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Surgical outcome of fracture both bones forearm in children using tens

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Abstract
Introduction: Injuries to the shaft of the radius and ulnar are the most common reasons for children to receive orthopedic care and are among the most challenging to the orthopedist because of the treatment complexity and the risk of complication. Operative treatment of radial and ulnar shaft fractures usually is reserved for fractures that develop unacceptable displacement during non-operative management. Elastic nailing of diaphyseal forearm fracture of children is safe, less invasive, cosmetically better, has short hospital stay, lower risk of stiffness and other complications.
Objectives: Objective of the study was to evaluate the functional outcome and results of elastic nailing of diaphyseal forearm fracture in children. To know and prevent the complication of closed reduction and internal fixation of diaphyseal forearm fracture in children. To reduce operative exposure to minimal, reduce hospital stay and to reduce the rotational and angular deformities of forearm.
Methods: The study was conducted in patients treated for diaphyseal forearm fracture at Adhichunchangiri Institute of Medical Science, BG Nagar from the month of May 2013 to Dec 2016. 50 patients were taken for the study.
Results: 50 cases of fractures of both bones forearms were treated by elastic nailing. The follow-up period ranged from 10-16 weeks. Male were predominate (70%) and right forearm affection more (56%) than left. Most of the fractures are due to RTA (44%) rather than self-fall and sports injury. The average age was 11.25 yrs with fracture being most common in 10-15 yrs age group. Most of the fractures of both bones of forearm were middle third and the fracture pattern transverse was commonest. 40 patients had sound union in less than 12 weeks, remaining 10 patients had union by 14 weeks.
The results were based on Price et al scoring system and in our study there were 36 patients with excellent results and 09 with good and 04 patients with fair results and one patient with poor results.
Conclusion: Our study was found to be satisfactory and hence we recommend elastic nailing for operative treatment of diaphyseal fracture of both bones forearm in children.

Keywords: Both bones forearm, Diaphyseal fracture Price *et al* scoring system, Elastic nailing

Introduction
Willis C. Campbell (1880-1941) stated, "When satisfactory alignment or fixation in fractures of both bones of the forearm in children is not possible by conservative measures, then skeletal traction or open reduction is required and internal fixation should be applied to prevent bowing [1]."

Fractures of the radius & ulna shafts account for only 3% to 6% of all children's fractures. About 75% of fractures of the shaft of the radius and ulna are in the distal third, 15% in middle third & 5% in the proximal third. Monteggia fracture dislocations and complex injuries account for the remaining 5% [5].

Fractures of the forearm in children are different from those in adults. The periosteum is thicker and less lightly to be torn when fractures occur. Long bones in children have small medullary canals and more cancellous bones near the epiphysis which extends much further proximally along the shaft. Greenstick and torus fractures occur exclusively in children. The need for near perfect anatomic alignment is not always necessary because of the remodeling properties inherent in the growing bone of a child and hence open reduction is rarely indicated [1].

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. Surgical treatment comprises of Closed Reduction & Internal Fixation with Elastic Intramedullary nails & Open Reduction & Internal Fixation with plates [2].

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 & development in the field of surgical instrumentation, surgical experience and improved rehabilitation techniques has put surgical treatment on the upper hand [3].

The purpose of this study is to determine the functional outcome and results of elastic nailing of diaphyseal fracture forearm in paediatric age group and to prevent the complications of closed reduction and internal fixation of diaphyseal fracture forearm in children.

In the present study, fifty cases of diaphyseal fracture of both bone forearm in paediatric age group are treated surgically with Closed Reduction and Internal Fixation with Elastic Nailing in Adichunchanagiri institute of medical sciences, B.G. Nagara. With price et al scoring system the functional outcome was evaluated using the range the forearm rotation and the complications are studied.

Aims and Objectives

This study intended for the following aims & objectives

1. To study the functional outcome and results of elastic intra-medullary nailing of diaphyseal fracture forearm in children.
2. To prevent the complications of closed reduction and internal fixation of diaphyseal fracture forearm in children.
3. To reduce operative exposure to minimal, reduce hospital stay and to minimize the rotational and angular deformities of forearm.

