AIM OF THE WORK

The aim of the work was to evaluate the results of treatment of displaced diaphyseal fractures of the tibia in children aged between 6 and 12 years by closed reduction and percutaneous flexible intramedullary nailing.

PATIENTS

The study included 20 patients presented to El-Hadara University Hospital, Faculty of Medicine, Alexandria University, suffering from displaced diaphyseal fractures of the tibia in children aged between 6 and 12 years.

1. Age of patients

The mean age was 9.63 ± 1.88 years and the range was six – twelve years old.

Age (years)	No.	%
<10	8	40.0
≥10	12	60.0
Min. _ Max.	6.0 – 12.0	
Mean ± SD.	9.63 ± 1.88	
Median	10.0	

Table (I): Distribution of the studied patients according to age (n =20)

2. Sex of patients

Thirteen patients were boys (65%) and seven patients were girls (35%).

Sex	No.	%
Male	13	65.0
Female	7	35.0

Table (II): Distribution of the studied patients according to sex (n =20)

3. Side affected

The right side was affected in ten patients (50%) and the left in ten patients (50%).

Side	No.	%
Right	10	50.0
Left	10	50.0

Table (III): Distribution of the studied patients according to side (n =20)

4. Mechanism of trauma

The mechanism of trauma was road traffic accidents (RTA) in nine patients (45%). And sport injuries in eleven patients (55%).

Method of trauma	No.	%
RTA	9	45.0
Sport injuries	11	55.0

Table (IV): Distribution of the studied patients according to method of trauma (n =20)

5. Type of fracture

Eighteen patients (90%) had closed fractures, while two patients (10%) had an open Grade II fractures.

Type of fracture	No.	%
Closed	18	90.0
Open	2	10.0

Table (V): Distribution of the studied patients according to type of fracture (n =20)

6. Level of fracture

Eleven patients (55%) had fractures of the middle third of the tibial shaft, four patients (20%) had fractures of the upper third of the tibial shaft and five patients (25%) had fractures of the lower third of the tibial shaft.

Level of fracture	No.	%
Middle	11	55.0
Upper	4	20.0
Lower	5	25.0

Table (VI): Distribution of the studied patients according to Level of fracture (n =20)

7. Shape of fracture

Eight patients (40%) had comminuted fractures, seven patients (35%) had Oblique fractures, and five patients (25%) had Transverse fractures.

Shape of fracture	No.	%
Transverse	5	25.0
Comminuted	8	40.0
Oblique	7	35.0

Table (VII): Distribution of the studied patients according to shape of fracture (n =20)

8. Presence of associated injuries

Thirteen patients (65%) had no associated injuries other than the tibial shaft fracture. Six patients (30%) had other bone fractures, and one patient (5%) had head injury.

Associated injuries	No.	%
No	13	65.0
Head injuries	1	5.0
other bone fractures	6	30.0

Table (VIII): Distribution of the studied patients according to Associated injuries (n =20)

9. Time lapse before surgery

The minimum time lapse before surgery was half a day and the maximum was eight days (mean = 2.93 ± 2.55 days).

Time lapse before surgery (day)	Min. _ Max.	Mean ± SD	Median
	0.50 – 8.0	2.93 ± 2.55	2.0

Table (IX): Statistical analysis of the studied patients according to Time lapse before surgery (n =20)

METHODS

Clinical assessment

On admission patients were clinically assessed as follows:

Personal data

- Name
- Age
- Sex
- Address

Complaints

- Pain.
- Swelling of the leg.
- Inability to use the injured limb.
- Affection of other regions

History of the present symptoms

- Time of injury
- Mechanism of injury
- Time lapse before surgery

Clinical examination

- Side affected
- Swelling or deformity
- Palpation for tenderness
- Skin condition
- Examination of the whole body for other associated injuries
- Vascular and neurological examination of the affected limb

Radiological evaluation

- Antero-posterior and lateral view radiographs of the affected leg (including the knee and ankle joints) were taken to assess the level and shape of fracture.

