Evaluation of Treatment of Displaced Diaphyseal Fractures of The Radius and Ulna in Children in Duhok Emergency Teaching Hospital

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Abstract

Background: Forearm fractures are extremely common in children, mostly in the distal third. In most cases non-operative management results in a good outcome, but there are circumstances in which operative management is necessary to optimise union and maximize functional outcome.

Objectives: To report the outcomes of both conservative and operative methods of treatment of the forearm bone fractures in children.

Patients and methods: This is a retrospective study of 103 children with displaced diaphyseal fracture of radius and ulna treated at Duhok emergency teaching hospitals between December 2010 and December 20012, their ages ranged from 2.5-13years, majority were male& majority were treated conservatively.For all patients presented with displaced fractures; manipulation under general anesthesia was done with cast application, these were assessed radiologically ,to be followed up for six months clinically and radiologically, if reduction is satisfactory, or else treated by open reduction and internal fixation if reduction is unsatisfactory, redisplaced, malaligned or became malunited later during the follow up. Outcome was assessed later both clinically and radiologically.

Results: In 78 patients conservative treatment were successful because of few complications, shorter duration of hospitalization and better functional-outcome results. The remaining 25 patients required operative treatment in which complications and period of hospital stay were longer and functional outcome was not as good as conservative treatment.

Conclusions: The majority of paediatric forearm fractures were caused by fall on outstretched hand and the majority were right handed in whom fractures occurred in the middle and distal third of the radius and ulna. Both methods of treatment were useful in dealing with such fractures but relatively with different outcome. Conservative treatment was safer, easier, with less complication, needs shorter period of hospitalization, and has better functional outcome.

Key Words: Fracture, Children, Forearm, Treatment, Conservative, Operative

الخلاصة

دراسة لتقييم علاج الكسورالمزاحة لعظمي الكعبرة والزند لدى الأطفال, أجريت هذه الدراسة في مستشفى الطوارئ التعليمي في دهوك.

لقد تم أجراء تحليل أستذكاري لثمانية وسبعون مريضآ عولجوا تحفظيآ,وخمسة وعشرين مريضآ عولجوا جراحيآ.

من دواعي إجراء عملية التداخل الجراحي لهذا النوع من الكسور لدى الأطفال: الكسور غير المستقرة, الكسور غير القابلة للرجوع, الكسور التي تزاح بعد إرجاعها, الكسور المهملة أو المتأخرة, الكسور المركبة, الكسور المتعددة, أذى الأوعية الدموية والأعصاب المصاحبة للكسور.

لقد وجدنا في هذه الدراسة أن (٩١٪) من المرضى المعالجين تحفظيآ عدم حدوث مضاعفات تذكر, (٦,٤١٪)عانوا من حدوث خزب, (٢,٤٦)٪ حدث لديهم ألتئام غير مقبول في عظام ألساعد وعولجوا جراحيآ.

بالنسبة للمرضى الذين تم علاجهم جراحيآ وجدنا عدم حدوث المضاعفات في(٧٢٪)منهم.(١٦٪)من المرضى المعالجين بهذه الطريقة عانوا من حدوث خزب بعد العملية, (٨٪) عانوا من التهابات سطحية في جروح العملية تم العلاج بالمضادات الحياتية, (٤٪)عانوا من تصلب خفيف في ألمفاصل وألذي شفي خلال شهر من رفع ألجبسونة.

لقد وجدنا بأن طريقتي ألعلاج ألتحفضية وألجراحية مفيدتان لهذه ألانواع من ألكسور,مدة البقاء في المستشفى للطريقة ألتحفظية أقصر من الطريقة ألجراحية. ووجدنا أيضا انه يوجد فرق في النتائج النهائية بين الطريقتين.

Introduction

Forearm fractures represent approximately 3.4% of all fractures in children and about 30% of all upper extremity fractures [1]. Approximately 18% of paediatric forearm fractures occur in the middle third, 7% in the proximal third, and an overwhelming 75% in the distal third[2]. Fractures of radius and ulna are extremely common in children [3]. A twisting force produces a spiral fracture with the bones broken at different levels; a direct blow may cause a transverse fracture of both bones at the same level. Additional rotational deformity may be produced by the pull of muscles attached to the radius [4]. Bleeding and swelling of the muscle compartment of the forearm may cause circulatory impairment and increases the risk of compartment syndrome and nerve injuries are rarely caused by the fracture itself, so it should be excluded before any intervention with the condition [5]. Therefore, if surgical treatment is chosen, the operative technique is of particular importance here and vascular injuries to the ulnar or radial arteries seldom present any problem, as collateral circulation is excellent[5].