Pathological Anatomy

Not only do children's fractures heal more rapidly than those in adults, but once healed, they are more likely to remodel residual deformity. Factors that affect the remodeling potential of a deformity include the amount of growth remaining and the plane of the deformity in relation to adjacent joints.

The single most important factor determining how much growth will contribute to the remodeling potential of a fracture is the patient's skeletal age. Other factors include the deformity's proximity to the physis and the growth potential of the particular physis. Wolff's law states that bone remodels according to the stress placed across it. It follows that post-traumatic deformity in the plane of motion of a joint will have greater potential to remodel than deformity not in the plane of motion.

Once the bone breaks, the direction & the extent of the displacement of the fracture fragments depend on the level of fracture, muscle action, and the direction of the breaking force. In the reduction & mobilization of these fractures, the origin, insertion and action of the forearm muscles must be considered. It is usually necessary to bring the movable distal fragment in line with the proximal fragment, which is displaced by the muscles attached to it and cannot be manipulated.

This feature has led to the division of forearm fractures in to 3 groups according to the forces acting on the proximal segment.

The rule of thirds

1. If the fracture of the shaft is proximal to the insertion of the pronator teres, the forearm should be held in supination.
2. If the fracture is in the middle third, midprone position is advised.
3. If the fracture is held in the distal third, pronation is the position of choice.

Surgical Anatomy

The radius and ulna are parallel to each other and function as a unit but come in contact only at their ends. They are bound proximally by a capsule of elbow joint, annular ligament and distally by capsule of the wrist joint, volar and dorsal radio ulnar ligaments.

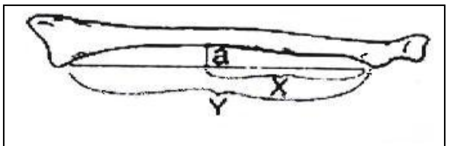
The radius bows laterally immediately distal to the bicipital tuberosity. The proximal radius is cylindrical, changing to a triangular shape at the junction of the proximal and middle thirds and flattening at its lower end. The fibers of interosseous membrane run obliquely across the interosseous space from proximal origin on the radius to their distal insertion on the ulna. The membrane provides attachment to deep muscles of the forearm and connects the two bones. The membrane is tense when the hand is midway between supine and prone position and is relaxed in complete supination and pronation.[4]

The radius is bound to the ulna by the interosseous membrane and annular ligament at the proximal radio ulnar joint. The triangular articular disk binds the radius to the ulna at the distal radio ulnar joint. These structures allow supination and pronation of the forearm [4].

The Interosseous distance is greater distally than proximally because of the curve of the radius. In pronation, the radius rotates diagonally across the ulna and the palm faces posteriorly. The crossover point of the two bones is in the proximal forearm.

The axis of rotation of the forearm bone extends from the center of the head of the radius to the insertion of the triangular fibro cartilage at the base of the styloid process of the ulna. If the relation of the forearm bones to this axis is altered by angulation, the mechanics of the radio ulnar joint are deranged and permanent limitation of rotation is inevitable. Maintaining length, axial alignment, rotational alignment and the radial bow, all four are important in achieving satisfactory functional results.

Technique for measurement of the amount and Location of maximal radial bow



Maximal radial bow a(mm)
location of maximal radial bow X/Y x 100

The maximal radial bow is determined by drawing a line from a bicipital tuberosity to the most ulnar aspect of the radius at the wrist. A perpendicular line is drawn from this line to the radius at the point of maximal radial bow and distance is measured in millimeters, location of maximal radial bow is determined by dividing the distance from the bicipital tuberosity to the point of maximum bow by the length of the entire bow. The value is expressed as a percentage. This measurement correlates with outcome following treatment of fracture of forearm bones.

Mechanism of Injury

The primary mechanism of injury associated with radial and ulnar shaft fractures is a fall on an outstretched hand that transmits indirect force to the bones of the forearm [7].

