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Research Article

Study of Titanium Elastic Nailing in Forearm Fractures in Elderly Patients

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Abstract

Background: As operative techniques and the quality of implants are improving, surgical management of diaphyseal fractures of forearm bones in elderly patients is gaining widespread acceptance. Titanium elastic nailing system (TENS) provides flexural, axial, translational, and adequate rotational stability. This study aims to analyze the outcomes of the treatment of diaphyseal forearm bone fracture with TENS nail.

Methods: Elderly patients with both-bone forearm (BBFA) fractures in diaphysis were evaluated clinically and radiologically and followed for an average of six months. The outcome was assessed using the Grace-Eversmann scoring system. We followed up with all 25 patients and evaluated them every two weeks until the fracture united.

Results: After approval of the ethics committee, twenty-five elderly patients with AO type 22A3 and 22B3 fractures of the forearm bone who fulfilled the inclusion and exclusion criteria were taken for the study. The mean age of the participants was 65 years. The average time to bone union was 12 weeks, and the average surgery time was 35 minutes. There was a superficial infection in one case. Most patients had a full range of elbow and wrist movements after the union.

Conclusion: The TENS is an acceptable and good tachnique for displaced BBFA diaphyseal fractures in elderly patients. It is easy, cheap, and convenient and gives elastic mobility, promoting a rapid union of fractures and stability, which is ideal for early mobilization. It provides a lower complication rate, shorter surgery time, good cosmetic outcome, and easy implant removal.

Keywords: Forearm Fracture; Fracture Fixation; Elderly; Intramedullary Nailing

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Background

The human forearm serves a vital role in the upper extremity function, facilitating the placement of the hand in space, thus helping to provide the upper extremity with its unique mobility. The relationship between the both-bone forearm (BBFA) is critical for function, especially supination and pronation. This relationship is so critical that the forearm has been called a functional joint. Malunited fractures can impair this functional joint, impairing pronation and supination. Increasing incidence of road traffic accidents, natural disasters, and industrial accidents, together with assault, leads to multiple fractures and a higher incidence of morbidity. According to the AO, forearm fractures accounted for 10-14 percent of all fractures (1).

To restore the dynamic function of the forearm, it is very important to maintain length, alignment, and rotation. Dynamic compression plates have been used previously for fracture fixation in forearms; however, there are certain disadvantages to plate and screw osteosynthesis, including wound-related complications, soft tissue trauma, neurovascular injury, evacuation of fracture hematoma, and impairment of periosteal blood supply due to periosteal stripping (2-4). Elderly osteoporotic bones are notorious for plate osteosynthesis, and the intraoperative chance of weak screw purchase is one of the complications with the plate fixation method. Chances of implant loosening in osteoporotic bones may lead to infection, nonunion, and other complications. The risk of refracture is also associated with plates if implant is extracted early (5).

Various intramedullary devices have been tried previously to stabilize fractures in forearms. Ivory pins, the Küntscher nail, the Rush nail, and Ender's nails had been used (6). The newly designed intramedullary nails provide satisfactory functional and clinical outcomes. The treatment method has been accepted more widely as the operative technique, the quality of implants is improving, and surgical management of diaphyseal in elderly patients is gaining widespread acceptance (5).

Biomechanically, these implants have been shown to act as internal splints (7). The titanium elastic nailing system (TENS) provides four properties, including flexural, axial, translational, and rotational stability. All four properties require to achieve good functional outcome (8). The titanium elastic intramedullary nailing provides immediate stability to the fractured bone segment which permits early recovery with a low complication rate (9, 10).

Nondisplaced fractures of the diaphysis of forearm bones are usually managed conservatively. The fracture site also affects the choice of treatment. If the radius fracture is proximal to the ulna, the closed reduction becomes more difficult. Fractures in the proximal diaphyseal forearm have a higher chance of loss of motion when managed non-invasively. Higher muscle bulk in proximal diaphysis may interfere with fracture reduction and maintenance in a cast. Closed reduction becomes more difficult due to the interposition of the pronator quadratus muscle, annular ligament, periosteum, or the interosseous membrane (IOM). Fracture with adjacent joint dislocation usually requires internal fixation; these

fractures are highly unstable and come under the fracture of necessity (11). Complete diaphyseal fractures and oblique fracture lines are two prime factors for instability; in such cases, internal fixation is generally advised. Surgical treatment is indicated in fractures with greater than 10 to 15 degrees of angulation and greater than 50% translation in the cast despite the closed reduction. Indications for intramedullary fixation are segmental fractures, open fractures with soft tissue loss, open fractures with bone loss, pathologic bone, failed plating, and multiple injuries.