In most cases non-operative management results in a good outcome. [6] There are circumstances in which operative management is necessary. The purpose of operative intervention is to prevent future cross union, angular, rotational deformity and maximize functional outcome. [7] In children, it is thought that 90% or more of paediatric both bone fractures are successfully treated conservatively with closed reduction and casting. The remaining 10% are often irreducible or unstable and can

pose a significant challenge in management. Alternatives include closed remanipulation and casting, [8] closed or open reduction and intramedullary (IM) nailing or plate and screws. It is difficult to ascertain the amount of residual angulations and rotational alignment that is acceptable in children at the time of initial reduction. [9] Some suggest that children do well despite residual angulations; others believe that there are functional limitations when residual angulations persists. In general, however, most agree that angulations of the middle third leads to more functional limitations compared with distal malunions. Furthermore, supination loss is more intolerable than pronation loss. It has been stated that the incidence of poor results of closed treatment of fractures in children older than 10 years age is widely underreported.[6]

Patients and Methods

Study design: This is a retrospective study of 103 children with displaced diaphyseal fracture of radius and ulna treated at Duhok emergency teaching hospitals between December 2010 and December 20012.

Patients were divided into two groups the first group of patients were 78 (75.72%) who were treated successfully conservatively by manipulation and casting, the other group of patients were 25(24.27%) 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.

The variables were: Age, sex, residence, mechanism of injury, date of injury, fracture side, dominant hand, x-ray level of fracture (upper, middle or lower third), type of fracture and degree of displacement, indication for open reduction, complications and duration of hospitalization. Functional outcome results at last follow up were graded on the system adapted by Price *et al*. [10]

An excellent results were on, with no complaints with strenuous activity and/or

loss of forearm rotation of ≤ 10 degrees. A good result, if there were only mild complaints with the activities and /or a loss of rotation of 11-30 degrees. Fair results, if there were mild complaints with daily activities and / or rotational loss of 31-90 degrees. All other results were classified as poor.

Exclusion criteria: Fracture dislocation (*Monteggia* and *Galleazi*), compound and undisplaced fractures.

Inclusion criteria: children from the age above 2 years and below 13 years.

All displaced fractures of radius and ulna[fig.1] presented to us immediately or during the first two to three days, were treated conservatively by manipulation under general anaesthesia, reduction and splintage by back-slab extended from the axilla to the knuckles (to control the rotation), with the elbow in flexion position 90 degrees [fig.2].

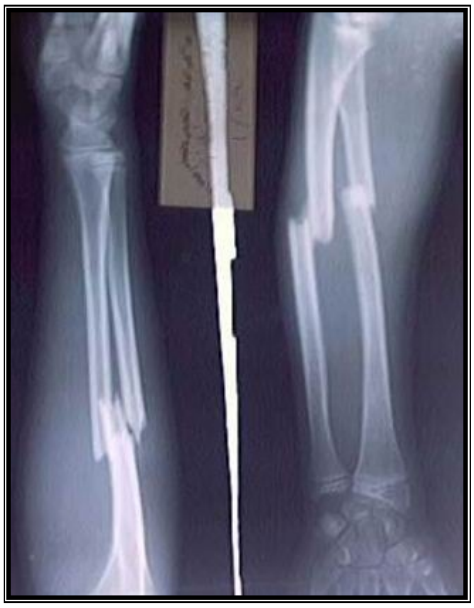

Figure 1 displaced fractures of radius and ulna

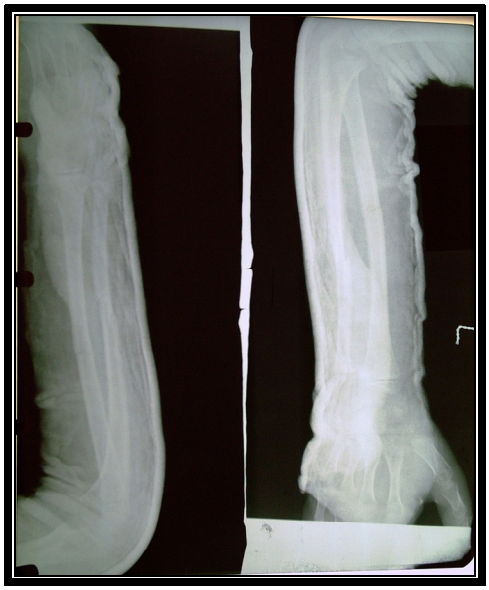

Figure 2 back-slab extended from the axilla to the knuckles , with the elbow in flexion position 90 degrees after manipulation under general anaesthesia.