Biomechanical studies have suggested that the junction of the middle and distal thirds of the radius and a substantial portion of the shaft of the ulna have an increased vulnerability to fracture. Often, a significant rotational component is associated with the fall, causing the radius and ulna to fracture at different levels. If the radial and ulnar fractures are near the same level, a minimal torsional component can be inferred. If comminution is present, higher-energy trauma should be suspected. Significant hyperpronation forces are associated with isolated shaft fractures of either the radius or the ulna and concomitant dislocation of either the distal or the proximal radioulnar joint.

The mechanisms of injury of two particular forearm fracture patterns, traumatic bowing (also known as bow fractures or plastic deformation) and greenstick fracture, also bear mentioning [7]. Bone behaves differently based on the direction of the forces applied to it. This is the so-called anisotropic property of bone, and it can be simply explained as follows: bone is more resistant to axial forces than to bending and rotational forces. Pediatric bone also is much more porous than its adult counterpart and behaves somewhat differently from a biomechanic standpoint. Because of its porosity, pediatric bone absorbs significantly more energy prior to failure than does adult bone. When relatively slowly applied, longitudinal forces bend immature bone beyond its elastic limits and into its plastic zone, resulting in traumatic bowing. Thus, when a bending force is applied relatively slowly, many micro fractures occur along the length of the bone, leading to macroscopic deformity without discernible radiographic fracture. This bending can usually be seen radiographically if suspected.

Greenstick fractures represent an intermediate step between plastic deformation and complete fractures. On anteroposterior (AP) and lateral radiographs, greenstick fractures show cortical violation of one, two, or three of their radiographic cortices, and thus some bony continuity is preserved. Rotational deformity is considered to be intimately related to the clinical deformity seen with greenstick fractures of the forearm, and the analogy of a cardboard tube that tends to bend as it is twisted has been offered by Holdsworth. Specifically, hyperpronation injuries usually are associated with apex-dorsal greenstick fractures of the forearm, and hypersupination injuries usually are associated with the opposite, apex-volar injuries. The treatment of these greenstick fractures requires a derotation maneuver in addition to correction of any angulation [5].

Classification

The most comprehensive classification of forearm fractures is the one adopted by the Orthopaedic Trauma Association (OTA) [7]. Although this system is sound in concept, its 36 discrete subtypes make it impractical for everyday clinical use, and it has not been widely used by clinical researchers. Despite its complexity, the OTA classification does not account for one of the most important prognostic factors in pediatric forearm shaft fracture: location of the fracture in the distal, middle, or proximal third of the shaft.

The diagnosis of the fracture is usually simple. The history of injury and the presence of pain, tenderness, swelling, crepitation & angular deformities are confirmatory. The radiographic findings make the diagnosis obvious.

Radiograph of anterior and posterior view, that include both the proximal and distal joints are essential and they should reveal whether the fractures are complete or incomplete.

It is essential to realize that either anterior or posterior angulation of greenstick fractures have a rotational element. It is necessary to determine the position of the proximal fragment, which cannot be controlled, so that the distal fragment, which can be controlled, can be made to align with it in the same amount of rotation as the proximal fragment. This can be determined by the position of the bicipital tuberosity in the fractured radius.

In a normal forearm, on complete supination, an anteroposterior view will disclose both bicipital tuberosity and radial styloid, but neither the coronoid process nor the ulnar styloid will be visualized.

The lateral view shows both the coronoid process and ulnar styloid but neither prominence of the radius will be visualized. Thus if the styloid process of the ulna is seen on the anterior posterior view and is absent on the lateral view, a torsional deformity of the ulna is present [7]. If the bicipital tuberosity of the radius projects medially in the anterior posterior view while the radial styloid is not seen, then torsional deformity of the radius is present. In the midprone position, no bony prominence will be seen in the anteroposterior projections but all four-prominence s will be seen on the lateral radiographs.

Treatment Options

Closed management

Greenstick fractures

Skillful closed management usually is successful for this injury. Greenstick fractures may appear to be angulated and may also have a rotational element Should greenstick fractures be made complete appears to be controversial. If not broken, the intact cortex is used as an aid to reduction.

