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Management of Fracture Shaft Femur in Children According to Recent Standard Criteria in Al-Hussein Teaching Hospital at Period from April 2018 to August 2019

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Abstract

This study aims to prove that the treatment of fracture shaft of the femur in children is according to their age and values of varus-valgus angle, Anterior-posterior angle, and shortening which compared with the standard acceptable angulations values, also to prove that these standard acceptable angulations are suitable in the treatment of these fractures. A prospective study of sixty children with the fractured shaft of femur their age range from four months to ten years was admitted to Al-Hussein Teaching Hospital in Samawa city at the period from April 2018 to August 2019 and assessed their sex, side and mechanism of fracture. Males more than females, left side is more than the right one, spiral fractures are the most common pattern, and these fractures located mostly in the middle part of the femur, most of them are caused by fall from a height, while the other hit by car and motorcycle. We have different models of treatments according to their age, the patients below five years treated conservatively such as traction, Pavlik harness, and hip spica, while those patients above five years of age were treated surgically such as Ender elastic nail, plate and screw, and external fixation. The elastic nail is a preferred method because it provides good stability for the fracture. We evaluate the complications like knee stiffness, infection, and malunion and length leg discrepancy. The values of varus-valgus angulations, anterior-posterior angulations, and shortening after treatment according to (AutoCAD 2007) program are correlated to the standard acceptable angulations and we prove that these standard values are reasonable, suitable and useful in the treatment of these fractures.

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Introduction

Pediatric femoral shaft fractures are uncommon; they account for 1.6-2% of all pediatric fractures. They are the most common pediatric orthopedic fractures that necessities admission to the hospital. Fracture of the femoral diaphysis between the area 5 cm distal to the lesser trochanter and 5 cm proximal to the adductor tubercle.

Anatomy

In contrast to adults, the immature skeleton is characterized by the presence of open physes, thicker periosteum, and a different biomechanical behavior in response to loading. As proximal and distal growth plates are both placed at risk during the insertion of intramedullary fixation, they must be protected to prevent varying degrees of growth disturbance. The paediatric femur, in contrast to the adult femur, has a high capacity for remodeling and as such will tolerate up to 25 degrees of angulations; up to 25 % of malrotation and. A shortening of up to 1 cm in those under the age of 10 is accepted due to overgrowth which is caused by the vessel-rich periosteum being stimulated in response to local injury [1-6].

Mechanism of Injury

- Child abuse.
- High energy injury like motor vehicle accidents.
- Gunshot wound.
- Pathological fracture (uncommon) such as Osteogensis imperfect.
- Benign lesion such as non-ossifying fibroma, aneurismal bone cyst.
- Stress fracture.

Clinical Features

- Extreme pain.
- Unable to walk.
- Obvious fracture.
- Swelling and deformity.
- Instability.
- Crepitance.
- Tenderness to palpation.
- Compartment syndrome (distal paresthesia, diminished

pulse, distal weakness, pain with passive range of motion).

Classification

- Open or closed.
- Location of fracture (Sub trochanteric, Diaphyseal (proximal, mid, distal third), Supracondylar).
- Fracture pattern (Transverse, Spiral, Oblique, Comminuted, Greenstick).
- Amount of shortening.
- Angular deformity.

Diagnosis

- Plain X-ray (anterio-posterior, lateral).
- CT scan.
- Magnetic Resonance Imaging for diagnosis of small buckle fragments.

Complications

- Leg length discrepancy. Angular deformity.
- Rotational deformity.
- Delayed union.
- Nonunion.
- Muscle weakness.
- Infection.
- Neurovascular injury.
- Compartment syndrome.

Treatment

Conservative for patients below five years includes: Pavlik Harness; Traction; Hip Spica.

Surgery for patients above five years includes: Elastic nails; Plate and screws; External fixation.

Types of models of treatment.

Principles of fracture treatment and factors influencing treatment

The aim of fracture treatment in children is the restoration of function and a normal level of activity as quickly as possible with the minimum physical and psychological distress [7-11]. Six key principles for the treatment of paediatric diaphyseal fractures:

- The simplest treatment is the best treatment.
- The initial treatment should be definitive whenever possible.
- Anatomic reduction was not required for perfect function.
- Alignment must be restored, especially rotational alignment.
- The more growth that remained, the more remodeling was available.
- The limb should be immobilized in a splint until definitive treatment had been instituted.

