Biomedical and Biopharmaceutical Research
Abbreviation: Biomed. Biopharm. Res.
Volume: 22: Issue: 02 |Year: 2025
Page Number: 867-874

Outcomes of Minimally Invasive Plate Osteosynthesis for Humeral Shaft Fractures

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Article Received:10-06-2025

Article Accepted:15-07-2025

Abstract

Background: Minimally invasive plate osteosynthesis (MIPO) has emerged as a advantageous surgical technique for humeral shaft fractures, aiming to preserve soft tissue integrity and reduce complications associated with conventional open plating or intramedullary nailing.

Methods: A study was conducted on 15 patients with diaphyseal humeral fractures treated with anterior MIPO at a tertiary care centre between December 2023 and November 2024. Patients were evaluated for radiological union, shoulder and elbow function (Constant-Murley Score and Mayo Elbow Performance Score MEPS), surgical time, and complications. The average follow-up period was 6 months.

Results: The mean age of patients was 42.7 years. All fractures united, with an average union time of 11.9 weeks. Mean Constant-Murley Score for the affected shoulder was 87, while the mean MEPS for the elbow was 97.33. Complications includes one delayed union and two cases of radial nerve palsy, one of which recovered completely. No infections were reported. The mean surgical time was 69 minutes, and average blood loss was 109 ml.

Conclusion: Anterior MIPO for humeral shaft fractures provides excellent functional and radiological outcomes, with low complication rates, minimal soft tissue disruption, and a cosmetically favorable approach. This technique is effective, particularly in appropriately selected patients, and facilitates early return to function.

Keywords: Minimally invasive plate osteosynthesis, Humeral shaft fractures, Functional outcomes.

INTRODUCTION

Humeral shaft fractures are commonly encountered orthopedic injuries, typically managed non-operatively. However, surgical intervention is warranted in specific scenarios, including polytrauma, open fractures, nonunion, and failed conservative treatment. Traditional methods such as open reduction and internal fixation (ORIF) and intramedullary nailing (IMN) are effective but associated with complications like radial nerve injury and shoulder dysfunction.

Minimally invasive plate osteosynthesis (MIPO) has gained attention as an alternative technique that minimizes soft tissue disruption and preserves periosteal blood supply. This approach offers stable fixation through small incisions and indirect fracture reduction, potentially improving outcomes and reducing complications. This study evaluates the clinical and radiological outcomes of anterior MIPO in treating diaphyseal humerus fractures.

MATERIALS AND METHODS

Study Design : study was conducted at the Department of Orthopaedics, Rajiv Gandhi Medical College and Chhatrapati Shivaji Maharaj Hospital, Maharashtra, from December 2023 to November 2024.

Inclusion Criteria:
Adults (>18 years)
Closed diaphyseal humerus fractures(includes transverse and oblique fractures)
Patients fit for surgery
Fractures with unacceptable displacement after closed reduction

Exclusion Criteria:
Skeletally immature patients
Pathological fractures
Open fractures
Patients managed conservatively

Surgical Technique: Patients were positioned supine with the arm supinated. A standard anterior MIPO technique was employed using two small incisions. The 4.5 mm locking compression plate (LCP) was inserted submuscularly and secured with locking screws. Care was taken to protect the radial nerve, and intraoperative fluoroscopy was used to confirm reduction.

Postoperative Protocol: Arm sling immobilization was provided postoperatively. Pendulum and elbow ROM exercises began within 48 hours, followed by active-assisted shoulder mobilization. Sutures were removed on postoperative day 14.

Outcome Measures:
Radiological union (bridging callus)
Functional outcomes: Constant-Murley Score CMS(shoulder), Mayo Elbow Performance Score MEPS (elbow)
Complications radial n palsy,vascular injury
Surgical time and intraoperative blood loss

Follow-Up: Patients were followed at 6 weeks, 3 months, and 6 months.

RESULTS
The study included 15 patients (10 males, 5 females) with a mean age of 42.7 years. The dominant mechanism of injury was road traffic accidents (73.3%), followed by falls (26.7%). The left side was affected in 53.3% of cases.