If the intact cortex is not broken, greenstick fractures have high chances of recurrence of angulation & high risk of refracture.

In a apex dorsal –pronation injury, the forearm should be supinated to achieve reduction. But in an apex volar – supination injury, a pronation force must be applied to secure reduction.

Limits of Alignment [5]

Age	Angulation	Malrotation	Displacement	Loss Of Radial Bow
Age <9yrs	15 Degrees	45 Degrees	Complete	Yes
Age >9yrs	10 Degrees	30 Degrees	Complete	Partial

Under intravenous sedation correction of angulation is done. A sugar –tong splint is then applied with the elbow flexed to right angle. One week later, the splint is removed and a well-molded long arm cast is applied. Maintenance of reduction is checked with radiographs. Cast immobilization is continued for 6 weeks.

Complete fractures

If the fracture is complete, an entirely different situation exists. The distal fragment may be in any position, but muscle pull determines the position of the proximal fragment. So the position of the proximal fragment should be determined so that the distal fragment can be aligned with it. The proper position for immobilization depends on the fracture.

If the fracture of the shaft is in the proximal third, the forearm should be held in supination. If the fracture is in the middle third, midprone position is advised & if the fracture is held in the distal third, pronation is the position of choice.

Under general anesthesia or local blocks, with traction and counter traction manual closed reduction is attempted. Then the forearm is placed in selected position of rotation. With elbow flexed to 90 degrees, a well-molded sugar tong splint is applied. Careful molding should be done to maintain the Interosseous space and the alignment. Radiographs are taken to check the alignment and angulation. Radiographs are made at 1st week, 2^{nd} weeks & 3^{rd} week after reduction. Cast change is done after 2 weeks. Cast is continued for 6 weeks.

Materials and Methods

50 cases of diaphyseal fractures of forearm in children were treated at Adichunchanagiri Institute of Medical Sciences Hospital and Research Centre, B.G Nagara by closed reduction and internal fixation with intramedullary nails were. The study was done on the children, aged up to 14 years of both sex with diaphyseal fractures of the forearm. Clearance was obtained from ethical committee

Inclusion criteria's are

> All closed diaphyseal fractures

Exclusion criteria's are

>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 & peripheral nerve injuries were carefully looked for. Clinical diagnosis was confirmed by taking antero-posterior & 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. All the surgeries were done within 3 to 7 days of injury under general anaesthesia under aseptic conditions.

Parental antibiotics were given for 3 days followed by oral antibiotics for 3 to 5 days. Active finger & shoulder movements were encouraged post operatively to promote better circulation and reduce edema. Postoperative radiographs were taken on the next day. Suture removal was done on the 10th days and the patients were discharged.

Review of the patient was done for 12 months with 5 visits (3^{rd} wk, 6^{th} wk, 3^{rd} month, 6^{th} month, 12^{th} month). Repeated radiographs were also taken to look for the callus formation. After 2nd week, POP cast conversion was done after confirmation of complete healing of surgical wound. After 6 to 8 weeks of post reduction, pop cast was removed & 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.

Technique of Closed Reduction

Vertical technique[6]

Closed reduction was done by vertical method. The forearm is suspended vertically with elbow in 90-degree flexion. Slight traction by exerting downward pressure on the arm is applied. The fracture is manipulated by applying pressure at the level of the fracture, squeezing the forearm between the surgeon's hands. During the procedure, the forearm is best held in supination, so that the squeeze separates the forearm bones from one another, thereafter the forearm can be allowed to fall into the lateral midprone position.

Reduction of the fracture is confirmed under C-arm. A single layer of wool followed by above elbow pop plaster is applied distally the plaster should not extend the metacarpo-phalangeal joint and the distal crease. During plaster setting it is important to apply the squeezing grip at the level of the fracture so as to mould the plaster into an oval cross section. This maintains the interrosseous space and keeps the forearm bones apart.

Horizontal technique [6]

This method was described by Bohler in which traction is applied to the fingers, while counter traction is applied at the elbow.

