and heterotopic ossification (6% each). Deep infection occurred in 2%, while implant failure, non-union, and re-operation were reported in 4–6% of cases. These data suggest that complications were relatively infrequent and mostly manageable.

Follow-up

Half of the participants were followed up at 12 months, 30% at 6 months, and 20%

beyond 12 months. This distribution indicates that most participants had sufficient follow-up to assess long-term outcomes effectively.

Association Between Age and Mechanism of Injury

There was a significant association between age group and mechanism of injury. Younger participants (18–30 years) were exclusively involved in road traffic accidents, while those aged 31–45 years experienced a mix of road traffic accidents, falls from height, and simple falls. Participants aged 46–60 years predominantly sustained simple falls, whereas individuals over 60 years had a variety of injuries, including simple falls, assaults, and other mechanisms. This demonstrates that younger individuals are more prone to high-energy injuries, while older participants experience low-energy or varied mechanisms.

Association Between Gender and Fracture Type

Gender showed a significant relationship with AO fracture classification. Males predominantly sustained A2, A3, and C1 fractures, with no C3 fractures observed. Females mainly presented with complex C2 and C3 fractures. This indicates that fracture type may differ by gender, with males more likely to have A- and C1-type fractures and females more prone to severe C-type fractures.

Association Between Fracture Type and Comorbidities

There was a significant association between AO fracture type and comorbidities. A2 fractures were mostly seen in participants with diabetes and hypertension. A3 fractures were associated with hypertension, while C1 fractures were prevalent among smokers. C2 fractures occurred in smokers and those without comorbidities, whereas C3 fractures were more common in participants with osteoporosis or no comorbid conditions. This suggests that certain fracture types are linked to specific comorbidities.

Association Between Gender and Mechanism of Injury

Gender was significantly associated with the mechanism of injury. All road traffic accidents and falls from height occurred in males, whereas females mostly sustained simple falls, assaults, or other types of injuries. This highlights that males are more likely to experience high-energy trauma, while females are more affected by low-energy or varied injury mechanisms.

CONCLUSION

CONCLUSION

The study population primarily consisted of middle-aged adults, with the largest proportion of participants falling within the 31–45 years age range. Younger and older adults represented smaller segments, indicating that middle-aged individuals were most affected. Road traffic accidents emerged as the leading cause of injury, followed by simple falls and falls from height, while injuries due to assaults and other mechanisms were comparatively rare. The predominance of males in the study reflects either a higher exposure to trauma or greater representation in the sample, with males more frequently involved in high-energy injuries and females more often sustaining low-energy or varied mechanisms.

Complex fractures were more common than simple A-type fractures, with type C1 fractures observed most frequently. Males predominantly sustained A- and C1-type fractures, whereas females were more likely to present with severe C2 and C3 fractures, suggesting gender-related differences in fracture patterns. Comorbid conditions were present in a significant portion of participants, with smoking, hypertension, diabetes, and osteoporosis being the most prevalent. Certain fracture types were associated with specific comorbidities, indicating that underlying health conditions may influence the nature and severity of fractures.

Surgical management using parallel plating was the standard approach, with selective use of olecranon osteotomy and bone grafting. Radiological outcomes were favorable, as the majority of fractures united within the expected timeframe and maintained acceptable alignment. Functional outcomes were generally good to excellent, with most participants achieving satisfactory range of motion and performance scores. Complications were relatively infrequent, and included ulnar nerve neuropathy, superficial and deep infections, heterotopic ossification, implant failure, non-union, and occasional re-operation, but these were largely manageable and did not significantly compromise recovery.

Follow-up was adequate, allowing for assessment of both short- and long-term outcomes. Younger participants were more likely to sustain high-energy injuries such as road traffic accidents, while older individuals experienced low-energy or varied mechanisms. Gender was significantly associated with both fracture type and mechanism of injury, highlighting that males were more prone to high-energy trauma and certain fracture patterns, whereas females tended to experience low-energy injuries and more complex fractures. Overall, the study demonstrates clear associations between age, gender, comorbidities, and fracture characteristics, and highlights the effectiveness of surgical management in achieving favourable radiological and functional outcomes with a manageable complication profile.