First aid treatment

- The fractured leg was splinted by above knee plaster slab.
- Analgesic and anti-oedematous measures were prescribed.
- Patients were put under observation in the hospital till time of surgery with management of any associated injuries and medical conditions.
- Antibiotics were prescribed preoperatively at the time of induction and for 48 hours postoperatively

Surgical technique

- All patients were treated by elastic intramedullary nailing inserted under image intensifier control, using two pre-bent titanium nails inserted in antegrade fashion.
- Basic requirements of this technique included (Fig. 16):
  - Titanium nails (400 mm in length, of different diameters; 2.0mm, 2.5mm, 3.0mm, 3.5mm, 4.0mm, 4.5mm)
  - Bone Awl
  - Cannulated T-Handle inserter
  - Nail cutter
  - Mallet

Fig. [16]: Implants and instruments.

- Steps of surgery:

  - The operation was carried out under general anaesthesia using a tourniquet and complete aseptic conditions. The patient was positioned in a supine position on a radiolucent table.

  - An image intensifier was positioned so that it can be rotated to obtain antero-posterior and lateral views of the whole tibia from the knee to the ankle joint.

  - The entire leg including the knee and the ankle joints was prepared as an operative field. External manipulation was conducted until adequate reduction was obtained and confirmed by fluoroscopy. (Fig. 17)

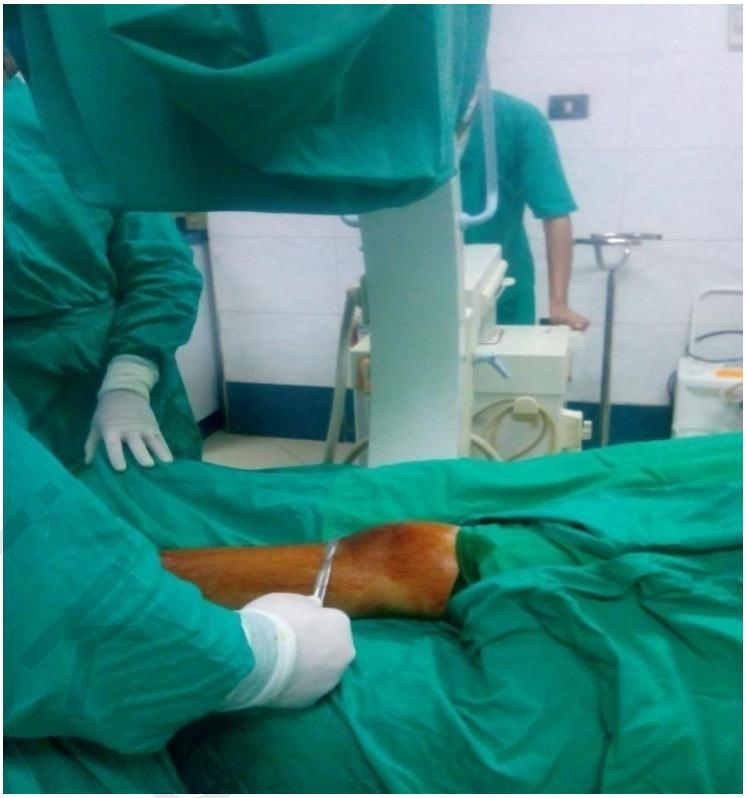


Fig. [17]: Patient positioning.

- The diameter of the individual nail was chosen by calculation *(nail diameter = minimum canal diameter x 0.4)*. To avoid varus or valgus angulation, both nails were always of identical diameter.

- Each nail was pre-bent at the same point by hand to an angle of 30°, ensuring that the tip lies in the same plane as the plane formed by bending, and that the apex of curvature lies at the level of the fracture site. In order to achieve optimum reduction, stabilisation and alignment of the fracture, the curvature had to be identical in both nails (Fig. 18).

Fig. [18]: Prebendig the nail

- A 2cm skin incision proximal to the required bone entry hole was made. Starting either on the anterolateral or anteromedial side. Regarding the entry point, the following precautions were taken into consideration:
  - The entry point should be 2 – 4 cm distal to the proximal tibial physis
  - The anterolateral and anteromedial entry points should be at the same level
  - The entry hole should be slightly larger than the diameter of the chosen nail
- The holes were performed by a bone awl. It was directed diagonally at an angle of 45° towards the far cortex to make the hole accommodating the direction of progressing nail. Also, the holes were performed in some cases by 3.2 drill bits by applying a careful angulation movement of the drill bit until the entry hole was at an angle of at least 45°. (Fig. 19)