Patients and Method

A prospective study of sixty child with the fracture shaft of femur were admitted to Al-Hussein Teaching Hospital in Samawa city at a period from April 2018 to August 2019 and evaluated for age, sex, side of fracture and mechanism of injury. All patients were sent for x-ray to evaluate:

- Varus-valgus angle at Anterio-posterior view.
- Anterior-posterior tilt angle at lateral view according to (AutoCAD 2007 program).
- Shortening.
- Pattern of the fracture whether it is transverse, oblique, spiral, or comminuted.
- Location of fracture whether at proximal, middle or distal part of femur. We use Fisher's exact test and Chi-square test when is applicable.

Measurements of different angles and shortening.

We treated the patients with conservative or surgical methods according to their age as shown in table 1.

In this study we evaluate the outcome of the treatment by following up of the patients every two months for six months to assess the union with the x-ray and CT scan and measuring varus-valgus angle, anterior-posterior tilt angle and shortening before and after the treatment and compare the results with the standard acceptable angulations values as shown in table 2.So the outcome of treatments whether excellent, satisfactory or poor as in the figure.

In this study we evaluated the complications of treatments through the follow up of the patients such as non-union, malunion, knee stiffness, leg length discrepancy and infection in case of surgical treatment of the fractures.

Results

A prospective study of sixty child with fracture shaft femur were admitted to Al-Hussein Teaching Hospital in Samawa city at the period from April 2018 to August 2019, we calculate the varus-valgus angulations, anterior-posterior displacement and shortening. Table 3 shows the values before the treatment, while in table 4 shows the values after treatment.

Discussion

Fractures shaft of femur are uncommon it account about 1.6-2% of all pediatric fractures. They are the commonest injury which necessity admission to the hospital. In this study we admit sixty child with the

Table 1: Treatment options for isolated femoral shaft fractures in children.

Age	Treatments
Birth to 24 months	Pavlik harness (newborn to 6 months) early spica cast traction → spica cast (very rare)
24 months- 5 years	Early spica cast traction → Spica cast external fixation (rare) flexible intramedullary nails (rare)
6-10 years	Flexible intramedullary nails traction → Spica cast Sub-Muscular plate external fixation

Table 2: Acceptable Angulations.

Age	Varus-Valgus (degrees)	Anterior-posterior (degrees)	Shortening (mm)
Birth to 2 years	30	30	15
2-5 years	15	20	20
6-10 years	10	15	15

Table 3: Before treatment.

Patient's No.	Age (year)	Sex	Varus-Valgus (degrees)	Anterior-Posterior (degrees)	Shortening (mm)	Treatment
1	4 months	Female	45	30	10	Pavlik harness +Hip Spica cast
2	1.5	Female	23	40	12	Skin traction +Hip Spica cast
3	2	Male	4	8	16	Skin traction +Hip Spica cast
4	7 months	Male	35	25	10	Pavlik harness
5	1	Male	20	28	15	Hip Spica cast
6	5 months	Female	40	25	10	Pavlik harness
7	10 months	Male	30	36	10	Pavlik harness
8	2	Male	15	21	15	Skin traction +Hip Spica cast
9	1.5	Female	33	50	10	Hip Spica cast
10	3	Female	39	72	20	Hip Spica cast
11	5	Male	50	40	20	Surgery (plate & screw)
12	4	Male	29	24	20	Surgery (Ender Nail)
13	2	Female	30	40	15	Skin traction +Hip Spica cast
14	4	Female	25	15	10	Skin traction +Hip Spica cast
15	3	Male	23	13	10	Skin traction +Hip Spica cast
16	5	Male	53	38	20	External Fixation
17	2.5	Female	31	16	10	Skin traction +Hip Spica cast
18	4	Male	4	15	8	Skin traction +Hip Spica cast
19	6	Male	21	52	20	Surgery (plate & screw)
20	3.5	Male	24	45	15	Skin traction +Hip Spica cast
21	5	Male	10	29	20	Plate & Screw
22	9	Male	20	35	20	Plate & Screw
23	6	Male	18	24	25	Plate & Screw
24	7.5	Female	35	28	20	Plate & Screw
25	8	Male	15	20	25	Plate & Screw
26	7	Male	22	18	25	Plate & Screw
27	6.5	Male	28	15	22	Plate & Screw
28	10	Female	15	30	25	Plate & Screw
29	7.5	Male	21	35	23	Plate & Screw
30	9.5	Male	25	40	24	External Fixation
31	8	Male	25	45	25	Plate & Screw
32	6	Female	15	30	25	Plate & Screw
33	6.5	Male	30	28	24	Plate & Screw
34	8.5	Female	26	33	23	Plate & Screw
35	9	Male	27	34	24	Plate & Screw
36	10	Male	33	20	25	Plate & Screw
37	9.5	Female	15	35	25	Plate & Screw
38	6	Male	36	24	23	Plate & Screw
39	8.5	Male	34	30	24	Plate & Screw
40	7.5	Male	25	20	23	Plate & Screw
41	7.5	Male	22	25	23	Ender Nail
42	8	Female	18	30	25	Plate & Screw
43	7	Male	15	28	25	Plate & Screw
44	6.5	Male	30	48	25	Ender Nail
45	10	Female	23	38	25	Plate & Screw
46	8.5	Male	26	30	26	External Fixation
47	7.5	Female	25	37	20	Plate & Screw
48	10	Male	38	35	25	Plate & Screw
49	8.5	Male	26	25	25	Ender Nail
50	9.5	Male	24	30	26	Plate & Screw
51	8	Male	25	40	25	Plate & Screw
52	6	Female	27	34	26	External Fixation
53	7.5	Male	38	45	25	Plate & Screw
54	9.5	Male	26	38	25	External Fixation
55	7	Male	36	40	25	External Fixation
56	8	Female	34	20	26	Plate & Screw
57	10	Male	22	18	20	Plate & Screw
58	6	Male	15	20	20	Ender Nail
59	9.5	Male	28	33	20	Plate & Screw
60	7.5	Male	24	42	25	Plate & Screw

