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# The Three-Stitch Technique for Antegrade Humerus Nailing: A Minimally Invasive Approach to Improved Functional Outcomes and Reduced Complications in Humerus Shaft Fractures Narrative review

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## Abstract

**Introduction:** Humerus shaft fractures constitute a significant proportion of long bone fractures, presenting challenges in treatment. While plate osteosynthesis and intramedullary nailing are common fixation modalities, traditional approaches often carry substantial risks, including extensive surgical exposure, rotator cuff violation, and neurovascular injury. This article details the three-stitch technique for antegrade humerus nailing, a minimally invasive approach designed to mitigate these perioperative and postoperative complications, particularly for comminuted shaft humerus fractures.

**Methodology:** This report synthesises findings from two prospective studies conducted at Dr. D.Y. Patil Medical College and Hospital, Nerul, Navi Mumbai. The first study (May 2016-May 2018) involved 20 adult patients with diaphyseal humeral shaft fractures. The second study (March 2022-March 2024) included 24 adult patients with posttraumatic comminuted humerus shaft fractures, classified up to type 12C according to AO/OTA. Both studies employed the three-stitch technique for closed antegrade intramedullary interlocking nailing. The surgical technique involved positioning patients in a "beach chair" position, using small stab incisions (approximately 1 cm) for the entry portal (anterior to the anterior rim of the acromion to preserve the rotator cuff), and for proximal and distal locking. Meticulous, blunt soft tissue dissection with a K-wire and the use of soft tissue protection sleeves were critical steps to protect neurovascular structures during drilling and screw insertion, particularly for the antero-posterior distal locking. Patients underwent early mobilisation and were followed up for functional outcomes.

**Results:** In the initial study of 20 diaphyseal fractures, all patients showed good to excellent results at one year, with a mean union time of 8 weeks, and all fractures united by 10 weeks. Crucially, no complications such as rotator cuff violation, shoulder stiffness, or neurovascular injury were reported. For the 24 patients with comminuted fractures, 22 (96%) exhibited excellent functional outcomes and good adherence to rehabilitation. There were only two instances of delayed wound healing, and importantly, no cases of nonunion were observed. Objective assessments using the Mayo Elbow Performance Index (MEPI) and University of California at Los Angeles (UCLA) scores demonstrated significant restoration of function, with MEPI scores improving from 18 to 23 within the excellent outcome group over 6 months, and UCLA scores enhancing from 20 to 23 (exceptional to good ratings).

**Conclusion:** The three-stitch technique for antegrade humerus nailing is a viable and advantageous alternative to conventional methods and other surgical techniques like external fixators and plate osteosynthesis, especially for comminuted injuries. It consistently yields favourable outcomes, significantly reduces complications (including rotator cuff violation and neurovascular injury), and improves cosmetic results.

**Keywords:** Antegrade humerus nailing, Three-stitch technique, Humerus diaphyseal fractures, MEPI score, UCLA score.

## Introduction

Approximately 5–10% of all long bone fractures occur in the humerus, with humeral diaphyseal fractures accounting for about 20% of all humeral fractures. Various modalities exist for internal fixation of these fractures, with plate osteosynthesis and intramedullary nailing being the most common. While plate osteosynthesis can provide rigid fixation and good functional recovery, it has reported disadvantages, including the requirement for wide surgical exposure and longer operative times compared to intramedullary fixation. Furthermore, plate osteosynthesis methods, particularly for comminuted humerus shaft fractures, are associated with risks such as increased blood loss, extensive soft tissue injury, nerve injury, surgical site infections, infected nonunions, osteomyelitis, and post infective scarring.