All fractures achieved union with an average time to radiological healing of 11.9 weeks (range: 8–20 weeks). Varus angulation >10° was seen in 4 cases, but none resulted in functional impairment

Functional Outcomes:
Shoulder: Constant-Murley Score averaged 87 on the operated side versus 90.67 on the unaffected side. 93.3% (14/15) of patients had excellent outcomes, 1 patient had a good result.

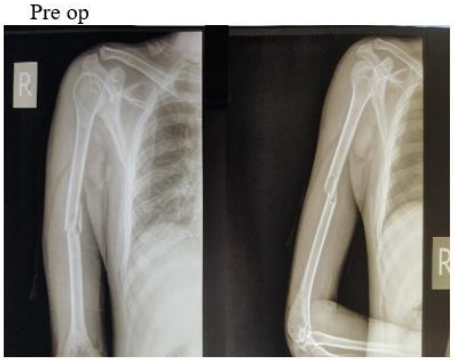
Elbow: The mean MEPS was 97.33. All patients scored in the excellent category (≥90).

Complications: ONE patient developed radial nerve palsy. which recovered fully within 3 months; . One delayed union occurred, attributed to distraction at the fracture site. No infections or implant failures were noted.

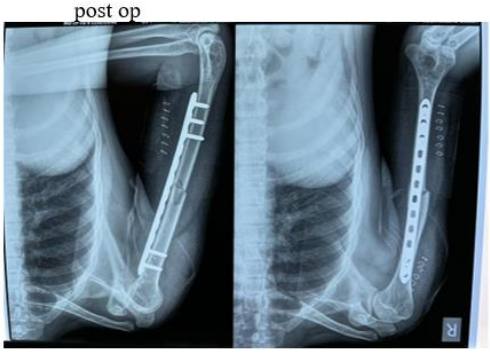
Surgical Metrics:
Mean surgical time: 69 minutes
Mean blood loss: 109 ml