Second attempt of manipulation and casting is carried out under anaesthesia for non reduced and unstable fractures. Unfortunately we did not have image intensifier in the emergency operation room, so reduction is checked by x-ray immediately after manipulation and casting, if the position is accepted, its repeated after one week if still acceptable then the back slab is changed to complete cast, follow-up x-ray repeated after two weeks and then at 6-8 weeks after removal of the cast to exclude redisplacement and to assess the state of healing, then follow-up x-ray monthly for six months. Fracture union was defined as bridging callus on both AP and lateral radiographs with non-tender fracture sites.

After 6-8wks we discard the p.o.p then check the fracture site clinically and radiologically, then monthly checking x-ray for 6 months

Those children who had unstable, irreducible fractures with overlapping, angulations and/or rotation; any form of rotation is not accepted, for angulations, those children under 10 years with residual angulations of more than 20 degrees and for children above 10 years with residual angulations of more than 10 degrees, or at any time of follow up developed redisplacement; those needed open reduction and internal fixation.

Operative procedure: Under G.A, antibiotic prophylaxis when necessary (cloxacillin and ampicillin) given at time of anaesthesia induction and continued post-operatively for 48 hours and tourniquet is applied.

Radius:15(60%) cases were explored through anterior (Henry) approach and 10(40%)cases through dorsal (Thompson's) approach. Ulna: is explored dorsally in all cases, the incision is relatively short directly over the fracture. Both fractures were explored and reduced before fixation of either of them, For (Kirschner-wires) we use different size and length usually (2-4 mm) in diameter, precise length of wires chosen for fixation and for radius the wires were introduced retrogradely through the distal radial physis after the reduction of the fracture. For ulnar fixation, we introduced the wire retrogradely from the fracture site toward the olecranon, then the fracture was reduced and the wire was pushed antegradely; at the end the tourniquet released, proper haemostasis done, fascia is left without suturing and the skin closed without drain then dressing and back-slab applied, then checking x-ray.

For plate and screws we usually used 3.5 mm 1/3-tubular plate (type AO) with (4-6) holes which was applied to the anterior surface of the radius and ulnar surface of the ulna, type of screws were 3.5mm cortical screws with appropriate length. The drill that used in this technique was manual one.Torniquet released, proper haemostasis done, the fascia was left without suturing and the skin closed without drain, then dressing and back slab applied from axilla to the knuckles with elbow in 90 degrees flexion and neutral rotation of forearm. Then checking x-ray done. Relatively shorter incisions are used when K- wires are applied. The patient stays (1-2) days for K-wires and (2-3) for plate and screws under observation. Then discharge home to be reviewed after two weeks for stitches removal and for re-checking x-ray.

The back-slab was discarded with x-ray checking before removal of k-wires after (6-8) weeks and the (K-wires) were then removed usually in the outpatient clinic and no other surgical procedure was needed [fig. 3] and the patients then checked by x-ray monthly for six months for patient treated by k-wires and every 2 weeks for 6 months for those treated by plate and screws. Plate and screws were removed between (6-8) months after fracture healing [fig. 4].

Figure 3 X-ray after removal of kirschnner wires.

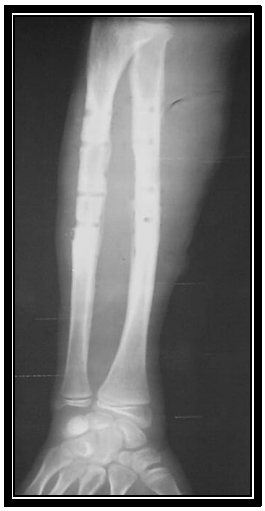

Figure 4 X-ray after removal of plates and screws.

Data analysis: Data were analysed using Microsoft Excel computer program.
T test and Fisher exact test were used when applicable, P value of equal or less than 0.05 was considered as statistically significant.

