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Clinico Radiological Outcome of Closed Diaphyseal Fracture Both Bone Forearm Treated with Tens in Adolescent

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ABSTRACT

The most frequent fractures in children are those to the forearm. While the intramedullary Titanium Elastic Nail System (TENS) and rigid plate fixation have significantly improved outcomes in teenagers, successful care in preadolescent patients is frequently conservative. Nevertheless, there are currently no objective standards to determine when teens can use TENS. The purpose of this study was to ascertain the skeletal age limits of TENS in teenagers by comparing the modified Sauvegrain *et al*. method for skeletal age scoring versus chronological age in order to predict treatment outcomes in adolescents treated with TENS for a forearm fracture. Our prospective study was conducted from March-October 2019-2022 (2 years 8 months) at Rampurhat Government Medical College and Hospital, Birbhum, West Bengal and cases were followed up for at least 12 months. In our studies, we had treated 36 adolescent patients and followed for at least for 1 year by serial x-rays and clinical examination. Age distribution from 12-18 year age. Mean age 14.5 year, Sex distribution Male-24, female-12. Sex ratio:2:1, Laterality Right 23 (63.89%) Left 13 (36.11%). Type of reduction for fracture fixation Closed reduction 25 cases, Open reduction of ulna 9 cases, open reduction of both radius and ulna in two cases. Final evaluation was done according to Anderson criteria. In our study out of 36 cases, 27 cases (75%) showed excellent, 8 cases (22%) satisfactory and one (3%) case showed poor result. TENS, both bone forearm fracture, adolescent diaphyseal fracture.

INTRODUCTION

A fractured forearm is among the most common types of fractures in children. The prevalence is highest in teens (12-16 years old) among children[1]. It has proven to be difficult to manage diaphyseal fractures of the forearm bones in adolescents without internal fixation because redisplacement can happen even after a successful closed reduction. The afflicted arm becomes immobile as a result of the forearm bones failing to join[2].

In order to prevent further damage to the physis and achieve an acceptable union and range of motion, internal fixation is required. Options available for internal fixation procedures are closed reduction with elastic nailing or open reduction with plate fixation. The risks of plate fixation include a larger incision, more damage to soft tissues, an increased risk of infection and the need for a second, equally invasive surgery to remove the implant, which adds unnecessary complexity to the process[3].

Reinhardt *et al*.[4] conducted a recent retrospective study that compared the results of plate stabilisation with intramedullary fixation for older children (10-16 years old) who had suffered bone forearm fractures. For this age group, they discovered that plate stabilisation and intramedullary nailing were both equally successful for forearm fractures, with the advantage of TENS being the ease of hardware removal. The study's limitations were a very young age range (12.5 years) for the intramedullary fixation group and a considerably older age range for the plate stabilisation group.

As an additional study, Shah *et al*.[5] compared intramedullary fixation to open reduction and internal fixation with a plate in an effort to learn more about how to mend bone forearm fractures in teenagers. This study details the experiences of a group of teenagers, some of whom were very old, who were all subjected to the same treatment plan and stabilised with titanium elastic nails. Even in older teenagers, forearm fractures can occur and the published results indicate that intramedullary treatment should be seriously examined as a means of stabilisation.

Our research set out to examine the radiographic and clinical results of teenage patients treated with titanium elastic nailing for closed diaphyseal fractures of the radius and ulna between the ages of 12 and 18.

METHODS

This prospective study was conducted during March-October 2019-2022 at Rampurhat Government Medical College and Hospital, Birbhum, West Bengal after approval from the review board. Thirty Six patients with closed diaphyseal both bone forearm fractures, ranging in age from twelve to eighteen years old, were included in this study. A minimum of twelve months was required for all cases to be followed up. Patients were not included in the study if they had any of the following conditions. open injury, neurovascular injury, undisplaced fractures, refusal to give consent, or isolated single forearm bone fractures.