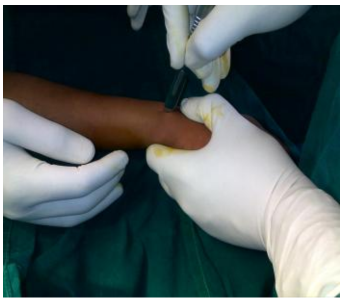
The fracture is manipulated by applying pressure at the level of the fracture, squeezing the forearm between the surgeon's hands. During the procedure, the forearm is best held in supination, so that the squeeze separates the forearm bones from one another. Application of the plaster is same as above.

Intramedullary fixation [8]

In children, nonunion are rare & minimal intramedullary fixation can maintain acceptable alignment until fracture healing occurs. Thus intramedullary nailing is more practical in children than in adults. The advent of image intensifier has made it easier for percutaneous routes.

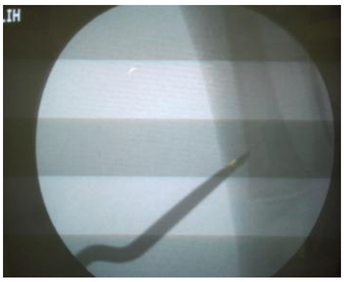
Contoured square nails, Kirschner nails or rush nails can be introduced proximally or distally in the ulna but are always introduced distally in the radius.

Ulna is entered just distal and lateral to the olecranon apophysis. The radius is approached radially just proximal to the distal physis with protection of the superficial radial nerve. A 45-degree oblique hole is drilled in the lateral cortex of the metaphysic to allow nail insertion. The nail is manipulated across the fracture site & advanced to the cancellous bone of the epiphysis.

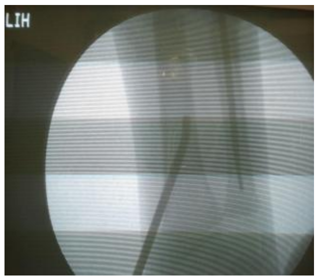


Skin Incision for Radius

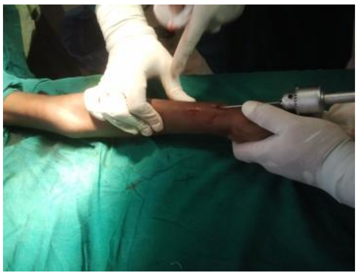
Bone Awl Entry



Bone Awl under C Arm

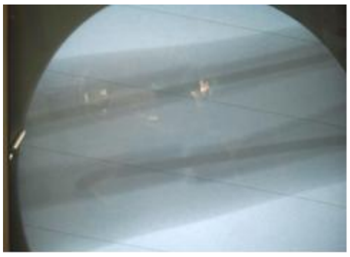


Radial Tens Entry

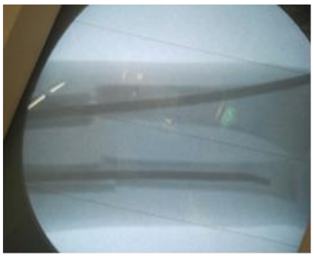


Reduction of Fracture

Ulna Entry

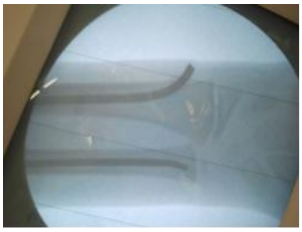


Nail Passing Fracture



Fracture Reduced

Proximal End



Distal End

Radial Entry Closure

Ulna Entry Closure

Case Series – 01

Pre-Operative Xrays – AP and Lateral View

Immediate Post-Operative Xrys– AP and Lateral View

3 Weeks Post-Operative Xrys–AP and Lateral View

12 Weeks Post-Operative Xrys– AP and Lateral View

Supination

Pronation

Case Series -02

Pre-Operative Xrays – AP and Lateral View

Immediate Post-Operative Xrys– AP and Lateral View

3 Weeks Post-Operative Xrys–AP and Lateral View

Results
This is a study of 50 cases of diaphyseal fractures of forearm in children treated by elastic nailing during the study period.