Case 1

Pre op



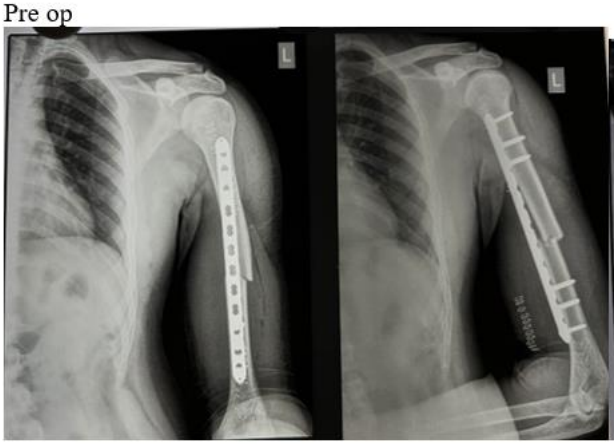
post op



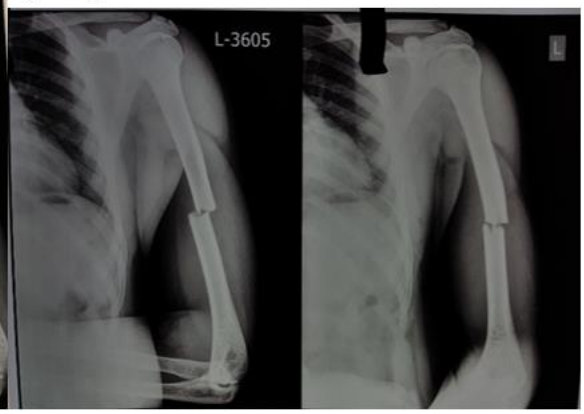
Post op after 6 months

Case 2

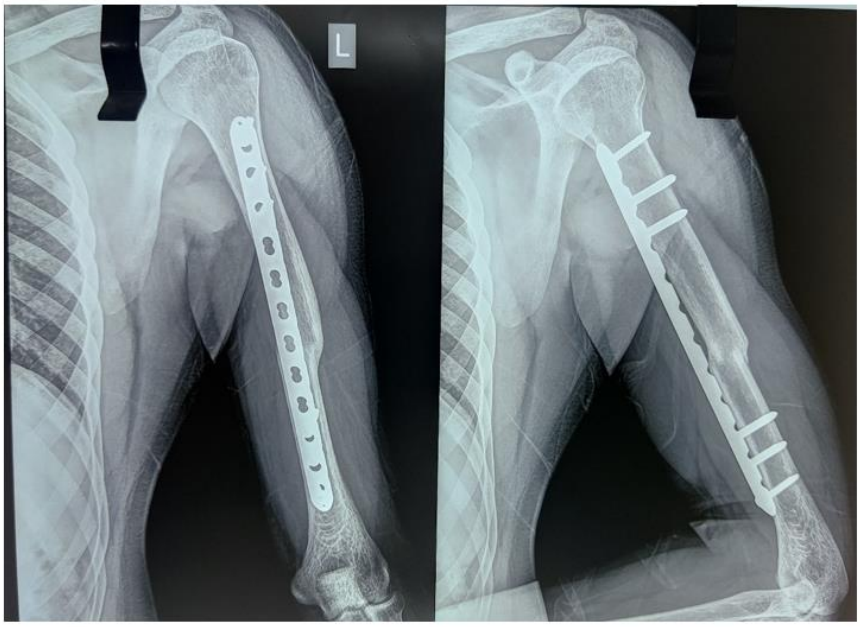
Pre op



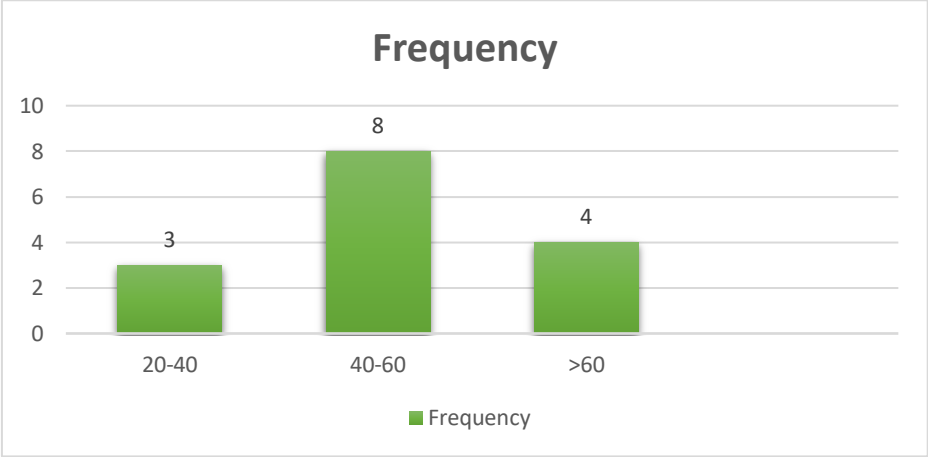
post op



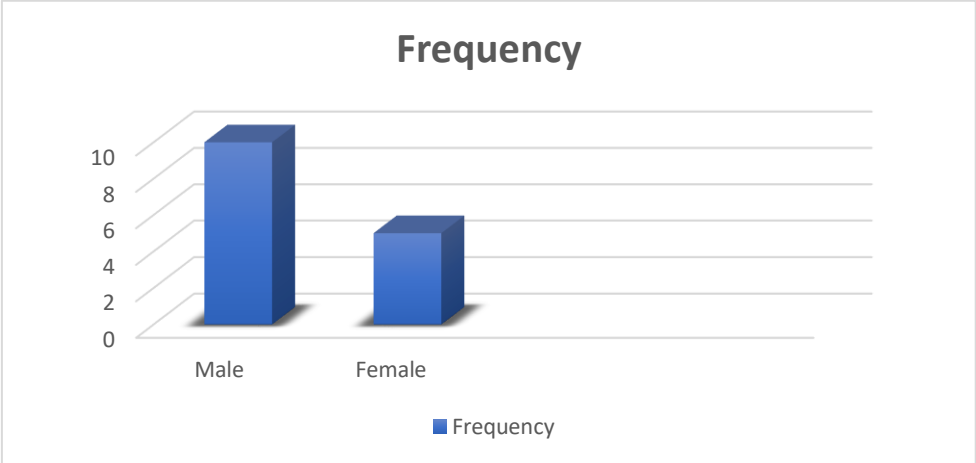
6 month ago



1.AGE DISTRIBUTION: Among the 15 patients studied, highest number of patients were seen in 40-60 years (53.3%) age group. The average was 42.7 years.

