

# Elastic intramedullary nailing of paediatric forearm fractures

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## Abstract

**Introduction:** Fracture shaft of both bones forearm account for 5% to 10% of children's fractures. The management of diaphyseal fractures of forearm bones in children remains a significant surgical challenge because of their treatment complexity and risk of complications. Because of numerous differences in both treatment and prognosis, shaft fractures are considered to be clinically distinct from fractures of the distal and proximal ends of the same bones. **Aims:** To study the functional results of elastic intramedullary nailing (tens) of displaced diaphyseal fracture forearm in children. **Methods and Materials:** Between 2011 and 2012 we treated 20 children aged between 5 and 15 years, with fractures of the forearm using elastic nailing (tens). Both bones were fractured in all 20 patients. **Results:** 14 patients were reduced closed, followed by nailing, while 4 fractures required mini open reduction prior to nailing. Bony union of all fractures was achieved by an average of 12 weeks (range 10 weeks to 14 weeks). Complications like superficial pin site infection in 2 patients, refracture in 1 patient and 2 patients had limb length discrepancy leading restriction of forearm rotation were noted in our study. **Conclusions:** Elastic nailing (tens) led to early bony union with acceptable bony alignment in all 20 patients available at final follow-up. We therefore recommend elastic nailing (tens) for the treatment of unstable diaphyseal forearm fractures in children.

**Keywords:** Paediatric forearm fracture, Elastic intramedullary nailing, Tens

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## INTRODUCTION

As the acceleration of life has been on the upbeat in the younger generation these days, fractures of forearm bones have become more common in day to day practice. The treatment of diaphyseal fractures of forearm bones in children remains a significant surgical challenge. Treatment options range from conservative to surgical methods. Conservative treatment includes Closed Reduction and POP application<sup>1, 2,4,14</sup>. Surgical treatment comprises of Closed Reduction and Internal Fixation with Elastic Intramedullary nails<sup>3,7,9,10,11,12</sup> and Open Reduction and Internal Fixation with plates<sup>5,6,8,10,12,13</sup>. Each of these

proposed methods has its limitation in certain types of these fractures. Conservative methods poses problems like deformity, loss of motion, non-union, mal-union etc. but whereas with recent advancement and development in the field of surgical instrumentation, surgical experience and improved rehabilitation techniques has put surgical treatment on the upper hand.

## SUBJECTS AND METHODS

20 cases of diaphyseal fractures of forearm in children were treated by elastic nailing. The study was done on the children, aged between 5 and 15 years of both sexes with diaphyseal fractures of the forearm. Clearance was obtained from ethical committee.

### Inclusion criteria's were

- Simple transverse fractures
- Oblique fractures
- Comminuted fractures
- Segmental fractures

### Exclusion criteria's were

- Compound fractures
- Pathological fractures
- Re-fractures
- Malunited fractures

A careful history was elicited from the patient or from the attendants of the patients. A careful clinical assessment of skeletal or soft tissue injuries and general condition of the patient was done. The clinical examination gave a clue to determine whether the fracture was caused by direct or indirect violence. Examination was done to rule out any other fractures. Vital signs were recorded; vascular injuries; compartment syndrome and peripheral nerve injuries were carefully looked for. Clinical diagnosis was confirmed by taking antero-posterior and lateral radiographs. Closed reduction was tried under conservative methods. Fractures, which fail to reduce, or which fail to maintain reduction were immobilized in above elbow slab until the surgery. Analgesics were given to relieve pain. Closed reductions of fractures were done under general anaesthesia under the guidance of the C-arm. All the surgeries were done within 7 days of injury under general anaesthesia under aseptic conditions. Antibiotic treatment given appropriately. Active finger and shoulder movements were encouraged post operatively to promote better circulation and to reduce edema. Postoperative radiographs were taken. Suture removal was done on the 10th days and the patients were discharged on their convenience. Review of the patient was done for 12 months with 5 visits (3rd wk, 6th wk, 3rd to look for the callus formation. After 2nd week, POP slab/ cast was applied after confirmation of complete healing of surgical wound and suture removal. After 4-6 weeks pop slab/cast was removed and radiographs were repeated. After confirmation of fracture union clinically and radiologically, patient was encouraged for joint

movements. Improvements in the range of movements were noted on every visit.