Methods

Source of Data, Sample Size, and Duration: After approval of the ethics committee, twenty-five elderly patients with AO type 22A3 and 22B3 fractures of the forearm bone who fulfilled the inclusion and exclusion criteria (as listed below) were taken for the study. This prospective study was done during the period from June 2019 to May 2023 at the Department of Orthopaedics, Jhalawar Medical College, Jhalawar, Rajasthan, India.

Inclusion Criteria

- AO type 22A3 and 22B3 fracture of elderly BBFA
- Elderly age group with or without co-morbid condition
- Close fractures
- Fresh fracture within one week of trauma
- Being fit for surgery

Exclusion Criteria

- Compound fractures
- Comminuted fractures
- Neurovascular injury at presentation
- Refusing operative procedure
- Children and middle-aged patients

On admission to the ward, a detailed history was taken regarding the demography, mode of injury, and past and associated medical illness. Routine investigations were done for all patients. Patients were operated on after informed consent and surgical fitness.

Surgical Technique: The entry point that is just medial to Lister's tubercle was the most preferred (Figure 1).

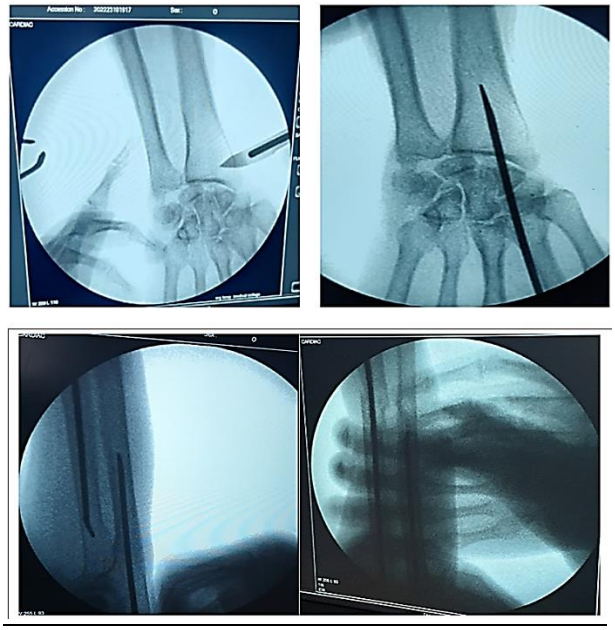

Figure 1. Titanium elastic nail (TEN) insertion in forearm fractures

The nail was passed across the fracture site under C-arm control. Radius was splinted first because it is often more difficult to reduce. The radial nail was inserted manually by an inserter into the medullary canal, with the nail tip at right angles to the bone shaft. Then, the nail tip was aligned with the axis of the medullary canal by rotating the nail through 180° with the inserter. Then, the nail was advanced up to the fracture site with oscillating movements. The radial nail tip was aligned with the medullary canal of the proximal fragment by external manipulations. The nail was advanced through the fracture site with smooth, oscillating movements. In the ulna, an antegrade entry point was made over the olecranon process of the ulna. An awl was introduced to make an entry hole in the ulna. The nail entered into the medullary canal up to the fracture site. It was advanced through the fracture site with smooth, oscillating movements, and was pushed into the distal ulna under the guidance of the C-arm (Figure 1). Nail end was cut and nail was bent. The skin was closed over the cut end. The ulna usually reduces spontaneously after radius reduction. However, in our study, we selected only closed-reduction internal fixation cases.

Post-Operative Care: The patient was discharged on the second day. Sutures were removed on the 12th post-operative day. All patients were immobilized with the above-elbow (A/E) Plaster of Paris (POP) slab, which continued for up to 3 weeks. It was discontinued after three weeks, and active movements were encouraged.

We followed up with all 25 patients and evaluated them clinically and radiologically every two weeks till the fracture united. All cases got united within 24 weeks at the last follow-up.

Complications: The diameter of the nail should be at least 60% of the internal diameter of the medullary canal for optimum fracture stability by elastic nails (60% for single nail inserted in single forearm bone and 40% each nail if 2 nails inserted in single long bone/tibia/femur). Selection of the improper diameter of the nail, poor surgical techniques, and post-operative loss of reduction can contribute to poor surgical outcomes. Infection, nerve injury, vascular injury, compartment syndrome, radioulnar synostosis, muscle and tendon entrapment and adherence, malunion, nonunion, and refracture are the potential complications of forearm fracture fixation.