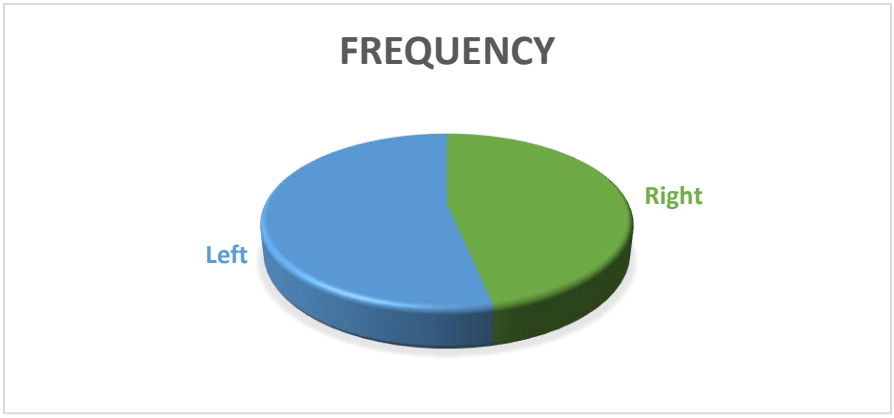


2.GENDER DISTRIBUTION

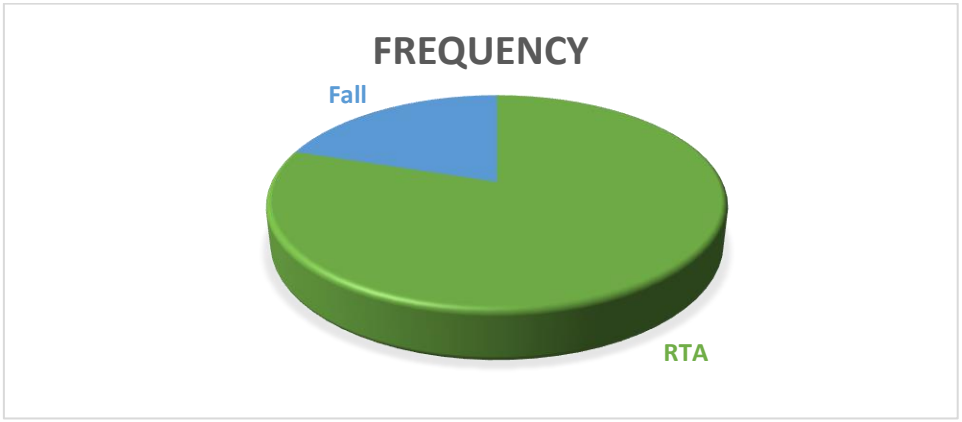


3. SIDE DISTRIBUTION

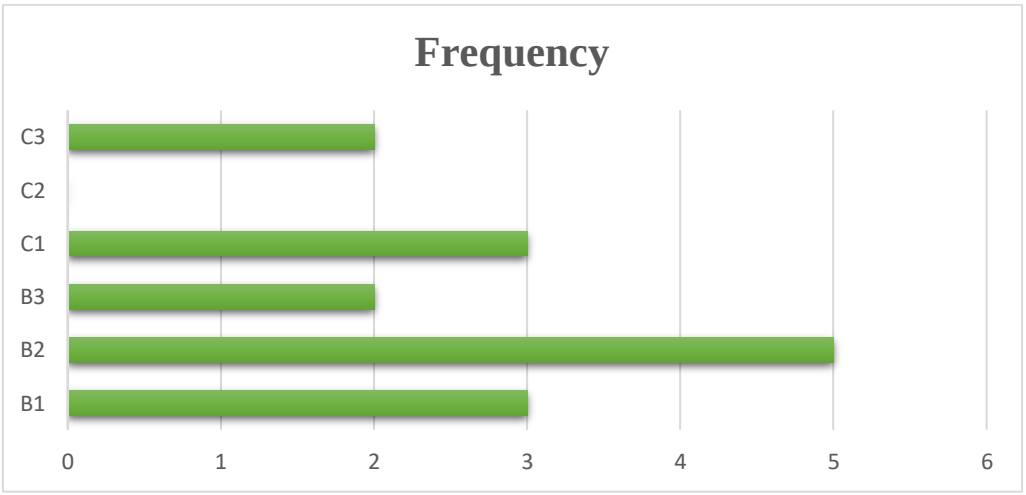
SIDE	Frequency	Percentage (%)
RIGHT	7	46.66
LEFT	8	53.33
TOTAL	15	100



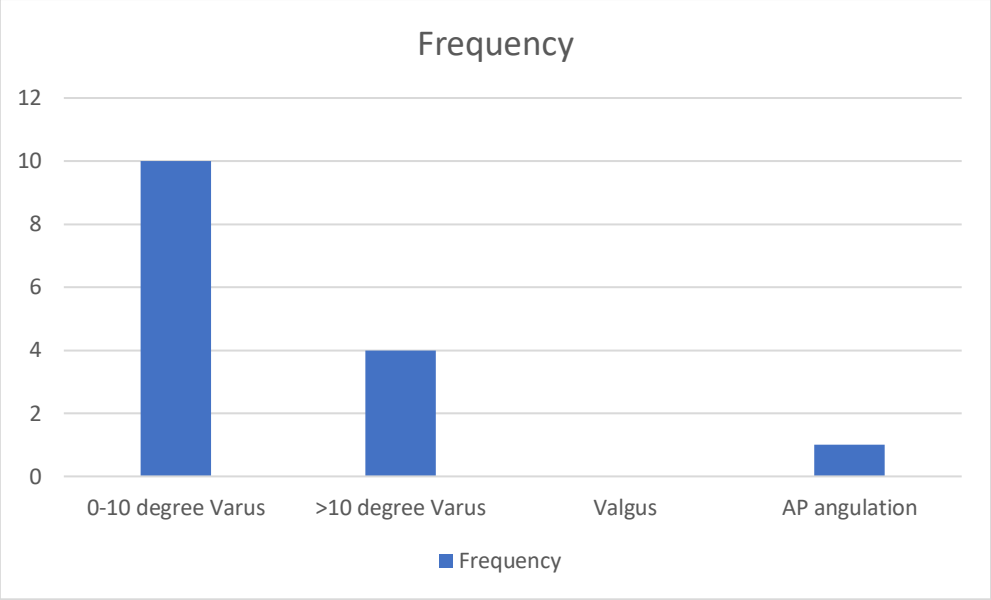
4. MODE OF INJURY



5. FRACTURE CLASSIFICATION (OTA Classification)



6. RADIOLOGICAL VALGUS/VARUS ANGULATION



DISCUSSION

Minimally invasive surgical techniques for skeletal injuries are designed to preserve the biology of both soft tissue and bone, which is critical for optimal healing. The core goal of fracture fixation is to restore both the anatomical alignment and mechanical function of the bone. Achieving effective bone healing requires a balance between the mechanical stabilization provided by the fixation and the biological environment that supports bone regeneration, which is facilitated by modern osteosynthesis techniques.

In contrast, open reduction and internal fixation (ORIF) often achieves precise fracture reduction and stable fixation but at the cost of significant soft tissue trauma. The extensive soft tissue dissection involved in ORIF can impair periosteal blood supply and result in complications such as delayed healing, osteonecrosis, and nonunion, highlighting the trade-off between stabilization and biological preservation.