Intramedullary nails, conversely, are biomechanically superior, acting as load-sharing and stress-shielding devices that are subjected to smaller bending loads and are less likely to fail due to fatigue. Among intramedullary nailing techniques, antegrade humerus nailing is generally preferred over retrograde nailing for diaphyseal humerus

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**Figure 1:** Stab incision for entry point just anterior to acromion

fractures due to several challenges associated with the latter. Retrograde nail insertion is technically more demanding and may lead to a longitudinal fracture above the site of bone trepanation. Proximal interlock with screws in retrograde nailing can damage vulnerable soft tissues around the shoulder girdle, such as the axillary nerve. Moreover, a narrow medullary canal can obstruct retrograde insertion in young patients, and the prone position required for the retrograde technique may carry high anaesthesia-related risks.

Despite the preference for antegrade humerus nailing, traditional antegrade methods also present technical problems and complications. These include the violation of the rotator cuff and soft tissue injury around the shoulder and elbow during proximal and distal locking procedures. The violation of the rotator cuff has been linked to suboptimal clinical outcomes and discomfort in the shoulder joint.

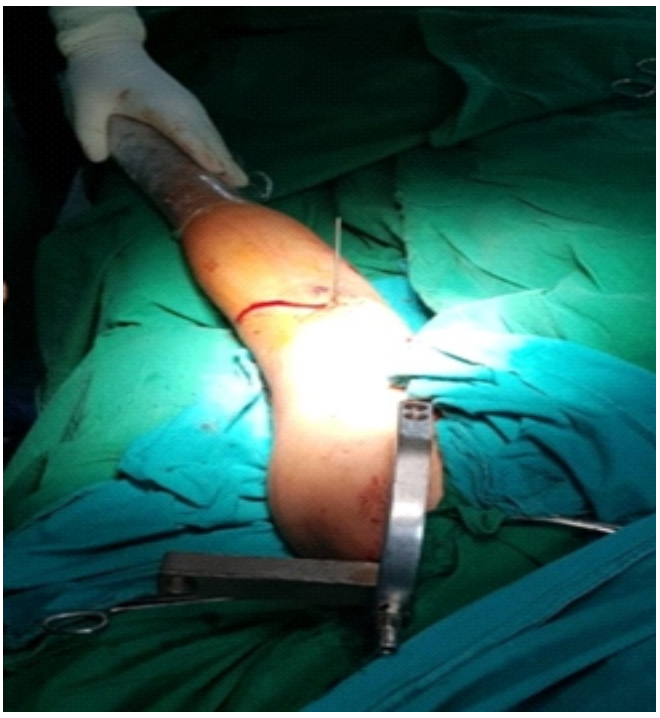

**Figure 3:** Stab incision for distal locking

**Figure 2:** Guidewire insertion into medullary cavity

Vulnerable structures around the shoulder, such as the axillary nerve, circumflex artery, long head of the biceps, and the deltoid, are susceptible to injury, commonly by proximal locking bolts. Additionally, distal interlocking of an antegrade humeral nail is considered challenging and time-consuming, partly due to difficulties in obtaining a clear lateral image intensifier view of the humerus and the risk of injury to the radial and/or lateral cutaneous nerves from lateral-to-medial screw insertion.

Acknowledging these limitations and complications inherent in conventional methods, the three-stitch technique for antegrade

