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Study of clinicoradiological and functional outcomes of intramedullary nailing in diaphyseal radius ulna fractures in adults

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Abstract
Introduction: One of the most common fractures is a forearm fracture. The most common causes of these fractures include high-energy incidents, direct trauma, and falls from great heights. It's not unusual to have open wounds with a neurovascular impairment. Supination of the forearm with a backward and upward loading force with a forward angulation while falling on an outstretched hand is comparatively a less severe mechanism than pronation and upward force. Direct impact which is referred to as 'Nightstick injury' also lead to shaft of ulna fracture. The goal of this study was to assess the results of closed fixation in radius ulna fractures with intramedullary nailing for a minimum of 6 months. Nailing with square nails, titanium elastic nails (TENS nails), or long Kirschner wire has proven to be extremely effective.
Method: Over the course of one year, this is a retrospective case series investigation of forearm bone fractures and the treatment options available. We chose patients where intramedullary nailing was used as a therapy option and were followed for at least 6 months. Galeazzi variety, monteggia variety, pathological fracture, and non-union following previous surgery were all ruled out. Disabilities of the arm, shoulder, and hand (DASH) score and Grace and Eversmann functional outcome score were used to assess the results.
Results: Of the 25 patients, 14 patients had excellent functional outcome according to Grace and Eversmann score, 8 patients had good outcome, 4 patients had acceptable while 1 was unacceptable. The mean DASH score was 16.32.
Conclusion: This study shows that closed method for fixation by intramedullary nailing of both bone forearm fractures leads to excellent to good functional outcomes (according to DASH score and Grace and Eversmann score) with less complications. In 6 months follow up x ray there is radiological union in all cases with no angulation, malunion or non-union.

Keywords: radius ulna fracture, intramedullary nailing, diaphyseal fractures, closed fixation

Introduction
One of the most common fractures is a forearm fracture. The most common causes of these fractures include high-energy incidents, direct trauma, and falls from great heights. It's not unusual to have open wounds with a neurovascular impairment. Variable levels of shaft of both bone forearm injuries result from axial loading, which is vertical compression combined with rotational stress.
Supination of the forearm with a backward and upward loading force with a forward angulation while falling on an outstretched hand is comparatively a less severe mechanism than pronation and upward force. Direct impact which is referred to as 'Nightstick injury' also leads to shaft of ulna fracture. The relationship between radius and ulna is critical for function, especially pronation and supination. Malunited fractures can impair this functional joint, with resulting impairment of pronation and supination. Therefore it is important to reestablish length, alignment and rotation for the forearm to maintain its dynamic function. Both conservative and surgical approaches are being used depending upon the level and displacement of fractures.
Wilson [1] found similar results in open and closed ways of operational procedures and fixation in their study of the outcome of open reduction and internal fixation of both bone forearm fractures.

George *et al*. [2] highlighted how, when done appropriately, open reduction with plating restores normal anatomy and aids in clinical and radiological union in the majority of instances. However, as described by Lee *et al*. [3], it comes with its own set of drawbacks, including periosteal stripping, disruption of normal biological anatomy, post-operative infection, neurovascular deficit, direct plate pressure and stress shielding, refracture following plate removal, and cost, to name a few. Nailing as the preferred technique, especially in open fractures, can help to avoid these complications. Closed intramedullary nailing, according to Street *et al*, has advantages such as a lower risk of infection, early union, smaller scars, less blood loss, and a shorter operating time [4].

Because it is difficult to sustain reduction with forearm shaft fractures that have both rotatory and angular motions, the conservative method is employed less commonly. Additionally, cast problems, nonunion, malunion, compartment syndrome, and Volkmann ischemic contracture are all common. As a result, the treating surgeon makes the final decision on surgical technique.

To minimise problems and obtain a satisfactory range of motion in the postoperative phase, adequate and early care of such fractures with internal fixation by nailing or plating is required. Supination, forearm pronation, wrist grip strength, and complete mobilisation at the elbow joint are all linked to effective fracture fixation.