## RESULTS

Twenty cases of fractures of both bones forearm were treated by elastic nailing. The follow-up ranged from 10 weeks to 16 weeks. Males were predominant (75%) and right forearm affection more (60%) than left. Most of the fractures are due to RTA (40%) rather than self-fall and sports injuries. The fracture being most common in 10-15 years age group. Most of the fractures of both bones of forearm were located in the middle third and transverse fractures were more common. Closed nailing was done in 16(80%) children other 4(20%) children needed mini open reduction. 75 % ( 15) operations were done within 45min. 90% of the patients were immobilized for less than 6 weeks 16 (80%) patients had sound union in less than 12 weeks, remaining 4 (20%) patients had union by 14 weeks Complications noted in our study were superficial pin site infection in 2 patients due to leaving the nails outside the skin, they were fully treated with oral antibiotics and refracture in 1 patient who had refracture after removal of nails when he sustained a self-fall in school he underwent open reduction and internal fixation with plating and 2 patients had limb length discrepancy leading restriction of forearm rotation. The results were based on Price *et al* scoring system and in our study, there were 15(75%) patients with excellent results and 3 (15%) with good and 2(10%) with fair results. We have not seen any poor results in our study.

**Table 1: Union Time**

Series	Union time (weeks)	Range (Weeks)	Union (%)
Richter <i>et al</i> <sup>22</sup>	11.5	9-13	100
Cullen <i>et al</i> <sup>24</sup>	10	8-12	97
Luhmann <i>et al</i> <sup>21</sup>	11.8	9-14	100
Present study	12	12-14	100

**Table 2: Complications**

Complications	Richter <i>et al</i>	Cullen <i>et al</i>	Luhmann <i>et al</i>	Van der reis <i>et al</i>	Young <i>et al</i>	Present study
Superficial infection	3%	20%	5%	-	1.8%	10%
Deep infection	-	-	-	-	-	-
Refracture	-	5%	-	-	1.8%	5%
Back out of nail	-	25%	4%	-	1.8%	-
Compartment syndrome	-	-	-	4.3%	-	-
Non-union	--	-	-	--	-	-
Delayed-union	3%	5%	-	4.3%	-	-
Mal-union	-	-	4%	4.3%	-	-
Injury to superficial branch of radial nerve	6%	10%	5%	-	-	-
Radio-ulnar synostosis	-	5%	-	-	-	-
Limb length discrepancy	-	-	-	-	-	10%

## DISCUSSION

20 cases of diaphyseal fractures of forearm in children were treated by elastic nailing. The study was done on the

children of both sexes with diaphyseal fractures of the forearm. In our study we found the incidence of forearm fractures to be 75% in males and 25% in females. The

incidence of forearm fracture was more among males compared to females which is comparable to the study by Richter *et al*<sup>22</sup> and Van der reis *et al*<sup>23</sup> and Cullen *et al*<sup>24</sup> in 1998 (males 60% and females 40%). Luhmann *et al*<sup>21</sup> in 1998 found males 68% and females 32%. Young *Et al*<sup>9</sup> found males 56% and females 44%. This could be attributed to the fact that male children are more active in school and sports activities compared to their female counterparts. In our study we found an incidence of 60% right forearm fractures and 40% left forearm fractures which is comparable to study by Cullen *et al*<sup>24</sup> (right 60% and left 40%) in 1998. Luhmann *Et al*<sup>21</sup> in their study found incidence to be 40% right and 60% left. Young *Et al*<sup>9</sup> found incidence to be 68% left and 32% right. This could be because, most of the children were right handed so they have a tendency to outstretch right upper limb to break the fall. In our study majority of patient's mode of injury is road traffic accident (RTA) 40% and 30% had sports injury 30% had self-fall which is comparable to study by Cullen *Et al*<sup>24</sup> in 1998 with sports 40%, RTA 20%, self-fall 40%. Richter *Et al*<sup>22</sup> found incidence of 65% self-fall and 35% sports injury and RTA together. In our study we found an incidence of 60% transverse fractures and 40% oblique fractures which is similar to the study done by Young *Et al*<sup>9</sup> who found 65% transverse fractures and 35% oblique fractures. Luhmann *Et al*<sup>21</sup> found in their study an incidence of 84% oblique fractures and 16% transverse fractures. In our study we found an incidence of 50% middle 1/3rd, 25% proximal 1/3rd and 25% distal 1/3rd fractures which is similar to study by Richter *et al*<sup>22</sup> (50% middle and 25% proximal and distal 1/3rd). In our study 80% of the fractures were treated with closed reduction under c-arm guidance and only 20% needed mini open reduction due to soft tissue interposition to pass the nail across the fracture site. This is comparable to studies by Richter *Et al*<sup>22</sup> (closed reduction 84%) and Young *Et al*<sup>9</sup> (closed reduction 75%) and Waseem<sup>19</sup> (closed reduction 72%). Cullen *Et al*<sup>24</sup> open reduction 75% and Luhmann *Et al*<sup>21</sup> open reduction 50%. In our study 75% of the fractures were fixed within 45 min which is comparable to Richter *Et al*<sup>22</sup> in 1998 which was 40 min. Van der reis *Et al*<sup>23</sup> found that in their study it took 100 min to fix fractures. In our study 90% of the patients were immobilized for a mean period of 4 - 6 weeks which is comparable to Luhmann *Et al*<sup>21</sup> who in their study immobilized children for a mean period of 7 weeks. Young *Et al*<sup>9</sup> in 1998 immobilized their patients for a period of 4 weeks. In our study 80% fractures united in less than 12 weeks and the remaining cases united by the end of 14 weeks. Table no 1 The implants were removed only after the radiographs showed signs of complete bony union of the fracture. In our study 90% of the implants were removed at 14 weeks which is