Results

Age incidence: The age of the patients range between (2.5-13) years, the mean age was (8.49), the mean age for those children that treated conservatively was 8.03 years and for those need open reduction and internal fixation by either of these two methods was 9.92 years

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Table 1 Age incidence

Age	Conservative	Operative	Total
2.5-5	14(13.59%)	1(0.97%)	15(14.56%)
6-9	38(36.89%)	9(8.73%)	47(45.63%)
10-13	26(25.24%)	15(14.56%)	41(39.80%)
Total	78(75.72%)	25(24.27%)	103

Table 2 sex distribution**:** The ratio of males to females was 8:1

Sex	Conservative	Operative	Total
Male	70(67.996%)	22(21.35%)	92(89.32%)
Female	8(7.76%)	3(2.91%)	11(10.67%)
Total	78(75.72%)	25(24.27%)	103

Table 3 The residence of those children was 80% from urban area and 20% from rural area.

Residence	Conservative	Operative	Total
Urban	66(64.07%)	17(16.50%)	83(80.58%)
Rural	12(11.65%)	8(7.76%)	20(19.41%)
Total	78(75.72%)	25(24.27%)	103

Table 4 Mechanism of injury: Most of those children developed such a fractures after fall on out stretch hand (92.23%).

Mechanism	Conservative	Operative	Total
Fall on out stretched hand	72(69.90%)	23(22.33%)	95(92.23%)
Direct trauma	4(3.88%)	1(0.97%)	5(4.83%)
Car accident	2(1.94%)	1(0.97%)	3(2.91%)

Table 5 Fracture side: 39 children (37.86) had fractures in the right forearm, and 64 children (62.13) % had fractures in the left forearm; the ratio of the fracture right: left side was 1:1.7.

Fracture side	Conservative	Operative	Total
Right	26(25.24%)	13(12,62%)	39(37.86%)
Left	52(53.85%)	12(11.65%)	64(62.13%)
	78(75.72%)	25(24.27%)	103

Table 6 Hand dominancy: 88.3% of those children were of right handed and 11.6% of them were of left handed. We depend on the parents to determine the dominant hand in those children under 7 years old (which hand used for eating).

	Conservative	Operative	Total
Right	68(66.01%)	23(22.33%)	91(88.34%)
Left	10(9.70%)	2(1.94%)	12(11.65%)
	78(75.72%)	25(24.27%)	103

Table 7 Correlation between fracture side and handedness: There were a correlation between the fractures side and handedness.

	Right handed	Left handed	Total
Right side	35(33.98)	4(3.88)	39(37.86)
Left side	56(54.36)	8(7.76)	64(62.13)
Total	91(88.34)	12(11.65)	103

Table 8 Indications for open reduction and internal fixation: Were; Unstable, still displaced after a trial of manipulation, redisplacement, neglected and malunited fractures.

Unstable	17(16.50%)
Redisplaced	7(6.79%)
neglected(presented late)	1(0.97%)
Total	**25(24.27%)**

Table 9 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	2 (1.94%)	2(1.94%)	4 (3.88%)
Middle third	44(42.71%)	8(7.76%)	52(50.48%)
Lower third	32(31.06%)	15(14.56)	47(45.63%)
Total	78(75.72%)	25(24.27%)	103

Those children that needed open reduction and internal fixation 25(24.27); we treat them either: By intra-medullary K-wires 23(92%) cases [fig 5] or by plate and screws 2(8%) cases. [Fig. 6]. The patient and method of fixation were chosen randomly.

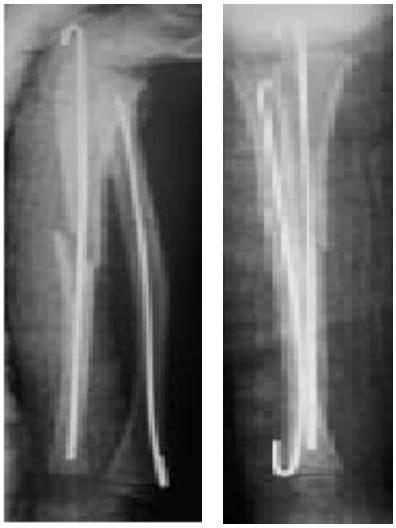

Figure 5 Open reduction and internal fixation by K-wires for both bones.

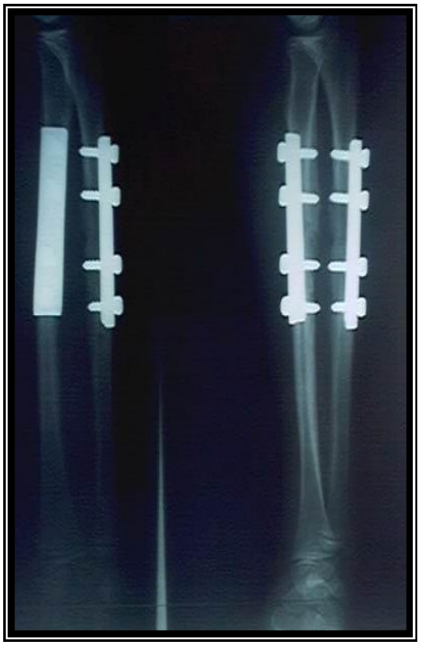

Figure 6 Open reduction and internal fixation by plates& screws for both bones.