The goal of this study was to assess the results of closed fixation in radius ulna fractures with intramedullary nailing for a minimum of 6 months. Nailing with square nails, titanium elastic nails (TENS nails), or long Kirschner wire has proven to be extremely effective. With adequate patient selection and surgical skill, nailing not only provides good functional results, but it has also proven to be a preferable option in nations where cost is a big consideration. Nails are less expensive, take less time, have less complications, and, most significantly, do not modify biological anatomy as much as other methods.

Methods

The research was carried out at Smt. SCL Municipal General Hospital, NHL Medical College, Ahmedabad, in the Department of Orthopaedics. It is a retrospective case series study of 25 individuals with both bone forearm fractures who were followed for at least 6 months from July 2020 to August 2021. A total of 14 male and 11 female patients, ranging in age from 19 years to 56 years, were involved in the study. 12 of the 25 patients were injured in road traffic accidents, 10 fell while walking, and three were assaulted directly. 5 patients had open wounds of Gustillo Anderson Type I, 1 patient had type II, and 19 patients had close wounds.

Patients who presented to our emergency department with both bone forearm fractures had a complete clinical assessment. After radiographs were taken to examine neurovascular state, distal mobility, and related upper extremity injuries, their fractured limbs were immediately splinted. All essential haematological surveys and studies were completed as part of the preoperative planning. We scheduled all patients for intramedullary nailing for both bone forearm fractures after getting informed written consent and securing institutional ethical procedure permission.

Inclusion criteria

Individuals between the ages of 19 and 59 years old who have both bone forearm upper, middle, and lower third fractures, as well as patients with Gustillo Anderson type I and type II open injuries.

Exclusion criteria

Patients with fracture dislocations at the elbow or wrist, old malunited fractures, and old operative non unions are all ruled out.

Axillary block anaesthesia was used on all of the patients. The parts were draped and prepared. In none of the cases, a tourniquet was applied. The fractures were examined in the traction view under image intensification. The most of the radius fractures (midshaft and upper third shaft) were reduced in a closed manner. Proximal third radius fractures were reduced in a closed manner, and nail was placed from Lister's tubercle up to the fracture site. After protecting the superficial radial nerve and thumb tendons, the entry was chosen from the radial styloid for TENS nail. The nail is advanced after reaching and crossing the fracture site, securing the fracture length and alignment. Closed techniques were used to treat ulna fractures with intramedullary nailing. After nailing both forearm bones, rotations and flexion extension of the upper extremity were tested and assessed under image intensification. Non-absorbable sutures were used to seal the wound at the entry site. Cleansing and debridement of open wounds were performed. The extremity was splinted and dressings were applied.

Dressing was changed on 2nd postoperative day and x-ray was taken. Post operatively volar below elbow supportive plaster slab was given to all patients. Finger and elbow mobilization was started on 2nd post-operative day. Slab was removed after 4 weeks. Rotatory exercises and wrist mobilization were started after clinico-radiological signs of Union appeared.

Results

Between July 2020 and August 2021, we conducted a study at our institute on the functional and radiological outcomes of 25 patients treated with a mean follow up time of 6 months. There were 14 male (56%) and 11 female (44%) patients in the age categories of 19 to 56 years, with a mean age of 34.5 years (Figure 1). 10 (40%) of the 25 patients had a domestic fall, 12 (48%) had a road traffic accidents, and 3 patients (12%) had a direct assault injury (Figure2). 16 patients (64%) had closed injuries, 5 patients (20%) had type I open injuries, and 1 patient (4%) had type II open injuries (Figure3). 1 patient had associated head injury treated conservatively. 20 patients operated within 24 hours of injury while rest of five patients were operated after 48 to 72 hours getting medical clearance. The average time from injury to operation was 1.5 days.

12 patients with mid shaft radius- ulna fracture were operated using square nails. 7 patients had proximal shaft ulna and mid shaft radius fractures. They had been operated using square nails.6 patients with shaft both bone fractures at variable level were operated using TENS nail in radius and square nails in ulna. In some patients we used two to three square or TENS nails in single bone as bundle nailing.