Table 4: After treatment.

Patient's No.	Age (year)	Sex	Varus-Valgus (degrees)	Anterior-Posterior (degrees)	Shortening (mm)	Outcome of Treatment
1	4 months	Female	8	12	1	Excellent
2	1.5	Female	10	15	0	Excellent
3	2	Male	1	3	2	Excellent
4	7 months	Male	8	15	0	Excellent
5	1	Male	10	15	2	Excellent
6	5 months	Female	25	18	0	Excellent
7	10 months	Male	15	18	1	Excellent
8	2	Male	10	14	5	Excellent
9	1.5	Female	20	25	5	Excellent
10	3	Female	13	18	5	Excellent
11	5	Male	2	5	2	Satisfactory
12	4	Male	15	18	5	Satisfactory
13	2	Female	2	1	0	Satisfactory
14	4	Female	10	8	0	Satisfactory
15	3	Male	15	6	2	Satisfactory
16	5	Male	15	20	10	Satisfactory
17	2.5	Female	14	10	0	Excellent
18	4	Male	1	3	2	Excellent
19	6	Male	8	12	0	Excellent
20	3.5	Male	15	20	2	Excellent
21	5	Male	10	15	0	Satisfactory
22	9	Male	8	13	2	Satisfactory
23	6	Male	10	14	6	Satisfactory
24	7.5	Female	7	12	4	Satisfactory
25	8	Male	10	15	5	Satisfactory
26	7	Male	8	5	3	Poor
27	6.5	Male	5	13	10	Poor
28	10	Female	10	15	6	Poor
29	7.5	Male	8	10	8	Satisfactory
30	9.5	Male	9	15	8	Excellent
31	8	Male	7	13	6	Excellent
32	6	Female	10	15	0	Excellent
33	6.5	Male	8	12	10	Excellent
34	8.5	Female	10	15	5	Excellent
35	9	Male	9	12	10	Satisfactory
36	10	Male	5	10	5	Satisfactory
37	9.5	Female	5	7	15	Poor
38	6	Male	10	10	5	Poor
39	8.5	Male	5	10	0	Excellent
40	7.5	Male	8	12	15	Excellent
41	7.5	Male	9	14	15	Excellent
42	8	Female	7	13	15	Excellent
43	7	Male	5	12	10	Excellent
44	6.5	Male	10	15	5	Excellent
45	10	Female	5	9	10	Excellent
46	8.5	Male	6	10	8	Satisfactory
47	7.5	Female	10	15	5	Satisfactory
48	10	Male	8	14	6	Satisfactory
49	8.5	Male	9	15	10	Satisfactory
50	9.5	Male	5	10	5	Poor
51	8	Male	5	9	10	Excellent
52	6	Female	10	14	6	Excellent
53	7.5	Male	10	15	5	Poor
54	9.5	Male	5	10	7	Poor
55	7	Male	10	14	5	Excellent
56	8	Female	4	8	6	Excellent
57	10	Male	9	12	15	Excellent
58	6	Male	3	7	5	Excellent
59	9.5	Male	10	13	8	Satisfactory
60	7.5	Male	5	10	10	Satisfactory