Radiographs were taken correctly after admission and a forearm slab was applied till operation. A thorough pre-operative evaluation and all necessary pre-operative tests were completed. Right before surgery the patient was given the right dosage of cefuroxime antibiotic intravenously and the damaged limb was thoroughly cleaned with povidone iodine scrub.

Operative technique: All procedures were carried out in a sterile operating room (OT) using a radiolucent table, general anaesthesia (GA) or supraclavicular block and an image intensifier for closed reduction. The radius was stabilised by retrograde nailing into the dorsal part of the distal radius, just medial to Leister's tubercle and proximal to the radial physis, once an acceptable reduction had been achieved. Care to be taken to prevent any harm of extensor tendon. Superficial branch of radial nerve injury can be prevented by dorsal approach. Proximal to the physis in the metaphysis, antegrade nailing was used to secure the ulna via the lateral border of the olecranon. According to Flynn *et al*. the diameter of the nail was found by measuring the canal width at the narrowest point of the diaphysis in both the anteroposterior and lateral views. The peak of curvature of the TENS nail must be located at the fracture. A thirty-degree bend at the tip of the nail helps in controlling and adjusting reduction effectively. In every instance the ends were curved and slashed down to the bone, yet enough length remained to be extracted later on and buried beneath the skin.

RESULTS

We followed up with 36 patients who participated in this trial for up to a year. Once after six weeks, one patient was no longer followed up with. With an average age of 14.23 years the patients ranged in age from 12 (the youngest) to 18 (the oldest). The frequency of both bone forearm fractures was 24 per

Fig. 1: Shows pre-op and post-op and final follow up radiographs

Fig. 2: Shows range of motion at final follow up (a) full range of pronation (b) full range of supination (c) full flexion at elbow (d) full palmar flexion at wrist (e) full dorsi flexion at wrist

Table 1: Classification of functional outcome

Result	Union	Flexion extension at elbow	Pronation supination forearm
Excellent	Bony union	<10 degree loss	<25% loss
Unsatisfactory	Bony union	>30 degree loss	>50% loss
Poor	Non union	±loss of motion	± loss of motion

Table 2: Distribution with all parameters

	No. of cases	Percentage
Gender		
Male	24	66.67
Female	12	33.33
Side involved		
Right	23	63.89
left	13	36.11
Fracture site		
Proximal	10	27.78
Middle	20	55.55
Distal	6	16.67
Anderson criteria		
Excellent	27	75
Satisfactory	8	22
Poor	1	3

10,000 male children and 12 per 10,000 female children. Post operative immobilization done for 2 weeks in most of the cases. In the event that patients have any of the following post-operative complications fever, unusual swelling, or pain, they are instructed to seek medical attention without delay. The patient was sent home after 48 hrs and contacted again after two weeks to have their stitches removed. The patients were instructed to actively move their fingers, wrists, elbows, and shoulders. At 2,4,6 and 12 weeks. Following stitch removal, patients were contacted for follow-up appointments. On a subjective basis, patients were evaluated clinically and radiologically at each visit.

DISCUSSIONS

For a long time, closed reduction and casting was the standard treatment for diaphyseal fractures in children. Angular deformity greater than 10° and full displacement are considered to be unacceptable reduction, according to Price *et al*.[6] Kids under the age of nine have stronger remodel potential, thus they are able to tolerate more deformity than kids older than that[12,13]. According to Franklin *et al*. functional prosthesis should be achieved in children with forearm fractures in a way that is painless and complication-free[7]. Research has demonstrated that forearm rotation can be severely impaired in cases of middle third forearm fractures with an angulation of 15-20 degrees[9]. Consequences of conservative treatment include atrophy of the muscles and bones, superficial skin infection , refracture, synostosis and stiffness of the elbow. With rates ranging from 10-60%, loss of reduction ranks as the most prevalent consequence in paediatric forearm fractures[8].