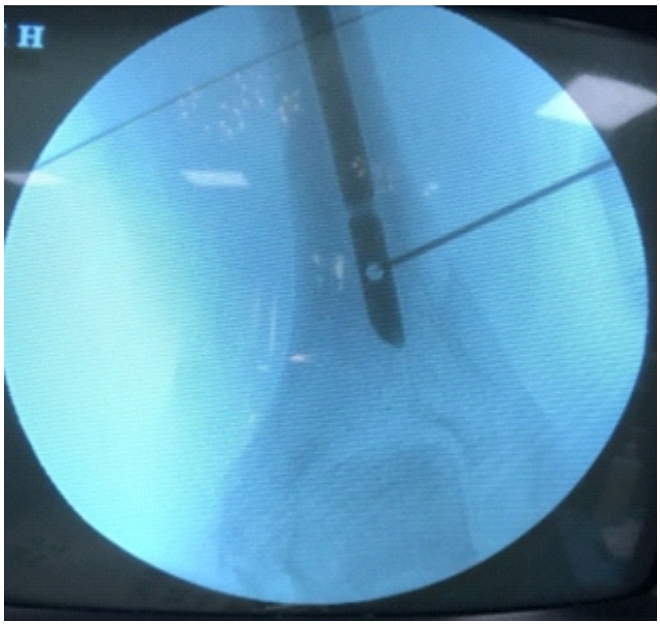


**Figure 4:** Bicortical drilling for distal locking

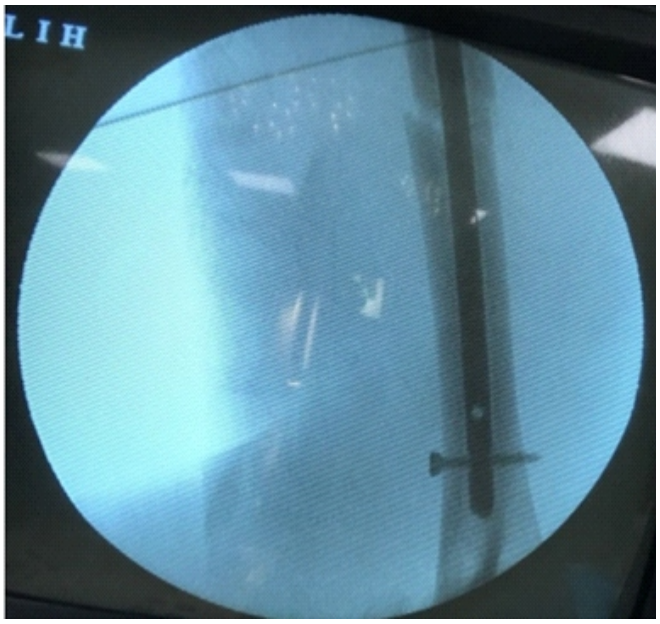

**Figure 5:** Distal locking done

humerus nailing was developed. This innovative approach specifically aims to avoid these common technical difficulties and complications, offering a minimally invasive solution for humerus shaft fractures, including complex comminuted injuries.

## Methodology

This article synthesises information from two distinct prospective studies conducted at the Department of Orthopaedics, Dr. D.Y. Patil Medical College and Hospital, Nerul, Navi Mumbai.

**Study Design and Patient Selection:**

• First Study: Conducted over two years (May 2016 to May 2018), this prospective study included 20 adult patients with traumatic diaphyseal humeral shaft fractures. Exclusion criteria included skeletally immature patients, those unfit for surgery, patients with associated fractures or head injuries, pathological fractures, Gustilo Anderson type II and type III compound fractures, or associated radial nerve palsy.