Minimally invasive surgery (MIS) differs from ORIF primarily in the approach to soft tissue handling and reduction techniques. MIS is not defined by the size of the incisions but by the use of small soft-tissue windows to insert implants and instruments, thus minimizing disruption to the fracture site and surrounding tissues. The technique relies on indirect reduction, which minimizes additional trauma to the soft tissues and fracture fragments. Direct reduction is only performed when absolutely necessary to achieve proper fracture alignment. Special instruments designed for minimal trauma at the fracture site are another hallmark of MIS, ensuring that bone and soft tissue integrity is preserved throughout the procedure.

Minimally invasive plate osteosynthesis (MIPO) offers significant advantages over open reduction and plate fixation for humerus fractures by minimizing soft tissue damage and preserving periosteal blood supply. In contrast, open techniques disrupt local vascularization, potentially leading to osteonecrosis beneath the implant, delayed healing, or nonunion, with reported nonunion rates of 5.8%. Additionally, primary bone healing without callus formation in open techniques is less robust, increasing the risk of refracture after implant removal.

MIPO also avoids the complications associated with intramedullary nailing, such as rotator cuff impingement, which can arise from entry-point issues.

In this study, the average fracture union time was 11.9 weeks (range: 8–20 weeks), with a union rate of 93.7%. One case experienced delayed union, taking 20 weeks, due to excessive traction during fixation, which caused distraction at the fracture site. These results compare favorably with the Concha et al. study, which reported a 91.5% union rate (32/35 cases) at an average of 12 weeks. Notably, all fractures in this study healed without the need for primary or secondary bone grafting.

ORIF for comminuted fractures often requires lag screw fixation or bone grafting, which increases surgery time, blood loss, and postoperative complications. Additionally, the nonunion rate is higher in ORIF, around 5.8%, due to the extensive soft tissue dissection. In contrast, MIPO offers advantages in reducing these issues.

Esmailiejah et al. found that MIPO provided better outcomes than open reduction and plating, particularly in terms of shorter surgery time, lower incidence of iatrogenic radial nerve injury (3% compared to 12%), and a reduced infection rate (0% compared to 6%). Patients treated with MIPO also experienced faster fracture union and a quicker return to normal activities.

In this study, 4 of the 15 cases showed more than a 10-degree angulation, but this did not result in any functional impairment. This suggests that the near-normal biological reduction achieved by MIPO does not negatively impact the patient's functional outcome.

- The average surgical time for MIPO was 69 minutes (ranging from 60 to 90 minutes), which was shorter than the 91.5 minutes reported in the study by M. Shantharam Shetty et al.
- Shoulder function was evaluated using the Constant Murley Score, with a score of 87 on the affected side and 90.67 on the healthy side. These results were better than those reported by Apivatthakakul et al., who found scores of 85.8 on the affected side and 90.6 on the healthy side.
- There were no cases of postoperative shoulder pain or stiffness, which is a common complication in the intramedullary nail group due to nail impingement.
- The mean Mayo Elbow Performance Score (MEPS) was 97.66, which aligns with findings from other studies.
- No infections were reported postoperatively, which was an improvement compared to Concha et al.'s study, where two cases of infection were noted.
- one case of postoperative radial nerve palsy occurred. One patient recovered fully by six months, These nerve injuries likely occurred early in the study due to issues with plate offset and unicortical drilling, which risked drill bit slippage into neural structures. To avoid this, the plate's position should be carefully checked both digitally and radiologically before drilling. It is important to ensure that the plate is advanced gently in the proper intermuscular plane, maintaining close contact with the bone and following a proximal-to-distal direction. The forearm should be positioned in supination, as pronation brings the radial nerve closer to the plate
- The scars from the procedure were cosmetically acceptable compared to those from ORIF.
- The average blood loss was lower than with ORIF, and all patients experienced an early return to activity due to reduced postoperative complications.