LIMITATIONS

LIMITATIONS

1. **Limited Age Representation** – The study population was predominantly middle-aged, with fewer younger and older participants, which may limit the generalizability of the findings to all age groups.
2. **Gender Imbalance** – The predominance of male participants may have influenced the observed patterns of injury and fracture types, potentially limiting applicability to female patients.
3. **Single-Center or Small Sample Size** – If the study was conducted in a single institution or with a relatively small cohort, the results may not fully represent wider populations or different geographic settings.
4. **Short to Moderate Follow-up Duration** – While follow-up allowed assessment of outcomes, longer-term complications or functional deficits beyond the study period may not have been captured.
5. **Potential Confounding by Comorbidities** – The presence of various comorbidities may have influenced fracture patterns, healing rates, and functional recovery, making it difficult to isolate the effect of surgical management alone.

RECOMMENDATIONS

RECOMMENDATIONS

1. **Age-Specific Risk Awareness** – Focus preventive measures and patient education on middle-aged adults, as they represent the majority of trauma cases in this population.
2. **High-Energy Trauma Management** – Be vigilant in managing road traffic accident injuries, which are the leading cause of fractures, particularly in younger male patients.
3. **Low-Energy Injury Consideration** – Consider low-energy trauma, such as simple falls, more carefully in older adults, ensuring thorough assessment even when injuries appear minor.
4. **Gender-Specific Evaluation** – Recognize that males are more likely to sustain high-energy injuries and A- or C1-type fractures, while females are prone to complex C2 and C3 fractures, guiding diagnostic imaging and surgical planning.
5. **Fracture Classification Awareness** – Use AO fracture classification for accurate preoperative planning, as complex C-type fractures are more prevalent and may require specialized fixation techniques.
6. **Assessment of Comorbidities** – Screen for comorbid conditions such as smoking, hypertension, diabetes, and osteoporosis, as these may influence fracture type, healing potential, and surgical risk.
7. **Surgical Technique Optimization** – Employ parallel plating as the standard fixation method, with selective use of olecranon osteotomy or bone grafting depending on fracture complexity and bone quality.
8. **Alignment and Union Monitoring** – Prioritize achieving anatomical alignment and timely union, as favorable radiological outcomes correlate with functional recovery.
9. **Functional Outcome Focus** – Plan rehabilitation programs to optimize range of motion and MEPS, considering that most patients can achieve good to excellent functional outcomes with proper management.
10. **Complication Prevention and Management** – Monitor for complications such as ulnar nerve neuropathy, infections, heterotopic ossification, implant failure, and non-union, with early intervention to minimize long-term impact.

11. **Follow-up Strategy** – Maintain structured follow-up schedules, ideally up to 12 months or beyond, to assess long-term functional recovery and detect delayed complications.
12. **Age-Related Mechanism Analysis** – Tailor evaluation and counseling according to age-specific injury patterns; high-energy trauma is more common in younger adults, whereas older adults require attention to falls and low-energy injuries.
13. **Gender-Specific Rehabilitation** – Consider gender differences in fracture patterns when designing post-operative rehabilitation, as females with complex C-type fractures may require more intensive functional recovery programs.
14. **Preoperative Risk Stratification** – Incorporate comorbidities into surgical planning to anticipate potential complications and optimize perioperative care.
15. **Patient Education and Prevention** – Educate patients, especially males at risk of high-energy trauma and older adults susceptible to falls, on safety measures, lifestyle modification, and early presentation for injuries to improve outcomes.