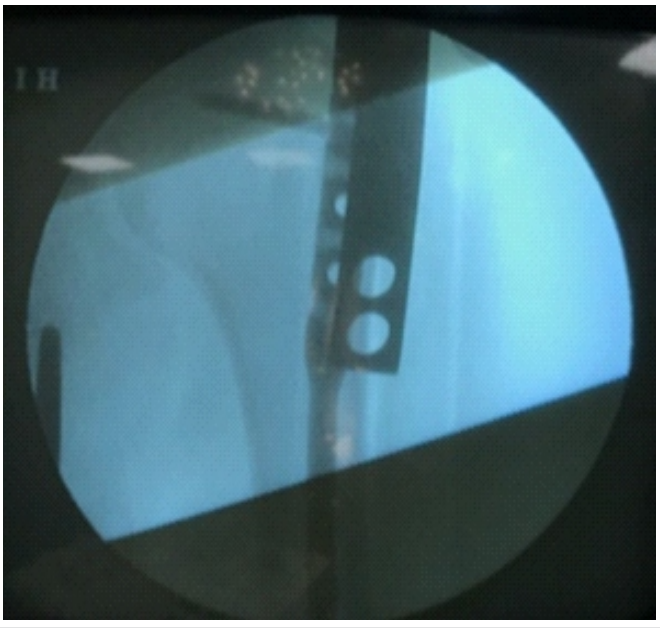

**Figure 7:** Proximal locking done.

**Figure 6:** Proximal locking sleeve inserted through the jig. Third incision taken for proximal locking

• Second Study: Conducted from March 2022 to March 2024, this prospective study involved 24 adult patients who sustained posttraumatic comminuted humerus shaft fractures. The inclusion criteria specified comminuted injuries ranging from type 12B to 12C according to the Arbeitsgemeinschaft für Osteosynthesefragen /Orthopedic Trauma Association (AO/OTA) classification. Exclusions comprised skeletally immature patients, those with significant comorbidities (e.g., diabetes mellitus, hypertension, ischemic heart disease), associated head injuries, AO/OTA classification type 12A compound fractures, radial nerve palsy, unstable vital signs, or active arterial bleeding.

**Ethical Considerations and Consent:** Both studies were initiated after approval from the Institutional Ethical Committee, and informed consent detailing methodologies and potential complications was obtained from each patient.

**Surgical Technique (Three-Stitch Approach):** All cases were treated using a closed antegrade intramedullary interlocking nailing

**Figure 8:** Simple mattress suture taken

technique with the three-stitch method.

1. Patient Positioning: The patient was positioned in the "beach chair" position, with the operative shoulder slightly over the edge of the operative table. The shoulder and arm were draped freely to allow ease of intraoperative manipulation. An image intensifier was positioned above the arm to obtain clear anteroposterior and lateral views of the fracture with the arm abducted.

2. Entry Portal (First Stab Incision): Access to the entry site was gained through a small stab incision, approximately 1 cm in length, positioned anteriorly to the anterior rim of the acromion. This specific placement ensures the avoidance of the rotator cuff. Careful soft tissue dissection was performed to expose the bone. A soft tissue protection sleeve was passed through this incision over the bone, and an entry point was made with a guide wire lateral to the articular surface of the humeral head under image intensifier guidance. The entry point was then widened, taking care not to damage surrounding soft tissue, and a guidewire was inserted into the medullary cavity.

3. Nail Insertion: Fracture reduction was achieved, and the guidewire was advanced into the distal fragment. Serial reaming was performed over the guidewire, and a nail of appropriate size and length was inserted. The guidewire was then removed.

4. Distal Locking (Second Stab Incision): Distal locking was performed using an antero-posterior approach with a free-hand technique under image intensifier guidance. The second stab skin incision was taken slightly lateral to the midline to specifically avoid the neurovascular bundle present anteriorly. Careful blunt soft tissue dissection was performed using the blunt end of a K-wire until the bone surface was reached. A soft tissue protection sleeve was then passed over this K-wire to prevent damage to neurovascular structures during drilling and screw insertion. A hole was drilled through both cortices, and distal locking was achieved with a screw.

5. Proximal Locking (Third Stab Incision): The proximal locking sleeve was inserted through the zig. A third stab incision, approximately 1 cm in length, was made over the skin. Blunt soft tissue dissection was carried out with the blunt end of a K-wire until the bone surface was reached. The proximal locking sleeve was carefully advanced over this K-wire until it reached flush with the bone surface to avoid entrapment and damage to the surrounding soft tissue during drilling and screw insertion. A hole was drilled through the zig, and proximal locking was done with an appropriate length screw.

6. Wound Closure: Simple mattress sutures were used to close all stab incisions.

Postoperative Care and Follow-up: Postoperatively, the patient's arm was kept in an arm pouch. Early mobilisation, in the form of range of motion (ROM) exercises, was initiated on the third postoperative day. In the first study, patients were followed up at 2 weeks, 4 weeks, and then monthly for one year to assess functional outcome. In the second study, patients were followed for 12 months, and their functional outcomes were assessed using preoperative and postoperative Mayo Elbow Performance Index (MEPI) and University of California at Los Angeles (UCLA) scores. All data was documented and analysed using Microsoft Excel.