fracture shaft of femur to the hospitals. The age of the patients range between four months and ten years, the age group (6-8) years is the most common as shown in figure 1 [12-18]. Males more than females and form about 70% of cases as shown in figure 2. Spiral fracture are the most common pattern as shown in figure 3. The left side fracture are the commonest as shown in figure 4. Most of the fractures located at the middle part of the femur as shown in figure 5. Most of the fractures are caused by fall from height as shown in figure 6.

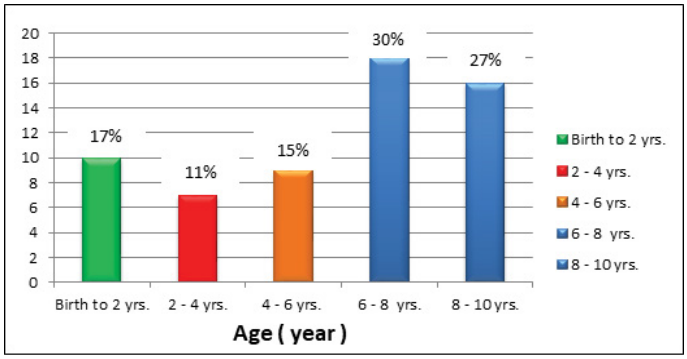

Figure 1: The percentage of the age group.

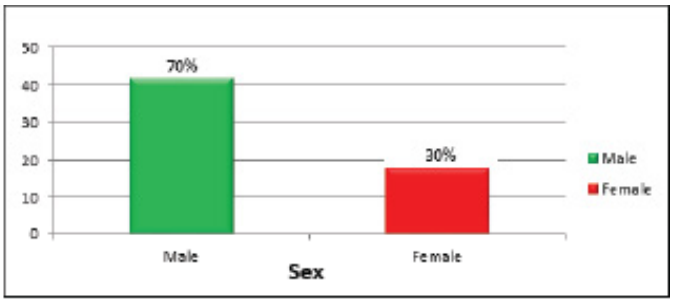

Figure 2: The percentage of the sex.

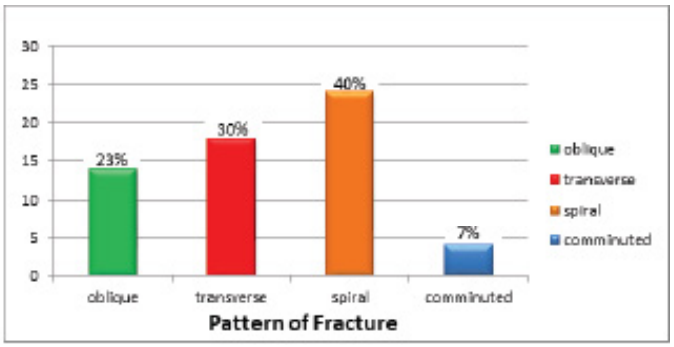

Figure 3: The percentage of the pattern of fracture.

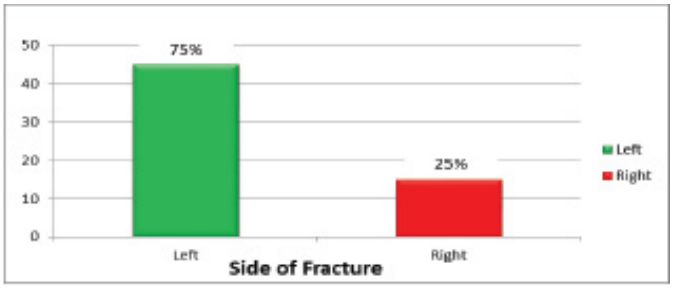

Figure 4: The percentage of the side of fracture.