Results

The age of the patients varied from 58 to 80 years. The mean age of the patients was 65 years. Of the 25 cases, 14 patients (56%) were men and 11 (44%) were women. Male to female ratio was 1.2:1.

The incidence of forearm bone fractures in this age group was nearly equal in both sexes. In our study, 17 (68%) out of 25 cases were of sustained injury due to falls on the ground, five patients (20%) due to road traffic accidents, and three patients (12%) due to assault. Falling on the ground was the most common mode of injury in this region of India, and no patients have had sports-related injuries. In our study, 15 patients (60%) visited the hospital within 24 hours of injury. The rest 40% (10 patients) visited after 24 hours of injury. 13 out of the 25 patients (52%) sustained an injury on the right side, and the remaining on the left side. Side predominance was not seen.

23 out of 25 cases (92%) showed radiological union in 6-12 weeks, and 2 (8%) showed delayed union (> 12 weeks). The average time to bone union was 12 weeks. All fractures united (100%) at the final follow-up at 24 weeks (Figures 2 and 3).

Figure 2. Radiological outcome of titanium elastic nailing (TEN) in elderly forearm fracture (Case 1)

Out of 25 cases, only one (4%) presented with superficial infection at the entry site. One patient presented with extensor pollicis longus injury that recovered with time after the removal of the implant.

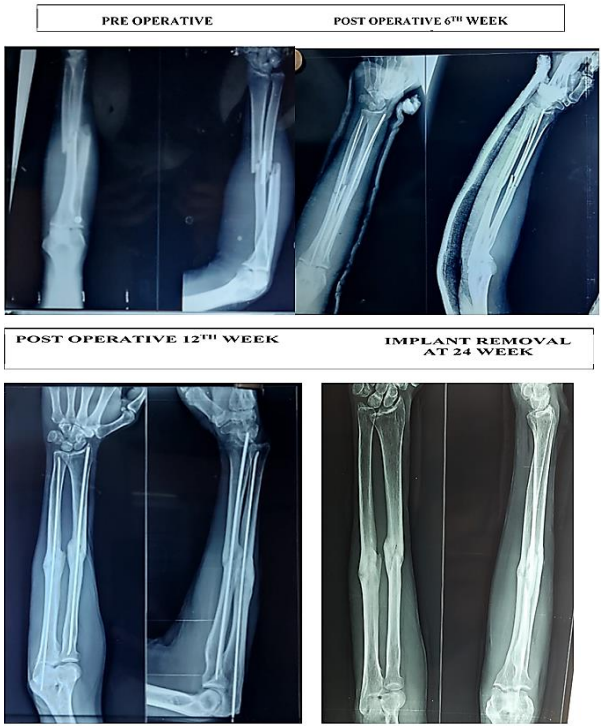

Figure 3. Radiological outcome of titanium elastic nailing (TEN) in elderly forearm fracture (Case 2)

2 cases showed delayed union, but later, both two fractures united within 18 weeks after surgery. No one had nonunion, malunion, refracture, or other complications. The average time of procedure was 35 (15-60) minutes.

In our study, out of 25 cases, only three patients (12%) had 10°-30° (> 10°) loss of supination and pronation at the end of 24 weeks (Table 1).

Table 1. Loss of movements at 24 weeks

Loss of movements at 24 weeks		n (%)
Elbow	Flexion	0 (0)
	Extension	0 (0)
Forearm supination	< 10 degrees	22 (88)
	10-30 degrees	3 (12)
	> 30 degrees	0 (0)
Forearm pronation	< 10 degrees	22 (88)
	10-30 degrees	3 (12)
	> 30 degrees	0 (0)

The functional outcome was assessed at the last follow-up using the Grace-Eversmann Scoring System (12). After six months (the last follow-up), 80% of patients (20 out of 25 cases) had an excellent functional outcome, the remaining 20% of patients (5 patients) had good functional outcome, and none of the patients had poor outcome (Figures 4 and 5).

Figure 4. Functional outcome of titanium nailing in forearm fracture (Case 1)

Discussion

The relationship between the all-forearm joints and the IOM space should be carefully maintained; otherwise, it may lead to functional impairment.

If a good range of movement has to be restored, then restoring bone length, opposition, axial, and rotational alignment is necessary (13). Malunion and nonunion are frequently seen in adult forearm fractures if managed non-invasively because of the loss of reduction of two parallel bones in the presence of the powerful pronating and supinating muscles that have angulatory as well as rotational influences (14).