## Discussion

The three-stitch technique for antegrade humerus nailing represents a significant advancement in the management of humeral shaft fractures, particularly for comminuted injuries, by directly addressing the common complications associated with conventional fixation methods.

**Addressing Complications of Conventional Techniques:**

• Rotator Cuff Preservation: Traditional antegrade humerus nailing frequently violates the rotator cuff, leading to suboptimal clinical outcomes, discomfort, and shoulder stiffness. The three-stitch technique explicitly tackles this by positioning the small entry portal (approximately 1 cm) anteriorly to the anterior rim of the acromion, thereby ensuring it is anterior enough to specifically avoid damage to the rotator cuff. This meticulous entry point contrasts with conventional methods that often result in rotator cuff impingement and related symptoms.

• Enhanced Soft Tissue and Neurovascular Protection during Proximal Locking: In conventional antegrade intramedullary nailing, vulnerable structures around the shoulder, such as the axillary nerve, circumflex artery, long head of the biceps, and the deltoid, are highly susceptible to injury, primarily from proximal locking bolts. Some traditional nails omit proximal locking bolts to mitigate these risks, but this can compromise fracture stability and increase the risk of nonunion. The three-stitch technique provides a solution by employing a precise, multi-step process during proximal locking: after making a small (approximately 1 cm) third stab incision, careful blunt soft tissue dissection is performed using the blunt end of a K-wire until the bone surface is reached. The proximal locking sleeve is then meticulously advanced over this K-wire until it is flush with the bone surface, ensuring soft tissues are not entrapped or damaged during drilling and screw insertion, thus avoiding injury to the surrounding neurovascular structures.

• Safer Distal Locking with Antero-Posterior Approach: Distal interlocking of an antegrade humeral nail is notoriously challenging and time-consuming in conventional techniques, often due to difficulty in obtaining a clear lateral image intensifier view and the "slippery" bony surface. Furthermore, inserting a locking screw from lateral to medial poses a significant danger of injury to the radial and/or lateral cutaneous nerves. To circumvent these difficulties and risks, the three-stitch technique adopts an antero-posterior distal locking approach. The second stab skin incision for distal locking is taken slightly lateral to the midline to specifically avoid the neurovascular bundle present anteriorly. Similar to proximal locking, careful blunt soft tissue dissection with the blunt end of a K-wire is performed to the bone surface, and a soft tissue protection sleeve is passed over this K-wire to prevent damage to neurovascular structures during drilling and screw insertion. This approach significantly reduces technical difficulty and minimises the risk of nerve injury associated with conventional lateral-to-medial insertion.

Comparative Advantages over Other Fixation Methods: The sources highlight that plate osteosynthesis, while offering rigid fixation, requires wide surgical exposure and carries risks of infection, nerve palsies, extensive soft tissue fibrosis, difficult rehabilitation, pain, and the need for additional surgeries for implant removal or salvage failures. The three-stitch technique, being minimally invasive, stands

out as a better alternative to external fixators and other plate osteosynthesis methods, particularly for comminuted injuries, due to its good results, fewer complications, and improved cosmetic outcomes. The antegrade approach itself is often less time-consuming and preferred by anaesthesiologists.

**Demonstrated Outcomes and Functional Recovery:**

• First Study Outcomes (Diaphyseal Fractures): A prospective study on 20 adult patients with diaphyseal humeral shaft fractures showed very positive results. All patients exhibited good to excellent functional outcomes at one-year follow-up. The mean union time was 8 weeks, with all fractures uniting by 10 weeks. Importantly, this study reported no complications such as rotator cuff violation, shoulder stiffness, or neurovascular injury.