It may be necessary to consider surgical intervention in older children with impaired remodelling capacity if a suitable reduction cannot be achieved or if redisplacement happens following first reduction. We opted for surgical surgery rather than conservative therapy due to these concerns. Open reduction internal fixation with a plate and closed reduction and intramedullary fixation are the two most common ways of fixation.

The anatomical benefit of open reduction and internal fixation with plates is the preservation of the radial bow during reduction[9]. Other advantages include early mobilisation and high fixation strength. Unfortunately, there are a few drawbacks to plate fixation as well. These include neurovascular injury, hardware irritation, refracture following plate removal, peri implant fractures if the plate is not removed and extensive surgical dissection. Additionally, there is the need for another major surgery of equivalent scale to remove the implants[9].

There is little cosmetic distortion, stable fracture healing, easy implant removal and adequate fracture reduction with IM nailing, according to several studies[10]. The blood flow to the periosteum and fracture hematoma are unaffected. Additionally, it permits micromotions at the fracture site, which aid in the creation of calluses. Its three-point fixation principle precludes post-reduction angulation, translation and rotation. Surface nail site infections,

skin irritation at nail insertion sites, implant migration or failure (bent or broken pins) tendon injury, restricted range of motion, loss of reduction, refracture and delayed or non-union are some of the documented consequences of this procedure[10]. Recent research by Kruppa *et al*.[11] looked at 201 patients in a row who had 202 forearm fractures. Average age 9.7 years, with a range of 3-16 years. Of the fractures, fifteen (or 7.4%) were open. The majority of the fractures (82.2%) were in the diaphyseal region of the forearm. 9.2 months of follow-up was recorded on average. Ten re-fractures, two malunions, three ruptures of the extensor pollicis longus tendon, one infection of the superficial wound and two restricted ranges of motion were all complications. A secondary operational intervention was necessary for fourteen (6.9%) children due to their complications. The average time to remove implants was 3.8 months, with a range of 0.4-16.3 months. Their research led them to the conclusion that elastic stable intramedullary nailing is a safe, dependable and less intrusive procedure. This approach is effective in treating both bone forearm fractures, single-bone fractures, Monteggia and Monteggia-equivalent fractures, and others. Even with ESIN in place, re-fractures are a common and serious consequence. Higher re-fracture rates can be attributed to early implant removal and improper physiotherapy.

In another study conducted by Martus, he compared paediatric and adolescent age group results treated with intramedullary fixation for forearm fractures. Post-operative compartment syndrome occurred in 3 isolated forearm fractures with a significant younger mean age (6.0 vs 10 year, p = 0.031). Outcomes were good or excellent in 91% of fractures. There was no statistical association of patient age with a fair or poor outcome.

In our study sex ratio was 2:1 and Side involvement were right side 63.89% and left side 36.11% cases.Out of 36 patients fracture sites were proximal 1/3rd 27.78%, middle 1/3rd 55.55% and distal 1/3rd 16.67%. According to Anderson criteria in our study we achieved 75% excellent, 22% satisfactory and 3% poor results. When using TENS in this research, we encountered minimal problems. One patient's nail was extracted as soon as union was achieved due to a superficial infection at the ulna entry site the infection was controlled with oral antibiotics. Nonunion of ulna occurred in one patient which was managed by removal of the nail followed by plating and bone grafting. After the implant was removed, we did not have any problems such as compartment syndrome, implant breakage, neurovascular injury, tendon injury, or refracture. If the concepts of closed reduction and three point fixation are followed without injuring the surrounding soft tissue with the use of an image intensifier, TENS can effectively treat adolescent forearm fractures. There is a lack of a conservative or plate fixation method control group in our study, which is one of its weaknesses. We could have used a bigger sample size and excluded open fractures from our analysis.

CONCLUSION

We conclude that TENS in both bone forearm fracture in adolescent age group in terms of union and range of motion is a minimally invasive and effective method of fixation without significant complication rate.

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