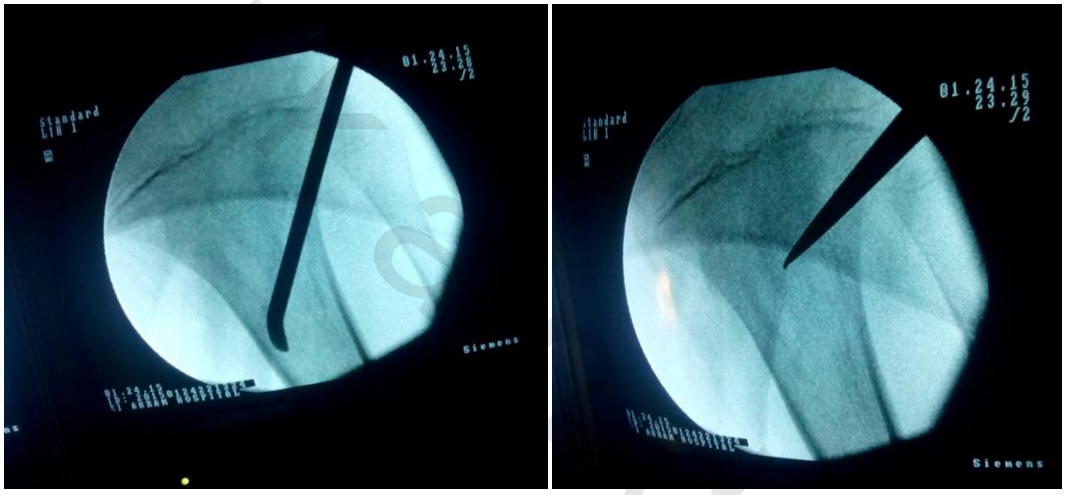


Fig. [19]: Entry hole and first nail

- The nail was held in a cannulated T- handle with the horizontal bar of the T-handle and the curved tip of the nail aligned in the same plane (this allowed identification of the curved tip as it passed along the medullary canal).
- The nail was passed through the entry hole with the curved tip pointing downwards. Once in the medullary canal it was rotated to point in the direction in which the nail is to be passed.
- The nail was driven down the canal by rotating the T-handle back and forth. With a mallet, the nail was gently tapped to cross the fracture site. The nail was advanced towards the metaphysis to anchor into the cancellous bone.(Fig. 20)

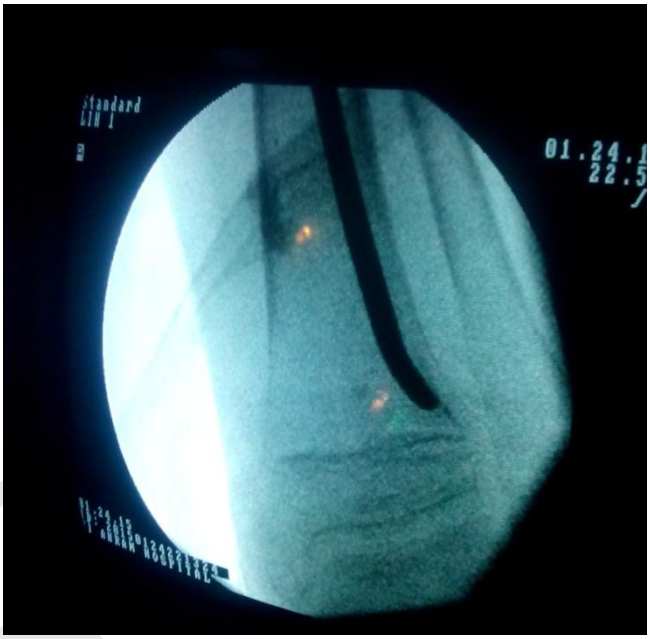


Fig. [20]: The first nail advanced distally

- The second nail was advanced using the same rotating movements and light taps. However, it was never rotated on its own axis through a full 360° to avoid winding itself around the first nail.
- Both nails were advanced and impacted at their final distal points just proximal to the distal tibial epiphyseal plate. (Fig. 21)