• Second Study Outcomes (Comminuted Fractures): A more recent prospective study on 24 adult patients with comminuted humerus shaft fractures (up to type 12C AO/OTA) further validated the technique. Twenty-two out of 24 patients (96%) exhibited excellent functional outcomes and good adherence to rehabilitation. Only two patients experienced delayed wound healing, with one successfully treated with vacuum-assisted closure therapy, and no cases of nonunion were observed. Objective assessments using the Mayo Elbow Performance Index (MEPI) and University of California at Los Angeles (UCLA) scores showed significant restoration of function. MEPI scores for the excellent outcome group improved from 18 to 23 over 6 months, and UCLA scores enhanced from 20 to 23 (exceptional to good ratings). This indicates an overall enhancement in elbow and shoulder function post-therapy.

Comparison with Other Intramedullary Nailing Studies: The sources also reference other studies on humeral shaft fracture management. A prospective study by Kumar et al. on 30 patients using antegrade interlocking nailing and dynamic compression plate fixation reported all fractures healed without complications, but two cases required bone grafting or nail reoperations. A retrospective analysis of 14 patients with complex humeral shaft fractures treated with percutaneous intramedullary nailing reported a 93% union rate with one nonunion requiring additional surgery, achieving good mean clinical outcome scores (American Shoulder and Elbow Society, Constant, Penn Shoulder, Single Assessment Numerical Evaluation). Stannard et al. investigated a novel flexible, locking intramedullary nail in 50 individuals, reporting 39 out of 51 fractures healed with an average union time of 12 weeks. While most patients regained full range of motion, four patients experienced five complications, including two nonunions, two hardware failures, and one wound infection. These comparative insights underscore the competitive and often superior outcomes of the three-stitch technique, especially with its reported low complication rates and absence of nonunions in the presented studies.

**Limitations**

The studies discussed have certain limitations. The second study on comminuted fractures, while prospective, acknowledged a retrospective aspect regarding data collection, which could introduce recall bias. Both studies were conducted at a single centre and involved relatively small sample sizes (20 and 24 patients, respectively). Therefore, a randomized controlled trial comparing plating and nailing in humerus fractures, or a long-term multicenter study with a larger number of cases, is recommended to further solidify the findings.

## Conclusion

The three-stitch technique for antegrade humerus nailing represents a significant advancement in the surgical management of humerus shaft fractures, including comminuted injuries. This minimally invasive approach successfully addresses and avoids common complications associated with conventional nailing techniques, such as rotator cuff violation, shoulder stiffness, neurovascular injury, and impingement. The studies presented demonstrate that the technique consistently leads to favourable outcomes, high union rates, and excellent functional recovery, as evidenced by improved MEPI and UCLA scores. With reduced complications and superior cosmetic results, the three-stitch technique stands as a viable and preferred alternative to external fixators and other plate osteosynthesis methods for treating these challenging fractures.

**Declaration of patient consent :** The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his/her consent for his/her images and other clinical information to be reported in the Journal. The patient understands that his/her name and initials will not be published, and due efforts will be made to conceal his/her identity, but anonymity cannot be guaranteed.

**Conflict of Interest:** None, **Source of Support:** None

## References

1. Rose SH, Melton LJ, Morrey BF, Ilstrup DM, Riggs BL. Epidemiological features of humeral fractures. Clin Orthop. 1982;168:24–30.
2. Sarmiento A, Waddellle JP, Latta LL. Diaphyseal humeral fractures: treatment options. Instr Course Lect. 2002;51:257-69.
3. Zuckerman JD, Koval KJ. Fractures of the shaft of the humerus. In: Rockwood and Green Fractures in Adults. 4th ed. Philadelphia, PA: JB Lippincott; 1996. p. 1025-51.
4. Farragos AF, Schemitsch EH, McKee MD. Complications of intramedullary nailing for fractures of the humeral shaft: a review. J Orthop Trauma. 1999;13:258-67. doi:10.1302/0301-620X.90B1.19215.
5. Lögters TT, Wild M, Windolf J, Linhart W. Axillary nerve palsy after retrograde humeral nailing: clinical confirmation of an anatomical fear. Arch Orthop Trauma Surg. 2008;128:1431-5.
6. Cheng HR, Lin J. Prospective randomized comparative study of antegrade and retrograde locked nailing for middle humeral shaft fracture. J Trauma. 2008;65:94-102.
7. Sarmiento A, Kinman P, Galvin E. Functional bracing of fractures of the shaft of the humerus. JBJS (Am). 1977;59-A:596-601.
8. McCormack RG, Brien D, Buckley RE, McKee MD, Powell J, Schemitsch EH. Fixation of fractures of the shaft of the humerus by dynamic compression plate or intramedullary nail. A prospective randomised trial. JBJS (Br). 2000;82-B:336-9.