Table 1: Distribution of Sample by Age

Age	Frequency	Percent
5-10yrs	19	38
11-15yrs	31	62
Total	50	100

Table 2: Distribution of Sample by Sex

Sex	Frequency	Percent
Male	35	70
Female	15	30
Total	50	100

Table 3: Distribution of Sample by Side

Side	Frequency	Percent
Right	28	56
Left	20	40
Bilateral	02	04
Total	50	100

Table 4: Moi- Mode of Injury

Mode of injury	Frequency	Percent
Fall	17	34
Sports	11	22
RTA	22	44
Total	50	100

Table 5: Distribution of Site of Fracture

Site	Frequency	Percent
Proximal 1/3	08	16
Middle 1/3	30	60
Distal 1/3	12	24
Total	50	100

Table 6: Type of the Fracture

Type of fracture	No of pts	Percentage
Transverse	32	64
Oblique	16	32
Comminuted	02	04
Total	50	100

Table 7: Type of Implant Used

Type Of Implant Used	No. of cases	Percentage
K-WIRE	5	10
TENS	45	90
Total	50	100

Table 8: Type of Reduction

Type Of Reduction	No. of cases	Percentage
CLOSED	38	76
MINI OPEN	12	24
Total	50	100

Table 9: Operation Time

Operation Time	No. of cases	Percentage
<30 min	05	10
30-45 min	37	74
>45 min	08	16
Total	50	100

Table 10: Period of Immobilization

Period Of Immobilization	No. of cases	Percentage
<4 weeks	13	26
4-6 weeks	25	50
>6 weeks	12	24
Total	50	100

Table 11: Duration of Fracture Union

Time of union	No. of cases	Percentage
<10 weeks	14	28
10-12 weeks	26	52
>12 weeks	10	20
Total	50	100

Table 12: Time of Implant Removal

Time Of Implant Removal	No. of cases	Percentage
<12 weeks	10	20
12-14 weeks	24	48
>14 weeks	16	32
Total	50	100

Table 13: Complications

Complications	No. of cases	Percentage
Superficial Infection	05	10
Refracture	02	04
Total	20	100

Table 14: Results -Based on Price Et Al., Criteria

Results	Frequency	Percent
Excellent	36	72
Good	09	18
Fair	04	08
Poor	01	02
Total	50	100

Discussion
50 cases of diaphyseal fractures of forearm in children were treated at Adichunchanagiri Institute of Medical Sciences, B G Nagar by elastic nailing. The study was done on the children of both sexes with diaphyseal fractures of the forearm.

Age Distribution
The mean age of the patients in our study was 11.25 years, which is comparable to the study made in 1998 by Richter et al who found it to be 9.6years [11]. Cullen et al accounted an average age as 13 years [12]. Chapman et al found average age to be 11 years [10]. Yung et al accounted average age to be 7 years [9].

Sex Distribution
In the present study we found the incidence of forearm fractures to be 70% in males and 30% in females. The incidence of forearm fracture was more among males compared to females which is comparable to the study by Richter et al and Van der reis et al and Cullen et al in1998 (males 60% and females 40%). Chapman et al in 1998 found males 68% and females 32%.[10] Young et al found males 56% and females 44% [9].

Extremity Affected
In our study we found an incidence of 56% right forearm fractures and 40% left forearm fractures which is comparable to study by Cullen et al (right 60% and left 40%) in1998[12]. Chapman et al in their study found incidence to be 40% right and 60% left [10]. Young et al found incidence to be 68% left and 32% right [9].

Mode of Injury

In our present study majority of patient's mode of injury is road traffic accident (RTA) 44%, 34% had self-fall and 22% had sports injury which is comparable to study by Cullen et al in 1998 with sports 40%, RTA 20%, self-fall 40% [12]. Richter et al found incidence of 65% self-fall and 35% sports injury and RTA together [11].

Type of Fracture

In our current study we found an incidence of 64% transverse fractures and 32% oblique fractures which is similar to the study done by Young et al who found 65% transverse fractures and 35% oblique fractures[9]. Chapman et al found in their study an incidence of 84% oblique fractures and 16% transverse fractures [10].