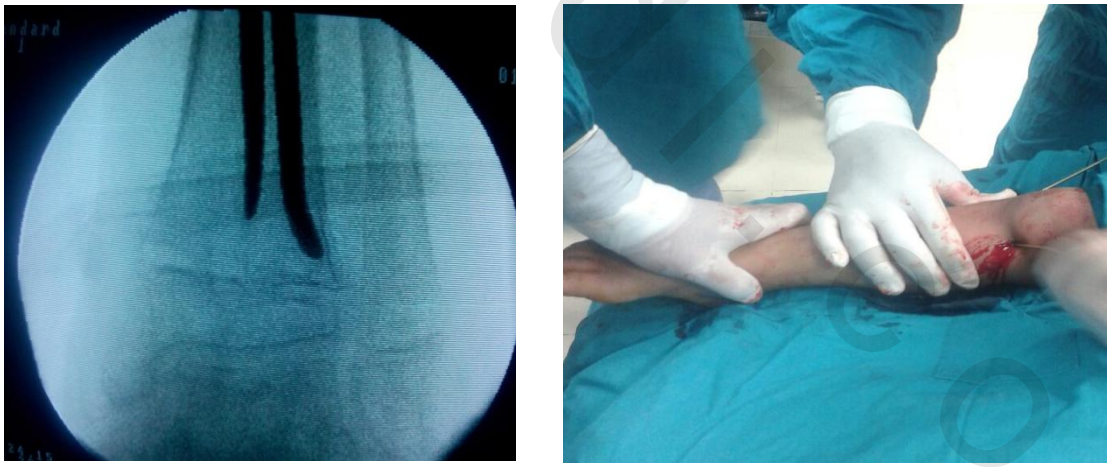


Fig. [21]: The second nail

- Reduction of the fracture and nail position were confirmed with the image intensifier. If the fracture was distracted, the patient's heel was impacted.
- The ends of both nails were cut, ensuring that about 1 cm of each nail remains outside the entry hole.
- Wound irrigation and closure was performed in layers.
- Sterile dressing and below knee plaster cast was applied.

Postoperative care

- Check X-rays were obtained to assess the reduction and the position of the nails.
- The patient was examined for vascular and neurological status.
- Analgesics and anti-oedematous medications were prescribed.
- Ambulation using support but without weight-bearing was allowed as soon as the fracture was pain-free.

Follow up

- The stitches were removed after two weeks.
- Check X-rays (anteroposterior and lateral views) were obtained after two, six, and twelve weeks then monthly till the end of follow up period.
- Walking cast and Partial weight-bearing with support was allowed when the fracture was pain-free and bridging callus was evident radiologically.
- According to fracture healing and as soon as the patient felt ready, full weight bearing was allowed (Fractures were determined to be healed with evidence of tricortical callus and no tenderness at the fracture site on clinical examination).
- The mean follow up period was twenty eight weeks (range from twenty-four to thirty six weeks).

Nail Retrieval

- The removal procedure was always performed under general anaesthesia, using a tourniquet, after radiographic confirmation of solid fracture healing (at around three - seven months).
- The medium-size "bone biter" was very helpful for initial nail grasp, allowing secure grip of the nail in the beginning of the retrieval. Once the nail was retracted a few millimetres, removal was usually completed by hand. If the nail was difficult to remove by hand, the cannulated T-handle and mallet were used to complete removal.(Fig. 22)