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ANNEXURES

ANNEXURE I

CASE RECORD FORM

Patient Information:

Name :

Age :

Gender :

Date of Admission:

Diagnosis : Distal end humerus fracture

Medical History:

- Relevant medical conditions (e.g., diabetes, hypertension):
- Previous surgeries:
- Current medications:
- Allergies:

Clinical Findings:

- Symptoms (e.g., pain, swelling, deformity):
- Physical examination findings:
- Radiographic findings (X-rays, CT scan, or other imaging):

Preoperative Assessment:

- Functional status and mobility:
- Baseline laboratory investigations:
- Haemoglobin level:
- Coagulation profile:
- Renal function tests:
- Liver function tests:
- Cardiac assessment:
- ECG:
- Echocardiography:
- Cardiac clearance (if required):

Surgical Plan:

- Surgical approach:
- Implant selection:
- Preoperative antibiotics (prophylactic):
- Anesthesia plan:
- Blood transfusion plan (if necessary):

- Intraoperative considerations (e.g., patient positioning, surgical team, equipment):

-Postoperative Care:

- Immediate postoperative management:
- Pain management plan:
- Antibiotic prophylaxis:
- Immobilization (e.g., splint, cast):
- Early mobilization and rehabilitation plan:
- Expected hospital stay:

Follow-up:

- Postoperative day 1:
- Postoperative week 2:
- Postoperative month 3:
- Postoperative month 6:
- Radiographic follow-up schedule:
- Rehabilitation progress and therapy:
- Complications and Management:
- Document any complications encountered during or after surgery
- -Management of complications:
- Outcomes and functional improvement

ANNEXURE II

INFORMED CONSENT

I Mr/Mrs……………………………………age ……Years hereby give my consent to participate in the

"A PROSPECTIVE STUDY ON FUNCTIONAL AND RADIOLOGICAL OUTCOME OF SURGICAL MANAGEMENT OF DISTAL END HUMERUS FRACTURE WITH DUAL PLATING TECHNIQUES."

1. There is no compulsion on me to participate in this project and I am giving my free consent for it.
2. I am ready and willing to undergo all tests and treatments in the present project.
3. I have read and I have been explained the general information

   and purpose of the present project.
4. I have been informed / I have read the probable complications while participating in the present project.
5. I know that I can withdraw from the present project at any time.
6. Any data or analysis of this project will be purely used for scientific purposes and my name will be kept confidential except when required for any legal purpose.
7. I can read English / I can understand data read out to me in English.

Date:

Name and Signature of the study participant: Thumbprint:

Name and Signature of the investigator:

ANNEXURE II

सूचित सहमति प्रपत्र

मैं, श्रीमान/श्रीमती ,____आयु_____ वर्ष

एतदद्वारा "में भाग लेने के लिए मेरी सूचित सहमति देता हूँ"

पूर्ण शीर्षक : **"डुअल प्लेटिंग तकनीक के साथ डिस्टल एंड ह्यूमरस फ्रैक्चर के सर्जिकल प्रबंधन के कार्यात्मक और रेडियोलॉजिकल परिणाम पर एक संभावित अध्ययन।"**

1. इस परियोजना में भाग लेने के लिए मुझ पर कोई बाध्यता नहीं है और मैं इसके लिए अपनी स्वतंत्र सहमति दे रहा हूं।
2. मैं वर्तमान परियोजना में सभी परीक्षणों और उपचारों से गुजरने के लिए तैयार और तैयार हूं।
3. मैंने पढ़ा है और मुझे वर्तमान परियोजना की सामान्य जानकारी और उद्देश्य के बारे में बताया गया है।
4. मुझे सूचित किया गया है / मैंने वर्तमान परियोजना में भाग लेने के दौरान संभावित जटिलताओं को पढ़ा है।
5. मुझे पता है कि मैं किसी भी समय वर्तमान परियोजना से हट सकता हूं।
6. इस परियोजना के किसी भी डेटा या विश्लेषण का उपयोग विशुद्ध रूप से वैज्ञानिक उद्देश्य के लिए किया जाएगा और मेरा नाम गोपनीय रखा जाएगा जब तक कि किसी कानूनी उद्देश्य के लिए आवश्यक न हो।
7. मैं हिन्दी पढ़ सकता/सकती हूं / मैं हिन्दी में पढ़े गए डेटा को समझ सकता हूं।

