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Conservative vs. surgical intervention in diaphyseal forearm fractures in age group 1 to 15 years: A prospective study

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Abstract
Pediatric diaphyseal breaks of the radius and ulna, regularly alluded to as both bone lower arm fractures, are the third most basic fractures in the paediatric populace and record for 13-40% of all pediatric fractures.1, 2. More than 40% of young ladies and more than half of young men manage no less than one fracture amid youth and adolescence, (3) with distal lower arm breaks being among the most widely recognized, representing up to 33% of all pediatric fractures. (3) Thus, the role of a childhood distal forearm fracture, in particular, on fracture risk later in life, would have practical clinical applications.
Given the magnificent rebuilding potential of youthful patients, certain examinations have concluded that even with 100% uprooting of the radius and ulna closed reduction is an amazing treatment decision for youngsters 9 years of age and younger [14, 15]. Nonetheless, the correct measure of angulation, dislodging, and revolution of bone stays questionable in the writing. It is by and large acknowledged that the nearer the fracture is to the distal physis, the more prominent the potential for rebuilding. Moderate management is yet the main line of treatment for pediatric lower arm fractures particularly in youngsters under 10 years of age. By and by if intervention is required whether adaptable nails or open reduction with plating is needed, then both plating and nailing are adequate treatment choices but however it is nailing which provides less invasiveness, Thus this study shows light upon the management choices available with their pros and cons for various forearm fractures.

Keywords: Conservative, surgery, diaphyseal, forearm fractures

Introduction
Pediatric diaphyseal fractures of the radius and ulna, commonly referred to as both bone forearm fractures, are the third most common fracture in the pediatric population and account for 13-40% of all pediatric fractures [1, 2]. Over 40% of girls and over 50% of boys sustain at least one fracture during childhood and adolescence [3] with distal forearm fractures being among the most common, accounting for up to one-third of all pediatric fractures [3] Furthermore, distal forearm fractures in childhood are increasing in incidence [4, 5] particularly among girls [4] Fracture rate peaks between ages 11 and 15 yr [5], corresponding to the period of maximum postnatal growth velocity. Thus, the role of a childhood distal forearm fracture, in particular, on fracture risk later in life, would have practical clinical applications.
Diaphyseal fracture of both bones of forearm in mature bone is now treated by open reduction and internal fixation. But it is not true for immature bones. Fractures of forearm in children and adolescent are extremely common [6]. Studies have demonstrated lower bone density or weaker bone structure in boys and girls with a distal forearm fracture compared with controls [7].
Recently there has been an increased interest in determining which method provides superior results, but the optimal treatment remains controversial [6] The goal of this paper is to study the current treatment of paediatric both bone forearm fractures in younger children (ages 1-15), and offer useful treatment algorithms for these injuries [8]. Recently, however, there has been a trend towards increased surgical management of these fractures in an effort to improve clinical outcomes [9].

Material and methods

- Institute Scientific & Ethics Committee Clearance was obtained before the start of the study. It was a prospective study of 50 cases done between the period of July, 2015 to September, 2017 at Dr D. Y. Patil Medical College, Pimpri, Pune.
- 50 patients with 50 forearm fractures, conservatively or operatively treated were included. The study was approved by the institutional ethical committee.
  Isolated radial head or neck fractures, multiple tauma, neurovascular injuries, Open fractures of Type 2 and 3 of Gustillo Anderson Classification, failure to achieve close reduction after three to four attempts, refractures, pathological Fractures and fractures with compartment syndrome were excluded
- Patients were divided into two groups the first group of patients were those who were treated successfully conservatively by manipulation and casting, the other group of patients were those who required open reduction and internal fixation. Variables were collected about the patients and methods of treatment (conservative versus open reduction and internal fixation) to find which of the two methods is more beneficial.