All of the patients were followed for at least six months. All of the cases had radiological union, with no cases of mal-union or non-union and a full range of flexion and extension movements (Figure4). Mean DASH score at final follow up was 16.32 (Figure5). according to Grace and Eversmann score at final follow up denoted excellent outcome in 14 (56%) patients, Good in 8 (32%), acceptable outcome in 4 (16%) and unacceptable in 1(4%) patient (Figure6).

Grace and Eversmann functional evaluation criteria [5].

	Union	Pronation supination comparison ratio with the uninjured arm
Excellent	+	90-100%
Good	+	80-89%
Acceptable	+	60-79%
Unacceptable	-	<60%

At 6 weeks, two patients (8%) with proximal ulna fractures treated with square nails had back out from the insertion site. At the final follow-up, one patient (4%) developed elbow stiffness. One patient had an infection with ulna nail back out, which was removed after seven weeks and a four-week above-elbow cast was given.

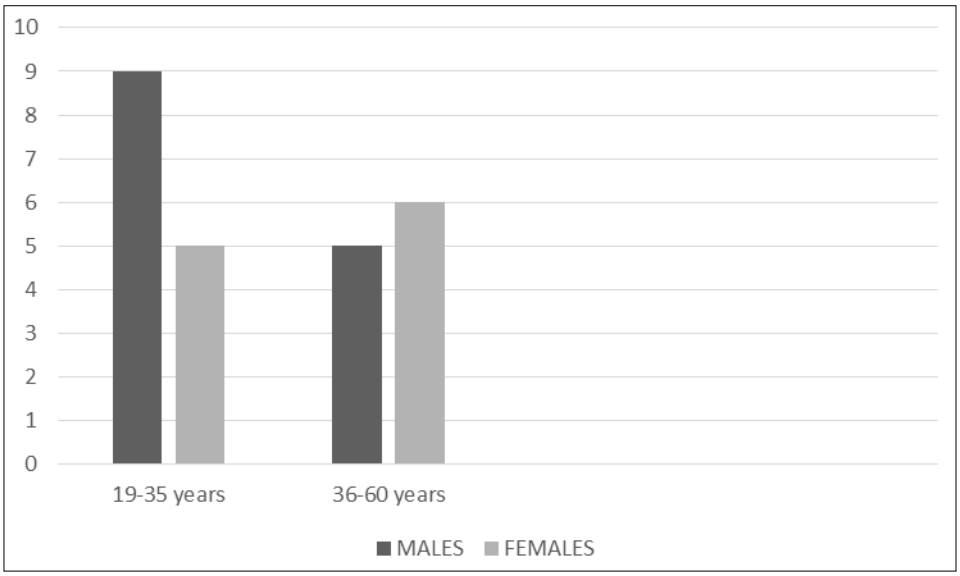

Fig 1: Age and gender distribution

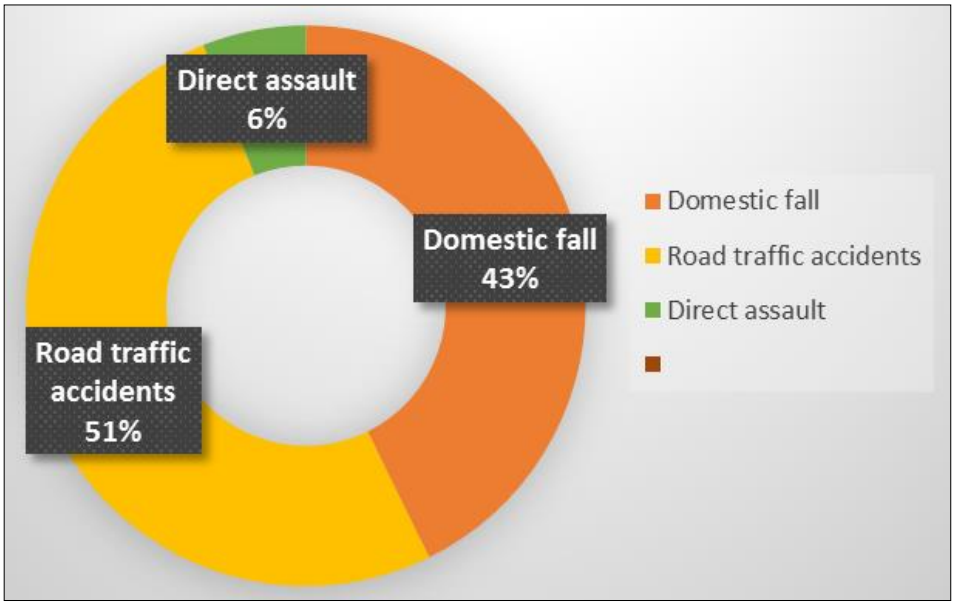

Fig 2: Mechanism of injury

Fig 3: Type of injury

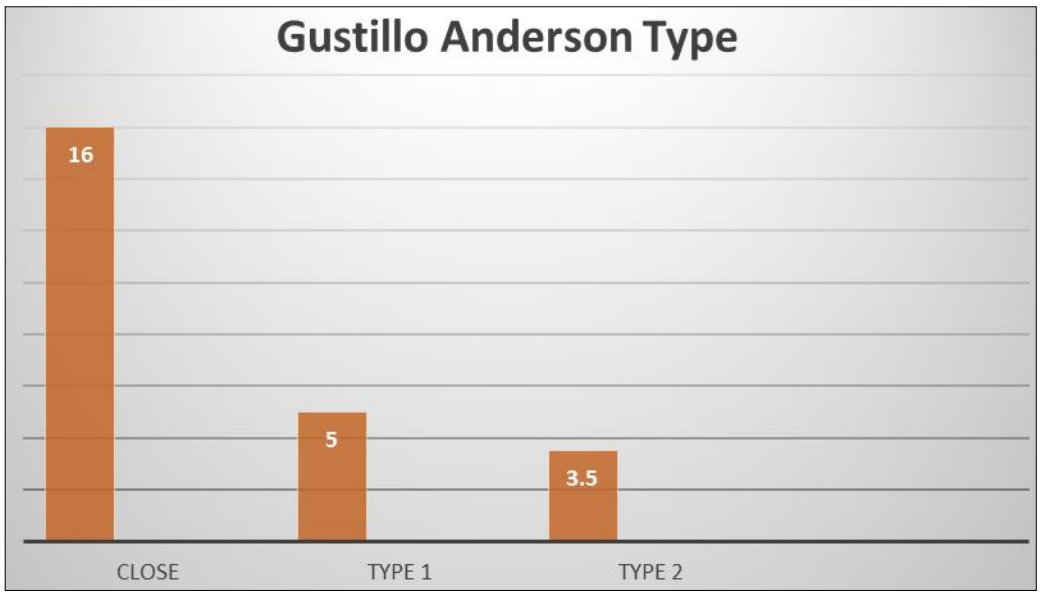

Fig 4: Functional and radiological outcome in 30 year old male.