दिनांक :

अध्ययन प्रतिभागी का नाम और हस्ताक्षर

अंगूठे का निशान

अन्वेषक का नाम और हस्ताक्षर

ANNEXURE II

सूचित संमती फॉर्म

मी, श्री/श्रीमती,

____वय,_ ___ वर्षे

यादवारे सहभागी होण्यासाठी माझी सूचित संमती द्याया प्रकल्पात सहभागी होण्यासाठी माझ्यावर कोणतीही सक्ती नाही आणि मी त्यासाठी माझी विनामूल्य संमती देत आहे.

शीर्षक: **"ड्युअल प्लेटिंग तंत्रासह डिस्टल एंड ह्युमरस फ्रॅक्चरच्या सर्जिकल व्यवस्थापनाच्या कार्यात्मक आणि रेडिओलॉजिकल परिणामावरील संभाव्य अभ्यास."**

1. या प्रकल्पात सहभागी होण्यासाठी माझ्यावर कोणतीही सक्ती नाही आणि मी त्यासाठी माझी विनामूल्य संमती देत आहे.

2. मी सध्याच्या प्रकल्पातील सर्व चाचण्या आणि उपचारांना सामोरे जाण्यास तयार आणि तयार आहे.

3.मी वाचले आहे आणि मला सामान्य माहिती समजावून सांगितली आहे

आणि सध्याच्या प्रकल्पाचा उद्देश.

4. मला माहिती देण्यात आली आहे / मी सध्याच्या प्रकल्पात भाग घेत असताना संभाव्य गुंतागुंत वाचल्या आहेत.

5.मला माहित आहे की मी सध्याच्या प्रकल्पातून कधीही माघार घेऊ शकतो.

6.या प्रकल्पाचा कोणताही डेटा किंवा विश्लेषण पूर्णपणे वैज्ञानिक हेतूसाठी वापरला जाईल आणि कोणत्याही कायदेशीर कारणासाठी आवश्यक असल्याशिवाय माझे नाव गोपनीय ठेवले जाईल.

7.मी मराठी वाचू शकतो / मला मराठी वाचलेला डेटा समजू शकतो

तारीख:

अभ्यासात सहभागी झालेल्या व्यक्तीचे नाव आणि स्वाक्षरी अंगठ्याची छाप

अन्वेषकाचे नाव आणि स्वाक्षरी

MASTER CHART

SR NO	AGE GROUP	GENDER	MECHANISM OF INJURY	AO TYPE	CO-MORBIDITIES				SURGICAL APROACH			RADIOLOGICAL OUTCOME		FUNCTIONAL OUTCOME			COMPLICATIONS	FOLLOW UP
					HYPERTENSION	DIABETES MELLITES	SMOKING	OSTEOPOROSIS	OLECRANON OSTEOTOMY	PARALLEL PLATING	FIXATION TECHNIQUE	UNION STATUS (WEEKS)	ALIGNMENT	MEPS GRADING	ROM	MYOS SCORE		
1	18	MALE	RTA	A2	PRESENT	ABSENT	ABSENT	ABSENT	DONE	DONE	GRAFT	6 WEEKS	ACCEPTABLE	EXCELLENT	90	85	SUPERFICIAL INFECTION	6 MONTHS
2	30	MALE	FALL FROM HIEGHT	A3	ABSENT	ABSENT	ABSENT	ABSENT	DONE	DONE	NONE	10 WEEKS	ACCEPTABLE	GOOD	100	85	NONE	12 MONTHS
3	27	MALE	FALL FROM HIEGHT	C2	ABSENT	ABSENT	PRESENT	PRESENT	DONE	DONE	NONE	6 WEEKS	ACCEPTABLE	GOOD	95	88	DEEP INFECTION	12 MONTHS
4	25	MALE	RTA	A2	ABSENT	ABSENT	ABSENT	ABSENT	DONE	DONE	NONE	8 WEEKS	MALALIGNMENT	GOOD	100	82	NON-UNION	15 MONTHS
5	23	MALE	FALL(GROUND LEVEL)	A2	PRESENT	PRESENT	PRESENT	ABSENT	DONE	DONE	NONE	14 WEEKS	ACCEPTABLE	FAIR	105	84	NONE	15 MONTHS
6	22	MALE	FALL FROM HIEGHT	A3	ABSENT	ABSENT	ABSENT	ABSENT	DONE	DONE	GRAFT	8 WEEKS	ACCEPTABLE	EXCELLENT	110	86	NONE	12 MONTHS
7	19	FEMALE	RTA	C2	ABSENT	ABSENT	ABSENT	ABSENT	DONE	DONE	NONE	10 WEEKS	ACCEPTABLE	GOOD	102	87	NONE	12 MONTHS
8	19	FEMALE	RTA	C2	ABSENT	ABSENT	ABSENT	ABSENT	NONE	DONE	NONE	10 WEEKS	ACCEPTABLE	EXCELLENT	104	83	SUPERFICIAL INFECTION	6 MONTHS
9	25	MALE	FALL FROM HIEGHT	A3	ABSENT	PRESENT	PRESENT	ABSENT	NONE	DONE	NONE	6 WEEKS	ACCEPTABLE	GOOD	106	84	NONE	12 MONTHS
10	25	MALE	FALL FROM HIEGHT	A2	ABSENT	ABSENT	ABSENT	PRESENT	NONE	DONE	GRAFT	8 WEEKS	ACCEPTABLE	GOOD	98	86	NONE	6 MONTHS
11	45	FEMALE	FALL(GROUND LEVEL)	A3	PRESENT	ABSENT	ABSENT	ABSENT	NONE	DONE	NONE	5 WEEKS	ACCEPTABLE	FAIR	96	85	NONE	12 MONTHS
12	32	FEMALE	RTA	C2	ABSENT	ABSENT	PRESENT	ABSENT	NONE	DONE	NONE	11 WEEKS	MALALIGNMENT	EXCELLENT	94	85	NON-UNION	6 MONTHS
13	37	FEMALE	FALL(GROUND LEVEL)	A2	ABSENT	ABSENT	ABSENT	ABSENT	DONE	DONE	NONE	13 WEEKS	ACCEPTABLE	GOOD	100	85	NONE	6 MONTHS
14	39	MALE	RTA	A3	ABSENT	PRESENT	PRESENT	ABSENT	DONE	DONE	GRAFT	15 WEEKS	ACCEPTABLE	EXCELLENT	110	85	SUPERFICIAL INFECTION	6 MONTHS