Site of Fracture

In our present study we found an incidence of 60% middle 1/3rd, 16% proximal 1/3rd and 24% distal 1/3rd fractures which is similar to study by Richter et al (50% middle and 25% proximal and distal 1/3rd) [11].

Type of Reduction

In our present study 76% of the fractures were treated with closed reduction and only 24% needed mini open reduction to pass the nails across the fracture site. This is comparable to studies by Richter et al (closed reduction 84%) [11] And Young et al (closed reduction 75%) and Waseem (closed reduction 72%). Cullen et al open reduction 75% and Luhmann et al open reduction 50% [10].

Procedure time

In our present study 74% of the fractures were fixed within 45 min which is comparable to Richter et al in 1998 which was 40 min.[11] Cullen et al found that in their study it took them 100 min to fix fractures [12].

Period of Immobilization

In our present study 76% of the patients were immobilized for a mean period of 4 - 6 weeks which is comparable to Young et al in 1998 who immobilized for a period of 4 weeks[9]. Chapman et al in their study immobilized children for a mean period of 7 weeks [10].

Time of Union

In our present study 80% fractures united in less than 12 weeks and the remaining cases united by the end of 14 weeks which was comparable to the studies done by Cullen et al [12] and Richter et al [11] which was 10 weeks and 11.5 weeks.

Time of Implant Removal

In our present study 68% of the implants were removed at 14 weeks which is comparable to the studies by Richter et al (12 weeks) [11] and Chapman et al (13 weeks) [10]. Cullen et al had removed the implants by a mean of 16 weeks [13].

Complications

In our study 05 (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 [6]. Following these complications, in the remaining patients the implants were cut short and buried under the skin. Two patients (4%) had re-fracture after the implant was removed when they sustained a minor fall 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 [15]. In our study we had 4 patients (08%) who had >30degree loss of rotation and 3 patients (06%) who had 11 – 30 degree loss of rotation [13]. 2 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, nonunion, malunion, implant backout, compartment syndrome. Our results were comparable with that of Chapman et al who had 24% complication rate which consisted of a case of implant migration and a case of non-union [10]. Cullen et al in 1998 in their study found 50% complication rate which include implant migration, infection, loss of reduction, nerve injury, refracture etc [12]. Van der reis et al noted complications in 25% patients with various complications like delayed union, angulation, rotational deformity and compartment syndrome [14].

Functional Results

Detailed analysis of functional results of the patient was done on the basis of following criteria by Price et al.

Clinical outcome	Symptoms	Loss of Fore arm Rotation
Excellent	No complaints with strenuous work	$<11^0$
Good	Mild complaints with strenuous work	$11^0 – 30^0$
Fair	Mild complaints with daily work	31^0-90^0
Poor	All other results	

Range of movements (rotations) and complaints on daily activities 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 36 (72%) patients with excellent results, 09 (18%) patients with Good results and 04 (08%) patients with Fair results. One patient with Poor result were observed in our study. Our results are comparable with that of Richter et al who had 24(80%) patients with excellent results, 5(16.6%) with good results and 1(3.3%) with fair results. In 1998 Chapman et al reported Excellent results in 21(84%), Good results in 4(16%) and no poor results [10]. Van der reis reported Excellent results in 18(78%) patients, Poor results in 5(22%) patients [14]. Cullen et al reported Excellent results in 17(89.4%) patients, Good results in 2(10.5%) patients [12]. In 1985 Amit et al reported 100% Excellent results in a study of 20 patients with no Poor results. Verstreken et al reported Good results in 6 patients treated with intramedullary nailing. Lascombes *et al* reported excellent results in 92% patients treated with elastic stable intramedullary nailing (ESIN).

Conclusion

- Advantages of elastic nailing of paediatric forearm fractures is that it facilitates biological fixation of the fracture and promotes early fracture union.
- 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.
- 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.
- Biomechanically, these implants have been shown to act

as internal splints provided the nails extend three or more diameters beyond the fracture site.

- 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.
- Hence the study was satisfactory and elastic nailing can be considered the best mode of operative treatment for diaphyseal fractures of both bones forearm in children.

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