Treatment of pediatric fractures [10]

Method	Remarks
Functional	Redression (e.g., collar-and-cuff bandage), functional bandage (Desault, Gilchrist) with acceptable degree of deformity
Immobilization	Plaster cast, conventional (white) or synthetic (rigid or semirigid; if necesary, correction by cast wedging
Adaptation osteosynthesis (Kirschner wires)	Metaphyseal fractures: additional plaster cast immobilization necessary (unstable)
ESIN (elastic stable intramedullary nailing)	In longitudinally stable (transverse) diaphyseal fractures (also greenstick fractures of forearm shaft; as intramedullary rod in proximal upper arm fractures
Plate fixation	As an exception, in fractures close to joints in adolescents
Medullary or locking nail	In diaphyseal fractures in adolescents

Non operative

Closed reduction and immobilization

Indications: most pediatric forearm fractures can be treated without surgery greenstick injuries, bayonet apposition if <10 years follow-up with weekly radiographs for first 3-4 weeks to monitor reduction, casting is done for 6-12 weeks in total short arm cast for distal 1/3 BBFA above elbow immobilization for any fracture proximal to distal 1/3
Operative

Percutaneous

Indications: unacceptable alignment following closed reduction i.e angulation >15°, rotation >45° in children <10y angulation >10°, rotation >30° in children >10y bayonet apposition in children older than 10 years both bone forearm fractures in children> 13 highly displaced fractures

Open reduction and internal fixation

Indications: unacceptable alignment following closed reduction open fractures refractures angulation >15° and rotation >45° in children <10y angulation >10° and rotation >30° in children >10y bayonet apposition in children older than 10 years both bone forearm fractures in children> 13 highly displaced fractures (Those children that needed internal fixation; we treat them either: By intra-medullary nails, K-wires cases or by plate and screws cases. The patient and method of fixation were chosen randomly).
With the exception of severe fracture comminution, most both bone forearm fractures that can be treated by plate fixation may also be treated with flexible nails through closed or open reduction techniques. Recently fracture fixation with flexible nails has gained popularity, with proponents arguing that nailing results in decreased surgical dissection and retention of biologic factors at the fracture site [12, 13] Both titanium and stainless steel flexible nails are available.
Table of recommended acceptable alignment parameters for both-bone pediatric forearm fracture [11].

Source	Age, years	Angulation, degrees	Malrotation, degrees	Bayonette apposition /displacement
Price (2010) [15]	<8	<15 MS, DS; <10 PS	<30	100% displacement
Noonan (1998) [16]	<9	<15	<45	<1 cm short
Tarmuzi (2009) [17]	<10	<20		No limits
Qairul (2001) [20]	<12	<20		

MS, mid-shaft; DS, distal-shaft; PS, proximal-shaft.

Observation and results

Level of fracture site: Of those children (3.88%) had fracture in the proximal 1/3, (50.58%) had fracture in the middle 1/3 and (45.63) had fracture in the lower 1/3 of forearm bones.

	Conservative	Operative	Total
Upper third	1 (2%)	1(2%)	2 (4%)
Middle third	22(44%)	4(8%)	26(52%)
Lower third	15(30%)	7(14%)	22(44%)
Total	38(76%)	12(24%)	50

The functional outcome result: For the functional outcome results, of those children that had been treated conservatively (89.74%) had an excellent and the remaining (10.25) had good functional outcome results while of those children that had been treated operatively (80%) had an excellent, (16%) had good and (4%) had fair functional outcome results, this is according to Price *et al.* [10]

Outcome	Conservative	Operative	Total
Excellent	70(67.96%)	20(19.41%)	90(87.37%)
Good	8(7.76%)	4(3.88%)	12(11.65%)
Fair	0	1(0.97)	1(0.97)
Poor	0	0	0
Total	78(75.72%)	25(24.27%)	103

Complications: The main complications are:

	Conservative	Operative	Total
1. no complication	35(70%)	9(18%)	44(88%)
2. oedema	2(4%)	1(2%)	3(6%)
3. superficial &pin tract infection	0	1(2%)	1(2%)
4. compartment syndrome	0	0	0
5.malunion(rotation)	1(2%)	0	1(2%)
6. joint stiffness	0	1(2%)	1(2%)
Total	38	12	50
Total	78(75.72%)	25(24.27%)	103

Duration of hospitalization: Were longer for those treated by operative method, those patients kept in the word under observation and care, for 1-2 days longer than those treated by conservative method, duration of stay in hospital for those treated by conservative method was (1-2) days, while for those treated by operative method was (2-3) days.

After treatment in day	Conservative	Operative	Total
1 day	73(70.87%)	0	73(70.87%)
2 day	5(4.85%)	21(20.38%)	26(25.24%)
3 day	0	4(3.88%)	4(3.88%)
More	0	0	0
Total	78(75.72%)	25(24.27%)	103

Discussion

Given the excellent remodeling potential with younger patients, certain studies have argued that even with 100% displacement of the radius and ulna closed reduction and casting is an excellent treatment choice for children 9 years old and younger [14, 15]. However, the exact amount of angulation, displacement, and rotation that is acceptable remains controversial in the literature. It is generally accepted that the closer the fracture is to the distal physis, the greater the potential for remodeling. Consequently more deformity can be accepted in the distal one third of the diaphysis *versus* the middle and proximal thirds.