15	41	FEMALE	FALL FROM HIEGHT	C2	PRESENT	ABSENT	ABSENT	ABSENT	DONE	DONE	NONE	8 WEEKS	ACCEPTABLE	GOOD	120	88	NONE	12 MONTHS
16	45	FEMALE	FALL FROM HIEGHT	C2	ABSENT	ABSENT	ABSENT	ABSENT	NONE	DONE	GRAFT	10 WEEKS	ACCEPTABLE	GOOD	90	82	NONE	12 MONTHS
17	42	MALE	DIRECT BLOW/ ASSAULT	C2	ABSENT	ABSENT	ABSENT	ABSENT	NONE	DONE	NONE	10 WEEKS	MALALIGNMENT	GOOD	80	82	REOPERATION	12 MONTHS
18	43	MALE	RTA	A2	ABSENT	ABSENT	ABSENT	ABSENT	NONE	DONE	NONE	6 WEEKS	ACCEPTABLE	POOR	85	88	NONE	12 MONTHS
19	31	MALE	RTA	C1	ABSENT	ABSENT	ABSENT	ABSENT	NONE	DONE	NONE	8 WEEKS	ACCEPTABLE	FAIR	95	85	NONE	12 MONTHS
20	45	FEMALE	RTA	C2	ABSENT	ABSENT	ABSENT	ABSENT	NONE	DONE	NONE	8 WEEKS	ACCEPTABLE	GOOD	105	86	ULNAR NERVE NEUROPATHY	12 MONTHS
21	38	FEMALE	FALL FROM HIEGHT	A2	ABSENT	ABSENT	ABSENT	ABSENT	NONE	DONE	NONE	5 WEEKS	ACCEPTABLE	EXCELLENT	115	86	NONE	12 MONTHS
22	39	MALE	FALL FROM HIEGHT	C1	ABSENT	ABSENT	ABSENT	ABSENT	NONE	DONE	GRAFT	11 WEEKS	ACCEPTABLE	FAIR	100	86	NONE	12 MONTHS
23	37	MALE	DIRECT BLOW/ ASSAULT	C1	PRESENT	ABSENT	ABSENT	ABSENT	NONE	DONE	GRAFT	10 WEEKS	ACCEPTABLE	GOOD	105	84	HETEROTROPIC OSSIFICATION	15 MONTHS
24	35	MALE	RTA	C1	ABSENT	ABSENT	ABSENT	ABSENT	NONE	DONE	NONE	10 WEEKS	ACCEPTABLE	GOOD	105	84	NONE	15 MONTHS
25	38	MALE	FALL FROM HIEGHT	C2	ABSENT	PRESENT	PRESENT	ABSENT	DONE	DONE	NONE	6 WEEKS	ACCEPTABLE	EXCELLENT	95	84	ULNAR NERVE NEUROPATHY	6 MONTHS
26	39	MALE	OTHER	A2	ABSENT	ABSENT	PRESENT	PRESENT	DONE	DONE	NONE	6 WEEKS	ACCEPTABLE	EXCELLENT	95	87	NONE	6 MONTHS
27	33	MALE	OTHER	C2	ABSENT	ABSENT	ABSENT	ABSENT	DONE	DONE	NONE	5 WEEKS	ACCEPTABLE	POOR	90	87	HETEROTROPIC OSSIFICATION	15 MONTHS
28	31	MALE	OTHER	C2	ABSENT	PRESENT	PRESENT	ABSENT	DONE	DONE	GRAFT	11 WEEKS	ACCEPTABLE	GOOD	110	87	NONE	15 MONTHS
29	32	MALE	RTA	C1	PRESENT	ABSENT	PRESENT	PRESENT	DONE	DONE	NONE	8 WEEKS	ACCEPTABLE	POOR	100	83	NONE	16 MONTHS
30	38	FEMALE	FALL(GROUND LEVEL)	C2	PRESENT	PRESENT	PRESENT	ABSENT	DONE	DONE	GRAFT	10 WEEKS	ACCEPTABLE	EXCELLENT	110	83	ULNAR NERVE NEUROPATHY	12 MONTHS
31	39	MALE	RTA	C1	PRESENT	ABSENT	ABSENT	ABSENT	NONE	DONE	NONE	10 WEEKS	ACCEPTABLE	EXCELLENT	90	83	HETEROTROPIC OSSIFICATION	12 MONTHS
32	37	MALE	FALL(GROUND LEVEL)	C3	ABSENT	ABSENT	ABSENT	ABSENT	NONE	DONE	GRAFT	6 WEEKS	ACCEPTABLE	FAIR	80	83	NONE	12 MONTHS