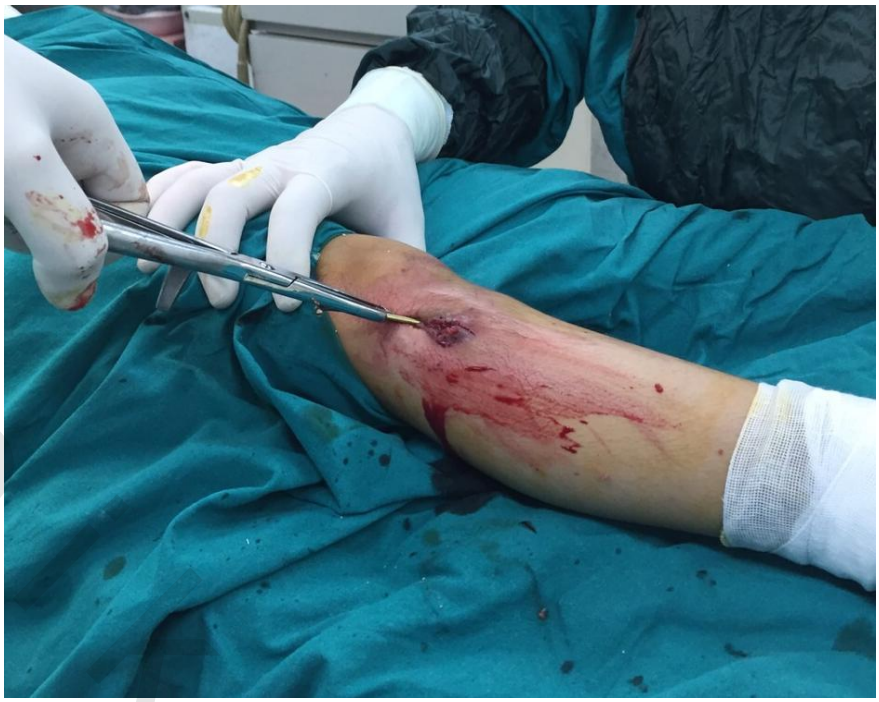


Fig. [22]: Nail retrieval

Assessment

- All patients were assessed after two weeks, six weeks, twelve weeks and twenty-four weeks according to the following modified scoring system, shown in (Table X)

	Excellent results	**Satisfactory results**	**Poor results**
Limb-length inequality	< 1.0 cm	1.0-2.0 cm	> 2.0 cm
Malalignment	5 degrees	5-10 degrees	> 10 degrees
Pain	none	none	present
Complications:	none	Minor and resolved	Major and lasting morbidity

Table (X): TENS outcome score (Flynn et al) [(55)]

- Radiological assessment:
  - Union
  - Infection
  - Axial deviation/ Malrotation
  - Loosening/ Breakage
  - Backing out nails

Statistical Analysis

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. Qualitative data were described using number and percent. Quantitative data were described using range (minimum and maximum), mean, standard deviation and median. Comparison between different groups regarding categorical variables was tested using Chi-square test. When more than 20% of the cells have expected count less than 5, correction for chi-square was conducted using Fisher's Exact test or Monte Carlo correction. The distributions of quantitative variables were tested for normality using Kolmogorov-Smirnov test, Shapiro-Wilk test and D'Agstino test, also Histogram and QQ plot were used for vision test. If it reveals normal data distribution, parametric tests was applied. If the data were abnormally distributed, non-parametric tests were used. for normally distributed data, comparison between the two studied groups were done using independent t-test while for abnormally distributed data, comparison were done using Mann Whitney test .Correlations between two quantitative variables were assessed using Spearman coefficient. Significance of the obtained results was judged at the 5% level.

RESULTS

According to the criteria of evaluation mentioned before [57], the results obtained were **excellent** in fifteen patients (**75%**) and **satisfactory** in five patients (**25%**). **(Fig. 23).**