Figure 5. Functional outcome of titanium nailing in forearm fracture (Case 2)

Open reduction and internal fixation (ORIF) with plating is usually advised for displaced diaphyseal fractures in adults because of the inherent property of fracture displacement by powerful muscles. In contrast to adults, elderly forearm muscles are weaker; thus, it becomes easier to maintain fracture reduction. Malunion and nonunion occur less frequently with titanium nailing in elderly patients.

BBFA fractures were managed non-invasively till the end of the 19th century with a POP cast. Later on, in the early 1900s, Lane (15) and Lambotte (16) studied the use of plates for treating diaphyseal forearm fractures. In 1913, Schöne first reported on the use of silver nails for radial and ulnar intramedullary fixation. Later on, various nails were designed for forearm fixation (17,). Interlocking nails for both radius and ulna were introduced in recent years. Titanium elastic nails, developed for fractures of the shaft of long bones in the pediatric and adolescent age group, are recently used in elderly diaphyseal forearm fractures.

The final results of movement at 24 weeks in our study are in accordance with a similar study conducted by Kapoor et al., in which 16% of patients had a loss of motion at BBFA (18). In our study, out of 25 cases, only three patients (12%) had 10°-30° loss of supination and pronation after 24 weeks.

Ozkaya et al. performed a study comparing locked intramedullary nailing and plate osteosynthesis in the management of adult forearm fractures and reported that mean union time was significantly shorter with nailing (10 weeks vs. 14 weeks, $P < 0.05$). Excellent/good outcomes were reported in 18 patients (81.8%) and acceptable in four patients (18.2%) treated with plating, compared to intramedullary nails, where excellent/good outcomes were reported in 18 patients (90%) and acceptable in two patients (10%), according to the Grace-Eversmann criteria. The mean Disabilities of the Arm, Shoulder, and Hand (DASH) scores were 15 and 13, respectively (19). Schulte et al. reported good results of surgical fixation with intramedullary nails; a bone union rate of 97% was reported (2).

In the latest study performed by Khanna and Sharma, it was reported that the average time for the union was 11.3 weeks, the average surgery time was 61 minutes, and the average fluoroscopy time was approximately 2 minutes. According to the Grace-Eversmann scoring, the outcome was reported as excellent in 21 (70%) patients, good in 5 (16.67%), acceptable in 3 (10%), and unacceptable in 1 (3.33%). The average DASH score was 15.21 (4-57.5). Thirty patients with displaced radius and ulna diaphyseal fractures were taken; out of them, 22 patients were women, and eight patients were men (20). In our study, we noted a nearly equal incidence of forearm fractures in the elderly age. Of the 25 cases, 14 patients (56%) were men and 11 (44%) were women. Male to female ratio was 1.2:1. The functional outcome was assessed at the last follow-up using the Grace-Eversmann scoring system (12). After six months (the last follow-up), 80% of patients (20 out of 25 cases) had an excellent functional outcome, the remaining 20% of patients (5 patients) had good functional outcomes, and none of the patients had poor outcomes. The final results are in accordance with the results of study conducted by Khanna and Sharma (20) which were excellent in 70% of patients, good in 16.67%, acceptable in 10%, and unacceptable in 3.33%; none had poor outcomes.

Conclusion

Forearm bone fractures are associated with high rates of consolidation and satisfactory mobility of the forearm since we obtain an acceptable reduction of the fracture, as it is more easily achieved by plate fixation. However, titanium elastic nailing (TEN) is a less invasive technique, allowing for restoring function more quickly with less pain, and it is less prone to complications. Excellent results can be achieved with TEN in mobility and union without deformity in elderly patients. Plate osteosynthesis can be considered a good treatment option, but elderly osteoporotic bones are notorious for plate osteosynthesis. Intra-operative chances of poor screw purchase and implant loosening in osteoporotic bones may lead to nonunion, infection, and other complications. Plating in elderly forearm fractures is also associated with soft tissue trauma, neural injury, evacuation of fracture hematoma, and impairment of periosteal blood flow due to periosteal stripping, cosmetic, and wound-related problems.

The advantages of intramedullary fixation are the preservation of fracture hematoma, early mobilization, being done as a daycare procedure, less post-operative morbidity, smaller incision, technically easy procedure, short operating time, reduced risk of infection, decreased hospital stays, and being an economical procedure. Since there is no axial loading after intramedullary fixation, the chances of implant failure

are very low. TEN is particularly useful in the middle third of forearm fractures as it provides three-point fixation that leads to stable fixation and proper alignment of fracture fragments. As newer techniques, these intramedullary devices require further evaluation, and a steep learning curve exists.

Conflict of Interest

The authors declare no conflict of interest in this study.

Acknowledgements

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