Franklin *et al.* defined successful treatment of pediatric forearm fractures should result in painless and complication-free outcomes with functional pronosupintation [15]. It has been shown that 15 to 20 degrees of angulation in middle third forearm fractures can lead to major loss of forearm rotation [16]. However, the significance of this range of motion loss as it pertains to clinical outcome remains debatable. Functional outcomes are satisfactory for closed management if manipulation can maintain reduction within this range [17, 18] Tarmuzi *et al.* concluded that up to 1cm of shortening can be accepted for closed management [17]. Failure of closed management is rare, with roughly 90% of injuries being amenable to closed management [19] Children under the age of 4 should be placed in an above-elbow cast for any forearm fractures as short arm casts may slip [20, 21] Post reduction, patients should be followed weekly for the first two to three weeks to ensure reduction is maintained. Holmes *et al.* found that if loss of reduction occurs, wedging the cast may restore alignment, but re-reduction or operative intervention may be required [21]. The complications associated with cast immobilization include disuse osteopenia, muscle atrophy, skin breakdown, and elbow stiffness [22, 23] Loss of reduction is the most common complication in pediatric forearm fractures, with rates between 10 and 60% [22].

Nonoperative management continues to be a very common, safe, and successful treatment option in pediatric forearm fractures. For those fractures that fail or are not amenable to conservative management however, surgical stabilization may need to be considered.

Different from other long bone of the human body, radius and ulna possess an important function of rotation, which play a crucial role for a series of nimble movements of the upper limb. The classic concept considers the double bones of forearm as a "joint" that allows rotation of the radius around the ulna, rather than two simple "long bone" [24, 25].

Holmes *et al*. stated that compression plating maximizes the ability to obtain anatomic reduction and restore normal radial bow [21] Additionally, given the construct fixation strength, plate fixation permits early range of motion. Although exact indications are debatable, it is suggested that plate fixation is indicated in the setting of significant comminution or with late loss of reduction after conservative management, as callous can prevent passage of intramedullary fixation [21] In contrast to adult fixation, smaller plate size and fewer screws can be used in children [21, 30] Generally screw diameters are 2.7 mm or 3.5 mm, and 1/3 tubular plates and may be considered adequate [26] Fixation through 4 cortices should be obtained proximal and distal to the fracture site, and the plate should not be wider than the bone [26, 27]

Complications of plate fixation include damage to surrounding structures, nonunion/malunion, and synostosis [24] The rate of synostosis has been noted to have an increased incidence if only one incision is used [24] The potential for nerve damage is also present, more commonly secondary to ulnar fixation [36]

Other important factor in plating is implant removal, there was a 7.3% risk of an *implant-related fracture* in the follow up period, which all occurred within the first 3 years

With the exception of severe fracture comminution, most both bone forearm fractures that can be treated by plate fixation may also be treated with flexible nails through closed or open reduction techniques. Recently fracture fixation with flexible nails has gained popularity, with proponents arguing that nailing results in decreased surgical dissection and retention of biologic factors at the fracture site.[28] Both titanium and stainless steel flexible nails are available. In the clinical setting, titanium (Ti 6A114V) is being used more often than stainless steel in most circumstances because of the elastic properties which allow for improved insertion and rotation while still providing adequate fracture stabilization.[29] Kang *et al*. evaluated 90 children treated with intramedullary nailing and reported *good results* and patient outcomes.[30] Complications secondary to intramedullary fixation include infection at the site of implantation, skin irritation, refracture after removal, implant failure, nerve/tendon injury, decreased range of motion, and compartment syndrome.

Conclusion

Conservative management is still the first line of treatment for pediatric forearm fractures especially in children less than 10 years old. Presently if operative intervention is required, both

plate fixation and flexible nailing are acceptable treatment options. However, based on analysis of the available literature, it is unclear whether flexible nails or open reduction and internal fixation with plates should be recommended as a superior technique. Adequate understanding of the subtleties of either technique is necessary to ensure optimal outcomes, including the limitations of each technique and possible complications. In general, severe comminution and bone loss should be considered as indications for plate fixation, while intramedullary nailing offers better cosmesis, and decreased soft tissue disruption.

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