In this study there are many options of models of treatment for fracture shaft of femur in children according to their age as shown in figure 7, the patient's age below five years treated conservatively with traction, pavlik harness or hip spica due to their excellent union and remodeling as shown in table 1, while those patients with the age above

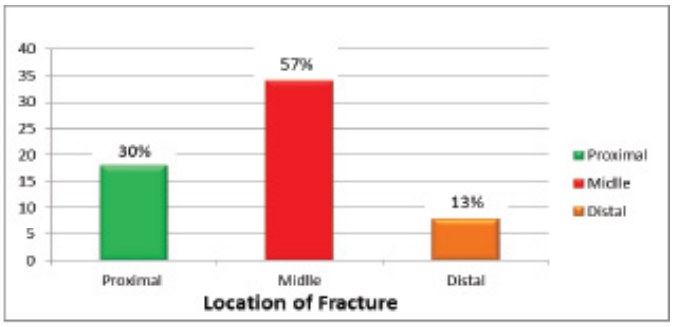

Figure 5: The percentage of the location of fracture.

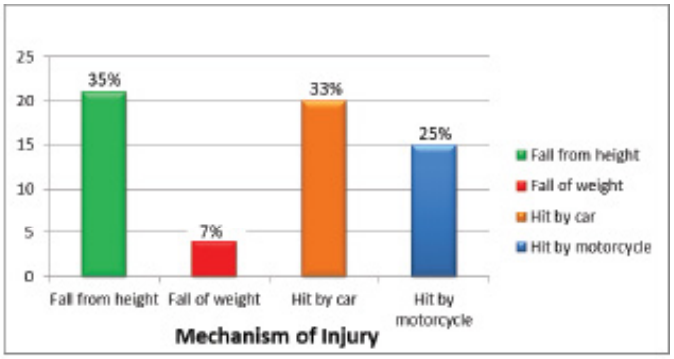

Figure 6: The percentage of the mechanism of injury.

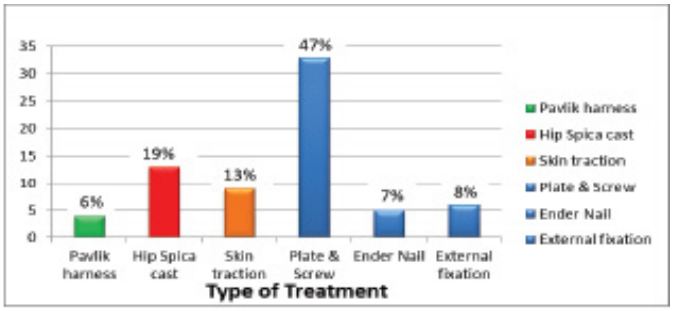

Figure 7: The percentage of the type of treatment.

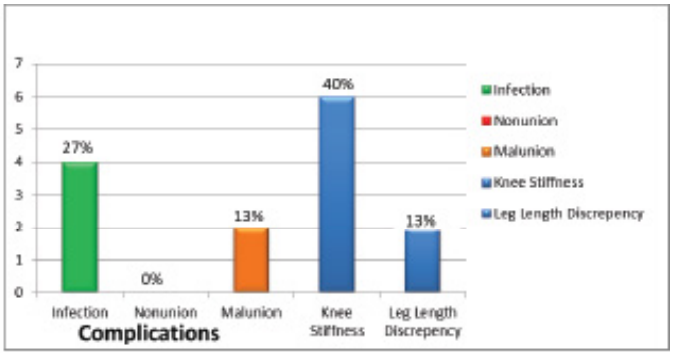

Figure 8: The percentage of the complications.

five years need to surgical fixation such as elastic nails, plate and screws and external fixation to prevent shortening and malunion [19-21].

Spica cast in school age children is associated with complications like cast breakage, loose of reduction, malunion, skin complications, and prolong mobilization, quadriceps weakness and psychological effect, so the treatment shifted toward operative stabilization of the fracture.

Elastic Ender nail is the preferred operative method rather than plate and screw and external fixation especially at middiaphyseal fracture and transverse fracture because of:

- Decrease hospitalization, low cost of implants, less damaged to growth centers, decrease blood loose and operative time.
- The femur is subjected to significant bending, axial, torsional stress that exceeds three to four times body weight during normal activities, elastic nails produce flexual stability, axial stabilityand rotational stability, so this prevents shortening and malunion, but this procedure requires a C-arm facility which not present at all centers.

All the patients had union at the fracture side with the evidence of bridging callus through follow up with the X-ray and CT scan every two months and for six months.