33	46	MALE	FALL(GROUND LEVEL)	C3	ABSENT	ABSENT	ABSENT	ABSENT	NONE	DONE	NONE	6 WEEKS	ACCEPTABLE	FAIR	85	87	NONE	12 MONTHS
34	60	MALE	FALL(GROUND LEVEL)	C1	ABSENT	ABSENT	ABSENT	ABSENT	NONE	DONE	NONE	8 WEEKS	ACCEPTABLE	GOOD	95	85	NONE	12 MONTHS
35	48	MALE	RTA	C3	ABSENT	ABSENT	ABSENT	ABSENT	NONE	DONE	NONE	8 WEEKS	ACCEPTABLE	FAIR	105	86	ULNAR NERVE NEUROPATHY	12 MONTHS
36	50	MALE	RTA	C3	ABSENT	ABSENT	ABSENT	ABSENT	NONE	DONE	NONE	5 WEEKS	ACCEPTABLE	EXCELLENT	115	84	NONE	14 MONTHS
37	55	FEMALE	FALL(GROUND LEVEL)	C1	ABSENT	ABSENT	PRESENT	ABSENT	NONE	DONE	NONE	11 WEEKS	ACCEPTABLE	EXCELLENT	120	84	NONE	6 MONTHS
38	54	MALE	FALL(GROUND LEVEL)	C1	PRESENT	ABSENT	ABSENT	ABSENT	DONE	DONE	NONE	15 WEEKS	ACCEPTABLE	FAIR	110	86	NONE	13 MONTHS
39	52	FEMALE	RTA	C3	ABSENT	ABSENT	PRESENT	ABSENT	DONE	DONE	NONE	8 WEEKS	ACCEPTABLE	GOOD	110	85	NONE	14 MONTHS
40	51	MALE	FALL(GROUND LEVEL)	C3	ABSENT	ABSENT	ABSENT	ABSENT	DONE	DONE	NONE	10 WEEKS	ACCEPTABLE	GOOD	90	85	NONE	6 MONTHS
41	58	MALE	RTA	C1	ABSENT	ABSENT	ABSENT	PRESENT	DONE	DONE	NONE	10 WEEKS	MALALIGNMENT	EXCELLENT	90	85	IMPLANT FAILURE	12 MONTHS
42	57	FEMALE	FALL(GROUND LEVEL)	C1	ABSENT	ABSENT	PRESENT	ABSENT	NONE	DONE	NONE	10 WEEKS	MALALIGNMENT	EXCELLENT	100	85	IMPLANT FAILURE	12 MONTHS
43	57	FEMALE	FALL(GROUND LEVEL)	C3	ABSENT	ABSENT	ABSENT	ABSENT	NONE	DONE	NONE	6 WEEKS	ACCEPTABLE	EXCELLENT	100	86	NONE	6 MONTHS
44	56	MALE	FALL(GROUND LEVEL)	C3	ABSENT	ABSENT	PRESENT	ABSENT	NONE	DONE	NONE	6 WEEKS	ACCEPTABLE	FAIR	110	84	NONE	6 MONTHS
45	65	MALE	RTA	C1	ABSENT	ABSENT	ABSENT	ABSENT	NONE	DONE	NONE	5 WEEKS	ACCEPTABLE	EXCELLENT	90	84	NONE	6 MONTHS
46	68	MALE	FALL(GROUND LEVEL)	C1	ABSENT	ABSENT	PRESENT	ABSENT	NONE	DONE	NONE	11 WEEKS	ACCEPTABLE	EXCELLENT	90	86	NONE	12 MONTHS
47	64	MALE	RTA	C1	ABSENT	ABSENT	ABSENT	ABSENT	NONE	DONE	NONE	14 WEEKS	ACCEPTABLE	EXCELLENT	110	85	NONE	6 MONTHS
48	67	FEMALE	RTA	C3	ABSENT	ABSENT	ABSENT	ABSENT	NONE	DONE	NONE	NON-UNION	ACCEPTABLE	EXCELLENT	100	85	REOPERATION	12 MONTHS
49	63	MALE	FALL(GROUND LEVEL)	C3	ABSENT	ABSENT	ABSENT	ABSENT	NONE	DONE	NONE	NON-UNION	ACCEPTABLE	FAIR	100	86	NONE	12 MONTHS
50	61	MALE	RTA	C1	ABSENT	ABSENT	ABSENT	ABSENT	NONE	DONE	NONE	NON-UNION	ACCEPTABLE	EXCELLENT	100	84	NONE	6 MONTHS