comparable to the studies by Richter *Et al*<sup>22</sup> (12 weeks) and Luhmann *Et al*<sup>21</sup> (13 weeks). Cullen *Et al*<sup>24</sup> had removed the implants by a mean of 16 weeks. Waseem<sup>19</sup> in his study removed the implant by 4 weeks. In our study 2 (10%) patients developed superficial infection at the pin site owing to leaving the implant proud of the skin. These were successfully treated with oral antibiotics. Following these complications, in the remaining patients the implants were cut short and buried under the skin. One patient (5%) had re-fracture after the implant was removed when he sustained a minor fall at school which was successfully treated with open reduction and internal fixation with plate and screws and he regained good range of motion according to Price *et al* criteria of evaluation. In our study we had 3 patients (15%) who had 11 – 30 degree loss of rotation and 2 patients (10%) who had >30degree loss of rotation, both these patients had 1cm loss of forearm length compared to the normal limb. In our study we did not see any other complications such as osteomyelitis, non-union, malunion, implant back out and compartment syndrome. We in our study found that limb length discrepancy is a cause of loss of forearm rotation. Table no 2 Detailed analysis of functional results of the patient was done on the basis of following criteria by Price *Et al*<sup>15</sup>. Range of movements (rotations) and complaints on daily/strenuous work are the two factors, which affect the functional outcome. Price *et al* scoring system was used as a measure for the functional outcome. In our study we had 15(75%) patients with excellent results, 3(15%) patients with Good results and 2(10%) patients with Fair results. No Poor results were observed in our study. Our results are comparable with that of Richter *Et al*<sup>22</sup> who had 24(80%) patients with excellent results, 5(16.6%) with good results and 1(3.3%) with fair results with no poor results noted. In 1998 Luhmann *et al*<sup>21</sup> reported excellent results in 21(84%), good results in 4(16%) and no fair/poor results seen. Van der reis *et al*<sup>23</sup> reported Excellent results in 18(78%) patients, Poor results in 5(22%) patients. Cullen *et al*<sup>24</sup> reported Excellent results in 17(89.4%) patients, Good results in 2(10.5%) patients with no poor results noted. In 1985 Amitl<sup>17</sup> reported 100% excellent results in a study of 20 patients with no good/fair/poor results. Verstreken *et al*<sup>16</sup> reported Good results in all 6(100%) patients treated with intramedullary nailing with no poor results. Lascombes *et al*<sup>20</sup> reported excellent results in 92% patients treated with elastic stable intramedullary nailing (ESIN), 8% good results with no poor results. Altay *et al*<sup>18</sup> reported Excellent results in 83.3%, good in 12.5%, fair in 2.1% and poor results in 2.1% patients.

## CONCLUSION

Advantages of elastic nailing of paediatric forearm fractures is that it facilitates biological fixation of the fracture and promotes early fracture union. Biomechanically, these implants have been shown to act as internal splints provided the nails extend three or more diameters beyond the fracture site. The nails have to be anchored in the upper and lower metaphyseal portions of the bone and, the summit of the curve must be calculated preoperatively to lie at the level of the fracture to produce an internal three-point fixation construct. Use of physis sparing bone entry points for radius and ulna, and preservation of the natural curves by contouring both nails is recommended, with particular attention to restoration of the appropriate radial bow, as these will lessen the rate of complications and radio-ulnar joint instability. It minimizes vascular damage to the bone and leads to more versatile and efficient application of internal fixation. The design of the Elastic nails does not interfere with periosteal circulation to the extent the plating does so, early union takes place and postoperative osteoporosis does not occur. It gives excellent functional results in the majority of patients. Complications after a well-performed surgery are minor and easily correctable. Easy implant removal. Complications can be noted at the earliest. Better than other modalities of treatment as the implants are flexible and available in different sizes and it is a biological fixation. We preferred immobilization in a slab in our patients because at the end of 3 weeks we were able to mobilize the patient at elbow in the slab itself. We found in our study that it is better to remove implant after 14 weeks. We found out in our study that reduction in forearm length was the cause for restriction in forearm rotations in our patients.

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