There was highly significant association between the age of the patient and the type of treatment as shown in table 5, that's mean for patient below five years treated conservatively and the patient above five years treated surgically (according to Fisher's Exact test).

There was no significant association between the type of treatment and the outcome as shown in table 6, because this depend on the age of the patients and the other criteria such as varus-valgus, anterio-posterior displacement and shortening.

There was no significant association between the age group and the outcome of the treatment as shown in table 7. In this table the poor outcome of treatment in patient with the age below five years is zero, while those with the above five years is eight, this explain that small children had rapid union and remodeling more than younger children but there is no significant association because the outcome not only depend on the age but there are other criteria play important roles in the outcome result such as varus-valgus angulations, anterior-posterior displacement and shortening.

There was no significant association between the pattern of the fracture and the outcome as shown in table 8, so the pattern play no role in the union and remodeling of the fracture but the outcome depend on the age and other factors.

The most common complications that evaluated in our study is stiffness of the knee as shown in figure 8, so it is better to start physiotherapy as early as possible (Figure 9). Many cases which were treated surgically presented with the infections so it should be applied them in asterile antiseptic technique regarding the theatre, equipments and medical staff.

The values of varus-valgus angle, anterior-posterior tilt and shortening were assessed before and after treatment as shown in

Table 5: The association between the age group and the treatment type.

		Treatment type							
		Pavlik harness+Hip Spica cast	**Skin traction+Hip Spica cast**	**Pavlik harness**	**Hip Spica cast**	**Surgery (plate & screw)**	**Surgery (Ender Nail)**	**External Fixation**	**Total**
Age groups	< 5	1	9	3	3	2	1	1	20
	> 5	0	0	0	0	31	4	5	40
Total		1	9	3	3	33	5	6	60
Fisher's Exact test = 43.403 ; P = 0.001									
Highly significant association									

Table 6: The association between the treatment type and the outcome.

Treatment Type		**Outcome**			
		Excellent	**Satisfactory**	**Poor**	**Total**
	Pavlik harness + Hip Spica cast	1	0	0	1
	Skin traction + Hip Spica cast	6	3	0	9
	Pavlik harness	3	0	0	3
	Hip Spica cast	3	0	0	3
	Surgery (plate & screw)	13	13	7	33
	Surgery (Ender Nail)	3	2	0	5
	External Fixation	3	2	1	6
Total		32	20	8	60
Fisher's Exact test = 9.757; P = 0.64					
Not significant association					

Table 7: The association between the Age group and the outcome.

		Outcome			
		Excellent	**Satisfactory**	**Poor**	**Total**
Age group	< 5	13	7	0	20
	> 5	19	13	8	40
Total		32	20	8	60
chi-square = 4.791; P = 0.086					
Not significant association					

Table 8: The association between the Pattern of fracture and the outcome.

		Outcome			
		Excellent	**Satisfactory**	**Poor**	**Total**
Pattern of fracture	Oblique	11	3	0	14
	Spiral	11	9	4	24
	Comminuted	1	2	1	4
	Transverse	9	6	3	18
Total		32	20	8	60
Fisher's Exact test = 6.646; P = 0.33					
Not significant association					

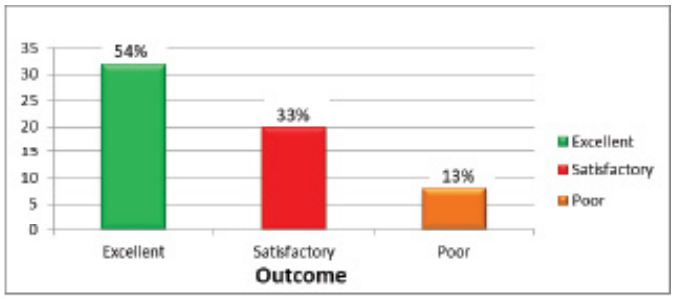

Figure 9: The percentage of the outcome.

tables 3 and table 4, which proved in our study were correlated with standard acceptable angulations criteria as shown in table 2, so this proved that the standard acceptable angulations criteria are reasonable and useful in treatment of the fracture shaft of femur in children. Also we proved that the age of the patient is an important factor in treatment of these fractures.

Conclusions

The age is an important factor in treatment of fracture shaft of femur in children we proved that the values of the varus-valgus angle, anterior-posterior displacement angle and shortening after treatment are correlated with the standard acceptable angulations which means that these standard angulations criteria are reasonable, suitable and useful in treatment of these fractures.

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