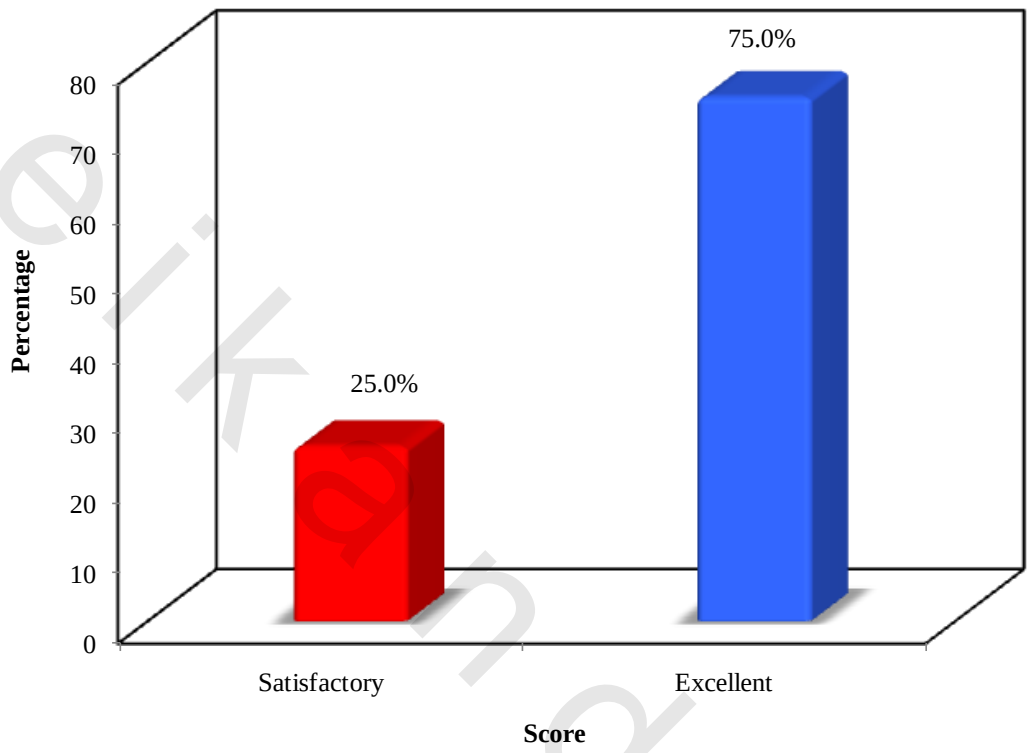


Fig. [23]: Distribution of the studied patients group according to score.

Union:

The mean time of clinical union, which implied absence of local tenderness with palpation, was 6.15 ± 0.99 weeks (range 4 to 8 weeks) while the mean time of radiological union, in which bony trabeculae crossed the fracture gap, was 8.90 ± 1.29 weeks (range 6 to 11 weeks) **(Tables XI -XII).**

Time of clinical union (week)	No.	%
<6	3	15.0
≥6	17	85.0
Min. _ Max.	4.0 – 8.0	
Mean ± SD.	6.15 ± 0.99	
Median	6.0	

Table (XI): Statistical analysis of the studied patients according to Time of clinical union (n =20)

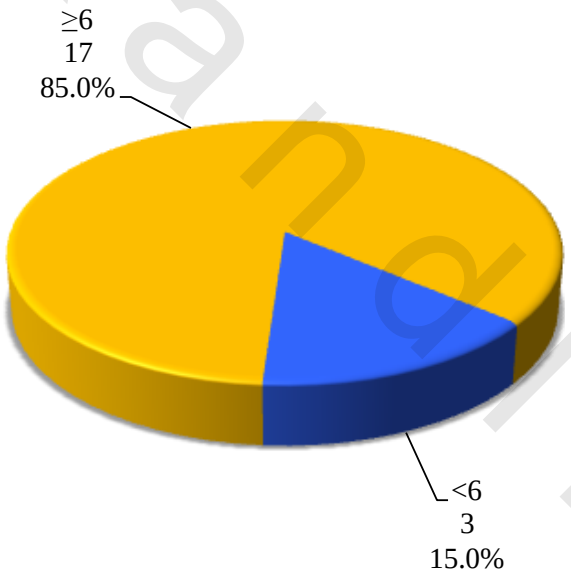


Fig. [24]: Statistical analysis of the studied patients according to Time of clinical union

Time of radiological union (week)	No.	%
<9	4	20.0
≥9	16	80.0
Min. _ Max.	6.0 – 11.0	
Mean ± SD.	8.90 ± 1.29	
Median	9.0	

Table (XII): Statistical analysis of the studied patients according to Time of radiological union (n =20)

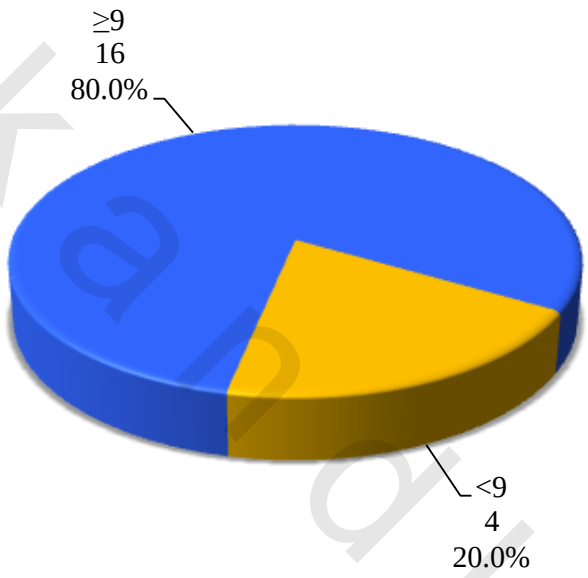


Fig. [25]: Statistical analysis of the studied patients according to Time of radiological union