9. Garnavos C. Diaphyseal humeral fractures and intramedullary nailing: can we improve outcomes. Indian J Orthop. 2011 May;45(3):208-13.
10. Stern PJ, Mattingly DA, Pomeroy DL, Zenni EJ Jr, Kreig JK. Intramedullary fixation of humeral shaft fractures. J Bone Joint Surg Am. 1984;66:639-46.
11. Evans PD, Conboy VB, Evans EJ. The Seidel humeral locking nail: an anatomical study of the complications from locking screws. Injury. 1993;24:175-6.
12. Garnavos C. Intramedullary nailing for humeral shaft fractures: the misunderstood poor relative. Curr Orthop. 2001;15:68-75.
13. Kolonja A, Vecsei N, Mousani M, Marlovits S, Machold W, Vecsei V. Radial nerve injury after anterograde and retrograde locked intramedullary nailing of humerus. A clinical and anatomical study. Osteo Trauma Care. 2002;10:192-6.
14. Barati H, Afzal S. Successful treatment of a multifocal comminuted open fracture of the humerus with severe soft tissue defect: a case report. J Med Case Rep. 2023;17:261.
15. Kumar M, Khatri JP, Singh CM. High-velocity gunshot fractures of humerus: results of primary plate osteosynthesis. Indian J Orthop. 2021;55:714-22.
16. Savvidou OD, Zampeli F, Koutsouradis P, Chloros GD, Kaspiris A, Sourmelis S, et al. Complications of open reduction and internal fixation of distal humerus fractures. EFORT Open Rev. 2018;3:558-67.
17. Shrestha SK, Devkota P, Mainali LP. Minimally invasive plate osteosynthesis in the treatment of isolated ulnar bone fractures. Malays Orthop J. 2012;6:16-9.
18. Bong MR, Kummer FJ, Koval KJ, Egol KA. Intramedullary nailing of the lower extremity: biomechanics and biology. J Am Acad Orthop Surg. 2007;15:97-106.
19. Meriqui RN, Masuda RY, Utino AY, Pierami R, Matsunaga FT, Tamaoki MJS. Intra- and inter-observer agreement in the AO and Garnavos Systems for diaphyseal humerus fracture. Acta Ortop Bras. 2017;25:159-61.
20. Kumar R, Singh P, Chaudhary LJ, Singh S. Humeral shaft fracture management, a prospective study; nailing or plating. J Clin Orthop Trauma. 2012;3:37-42.
21. Hudson PW, Gulbrandsen MT, Liu JN, Ponce BA, Phipatanakul WP. Percutaneous intramedullary nailing of complex humeral shaft fractures: a retrospective case series. Cureus. 2022;14:e32999.
22. Stannard JP, Harris HW, McGwin G Jr, Volgas DA, Alonso JE. Intramedullary nailing of humeral shaft fractures with a locking flexible nail. J Bone Joint Surg Am. 2003;85:2103-10.
23. Scaglione M, Casella F, Ipponi E, Agretti F, Polloni S, Giuntoli M, et al. Multifocal humeral fractures: clinical results, functional outcomes and flowchart of surgical treatment. Strategies Trauma Limb Reconstr. 2022;17:81-7.

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