CONCLUSION

Minimally invasive anterior plating using the MIPO technique is a safe and effective method for treating diaphyseal humeral fractures. It offers excellent union rates, favorable functional recovery, minimal complications, and better cosmetic outcomes. With proper technique and patient selection, MIPO should be considered a preferred option in suitable cases.

REFERENCES

1. Gupta, T., Shamim, S., Ahmed, A., Gupta, V., Mazumdar, G., & Vaish, A. (2024). A Study on Outcome of Conservative Management of Shaft Humerus Fracture: A Case Report. *Journal of orthopaedic case reports*, *14*(12), 252–256. https://doi.org/10.13107/jocr.2024.v14.i12.5088
2. Martinez-Catalan N. (2023). Conservative Treatment of Proximal Humerus Fractures: When, How, and What to Expect. *Current reviews in musculoskeletal medicine*, *16*(2), 75–84. https://doi.org/10.1007/s12178-022-09817-9
3. Soler-Peiro, M., García-Martínez, L., Aguilella, L., & Perez-Bermejo, M. (2020). Conservative treatment of 3-part and 4-part proximal humeral fractures: a systematic review. *Journal of orthopaedic surgery and research*, *15*(1), 347. https://doi.org/10.1186/s13018-020-01880-7
4. Daoub, A., Ferreira, P. M. O., Cheruvu, S., Walker, M., Gibson, W., Orfanos, G., & Singh, R. (2022). Humeral shaft fractures: a literature review on current treatment methods. *The Open Orthopaedics Journal*, *16*(1).
5. Orapiriyakul, W., Apivatthakakul, V., Theppariyapol, B., & Apivatthakakul, T. (2023). Humerus shaft fractures, approaches and management. Journal of Clinical Orthopaedics and Trauma, 43, 102230.
6. Hurley, E. T., Wickman, J., Crook, B. S., Cabell, G., Rodriguez, K., Boadi, P., ... & Klifto, C. (2023). Intramedullary nailing vs. open reduction–internal fixation for humeral shaft fractures: a meta-analysis of randomized controlled trials. *Journal of Shoulder and Elbow Surgery*, *32*(12), 2567-2574.
7. Wong, J., Newman, J. M., & Gruson, K. I. (2016). Outcomes of intramedullary nailing for acute proximal humerus fractures: a systematic review. *Journal of Orthopaedics and Traumatology*, *17*, 113-122.
8. Launonen, A. P., Lepola, V., FLinkkiLä, T., Laitinen, M., Paavola, M., & Malmivaara, A. (2015). Treatment of proximal humerus fractures in the elderly: a systematic review of 409 patients. *Acta orthopaedica*, *86*(3), 280-285.
9. Sarhan, M., Hegazy, M., Montaser, M. G., & El-Hammady, A. (2023). Minimally Invasive Plate Osteosynthesis for humeral shaft fractures: a systematic review. *Benha Medical Journal*. https://doi.org/10.21608/bmfj.2023.237050.1901
10. Sugumar, N., Sathiyaseelan, N., Purushothaman, J. R., & Natarajan, S. (2024). Assessing functional and radiological outcomes: open reduction and internal fixation vs. minimally invasive plate osteosynthesis for humerus shaft fractures-a prospective comparative study. *International Orthopaedics*, *48*(11), 2979-2991.
11. Sidhu, G., Jain, D. K., Selhi, H. S., Kaur, H., Rowinski, S., Pattnaik, S., & Ashwood, N. (2024). A prospective cohort study: promising results with minimally invasive plate osteosynthesis of anterior bridge plating in adult humeral shaft fractures. *Clinics in Shoulder and Elbow*. https://doi.org/10.5397/cise.2024.00423

12. Hu, C., Qiu, B., Chen, C., Luo, Q., & Cao, Y. (2024). 3D printing assisted MIPO for treatment of complex middle-proximal humeral shaft fractures. *BMC Musculoskeletal Disorders*, *25*. https://doi.org/10.1186/s12891-024-07202-w