Table 10 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

Table 11 Complications: The main complications are:

	Conservative	Operative	Total
1. no complication	71(68.93%)	18(17.47%)	89(86.40%)
2. oedema	5(4.48%)	4(3.88%)	9(8.73%)
3. superficial &pin tract infection	0	2(1.94%)	2(1.94%)
4. compartment syndrome	0	0	0
5.malunion(rotation)	2(1.94%)	0	2(1.94%)
6. joint stiffness	0	1(0.97%)	1(0.97%)
Total	78(75.72%)	25(24.27%)	103

Table 12 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

In our study the children were from the age above 2 years and below 13 years, the mean age for children treated conservatively was 8.03 years and for those who needed open reduction and internal fixation was 9.92 years. This was comparable to other studies as Bhasker AR, Roberts JA; the mean age was ranged between 9-11 years [3] .

The ratio of males to females was 8:1, and we found that in all other studies; as Qidwai SA fracture radius and ulna is more common in male than females [11].

Of those children 80% were from urban area and 20% from rural area.

Most of those children (92.23%) developed such fractures after fall on out- stretched hand and this is agreement with other studies[12].

39 children (37.86) had fractures in the right forearm, and 64 children (62.13) % had fractures in the left forearm; the ratio of the fracture right: left side was 1:1.7 and this is similar to other studies that the fractures occur more in the left side. [13] It may be due to intentional protection of mainly right dominant arm after falls.

88.3% of those children were of right handed and 11.6% of them were of left handed, we depend on the parents to determine the dominant hand (of eating) in those children under 7 years old.

We found that 2/3 of those children with right-handed had fractures in the left forearm bones. Unfortunately we couldn't trace other related studies to compare with.

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 radius and ulna. And its approximately correspond with other studies which entail that most of these fractures occur in the middle and distal third of forearm bones[14]

The Indications for open reduction and internal fixation of such fractures were: Unstable 17(16.5%) cases, redisplacement 7(6.79%) cases, neglected and malunited fractures 1(0.97%) case. In other studies we found another additional indications for open reduction of such a fractures in addition to those mentioned above, like pathological, multiple, compound, segmental fractures, refractures, neurovascular injuries and compartment syndrome; those indications are not included in our study[2, 11, 15, 16, 18]

71(91%) of those children that treated conservatively had no complications; other 5(4.48%) cases developed oedema and 2(1.94) cases got malunion (rotation) which need open reduction and internal fixation. While for operative treatment the complications were more: 18(72%) cases of them passed with-out complications, others; 4 (28%), cases developed oedema, superficial and pin tract infection 2 (1.94%) cases which subside by antibiotics, mild joint stiffness 1(0.97%) case which resolved within one month from cast removal.

There were no reports of severe complication to compare with our study [17].

The Duration of hospitalization was longer for those treated by operative method being (2-3) days, compared to (1-2) days in case of patients treated conservatively ,statistically significant according to T-Test, the (P) value was less than 0.005.

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.

Statistically Fisher exact Test was applied after combining the last two strata, the P value was 0.296 (more than 0.05) which was of no significance. So we found that there were no statistical significant differences in the functional outcome results between these two methods of treatment, and this is in agreement to the outcome results of other literatures[7].

Conclusions

1) The majority of these fractures in this age are caused by fall on the out stretched hand.

2) 2/3 of right handed Children sustain fracture in left forearm bones. The majority of forearm bones fractures occur in middle and lower third.

3) There are some circumstances under which open reduction and internal fixation are indicated and can be safely performed in children when closed treatment methods have failed.

4) Both conservative treatment by manipulation and casting or ORIF by intramedullary K-wires fixation and plate and screws fixation are useful techniques for dealing with such fractures in children.

5) Intramedullary K-wires are superior to plate and screws fixation: The procedure is easier, skin incisions are smaller, less soft tissue dissection and the stripping of the periosteum is avoided. Intramedullary fixation provides three-point fixation; and function as an internal splint to maintain bony alignment. These allow shorter operative time and decrease the risk of prolonged anaesthesia. Second operation for removal as in plating is not needed as wires can be removed in the outpatient clinic.

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