Fig 5: Dash score range

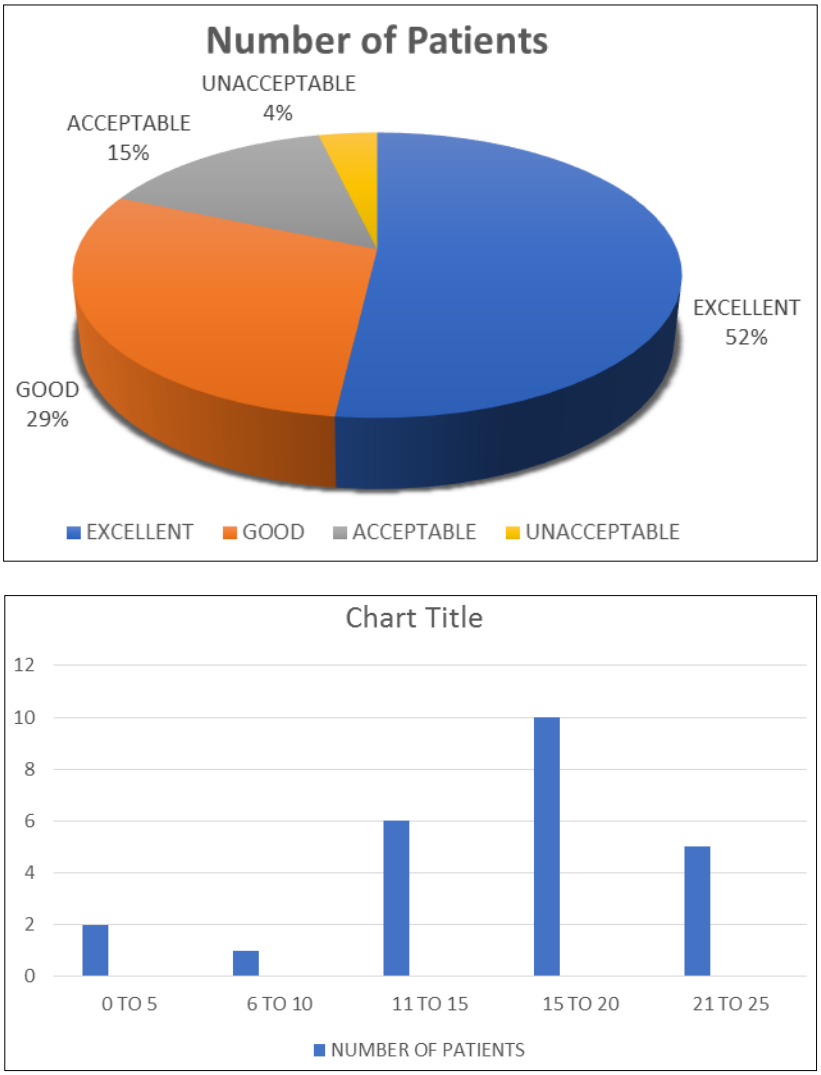

Fig 6: Functional outcome based on Grace and Eversmann score.

Discussion

Kapoor *et al.* [6] described the results of intramedullary nailing in youngsters, finding that 95% of the patients had full union and all had excellent functional outcomes. The benefits of TENS nailing in paediatric radius ulna fractures were discussed by Sahu *et al.* [7], who determined that it provided various benefits, including a better cosmetic and functional outcome with few complications. Our study has a mean DASH score of 16.32 with similar results.

Variable levels of shaft of both bone forearm injuries result from axial loading, which is vertical compression combined with rotational stress. Supination of the forearm with a forward angulation and a backward and upward loading force while falling on an outstretched hand is a less severe mechanism than pronation and upward force. Direct impact, commonly known as a 'Nightstick injury,' can result in a shaft of ulna fracture.

In their investigation of radius ulna diaphyseal fractures treated with plating versus nailing procedures, Agarwal *et al.* [8] found equal functional outcomes. Nailing methods provide advantages such as a simpler procedure, less soft tissue injury, and inexpensive surgical devices, making it a feasible choice to consider when choosing a surgical intervention strategy for patients.

Individual attention to the complications of forearm injuries with utmost care and effort is required for the restoration and maintenance of anatomic alignment of forearm fractures. We documented open injuries as well as closed injuries with skin abrasions in our research. Soft tissue injuries are more common in the forearm region than in other bones, so extra caution and close monitoring are required throughout the perioperative period.

To avoid stiffness and Sudeck's osteodystrophy, the post-operative period of forearm nailing should be kept as short as possible. We mobilized all patients post-operative immediately after giving volar below elbow plaster slab encouraging full flexion and extension at elbow. One patient came to follow up after 6 weeks of surgery with stiffness at elbow joint. None of the patient was operated by open method. Open method with plating is the treatment of choice which controls forearm rotations and achieves adequate length. But it carries the risk of extensive periosteal stripping, nerve damage and infection.

Azboy [9] described a novel locking intramedullary nail for forearm fractures in 32 patients, with an excellent Grace and Eversmann score in the majority of cases and less sequelae. In two cases, we had the ulna nail come out with delayed union in the ulna mid shaft fracture. This risk can be reduced by using locking design nails with ulna jig assembly.

Conclusion

With a mean DASH score of 16.32 and a lower rate of complications, we conclude that choosing a closed method for fixation of both bone forearm fractures leads to excellent to good functional outcomes in patients according to DASH score and Grace and Eversmann score. In all cases, a one-

month follow-up X-ray reveals radiological union. This was accomplished without causing any biological disruption or increasing the danger of postoperative neurovascular insufficiency.

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