- **Limb length inequality**

Seventeen patients (85%) had no limb length inequality, three patients (15%) had 1-2 cm limb length inequality. **(Table XIII)**

Limb length inequality	**No.**	**%**
No	17	85.0
Yes	**3**	**15.0**
Min. _ Max.	1.0 – 1.50	
Mean ± SD	1.33 ± 0.29	
Median	1.50	

Table (XIII): Distribution of the studied patients according to Limb length inequality (n =20)

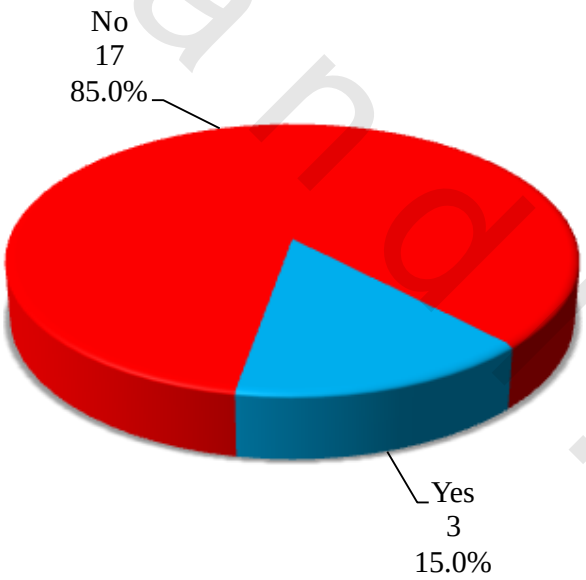


Fig. [26]: Distribution of the studied patients according to Limb length inequality

- **Angulation**

Eighteen patients (90%) had no angulation and two patients (10%) had about 10 degrees of angulation. **(Table XIV)**

Angulation	**No.**	**%**
No	18	90.0
Yes	**2**	**10.0**
Min _ Max	10.0	
Mean ± SD	11.0 ± 1.41	
Median	11.0	

Table (XIV): Distribution of the studied patients according to Angulation (n =20)

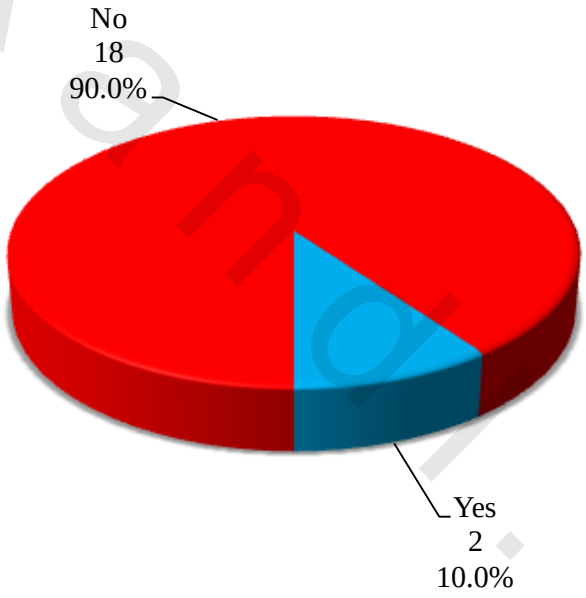


Fig. [27]: Distribution of the studied patients according to Angulation

- **Factors affecting the final score:**

1. Age:

The mean age of the patients that achieved an excellent outcome was 9.30 ± 1.99 years; whereas the mean age of those patients who got a satisfactory outcome was 10.60 ± 1.19 years. However, this difference of means was statistically insignificant. **(Table XV)**

Age (years)	Score				Test of sig.	p
	Satisfactory (n = 5)		Excellent (n = 15)			
	No.	%	No.	%		
<10	1	20.0	7	46.7	χ^2= 1.111	^{FE}p= 0.603
≥10	4	80.0	8	53.3		
Min. - Max.	9.0 – 12.0		6.0 – 12.0		t= 1.366	0.189
Mean ± SD.	10.60 ± 1.19		9.30 ± 1.99			
Median	10.50		10.0			
r_s(p)	-0.282 (0.228)					

χ^2: value for Chi square
FE: Fisher Exact test
t: Student t-test
r_s: Spearman coefficient

Table (XV): Relation between score and age

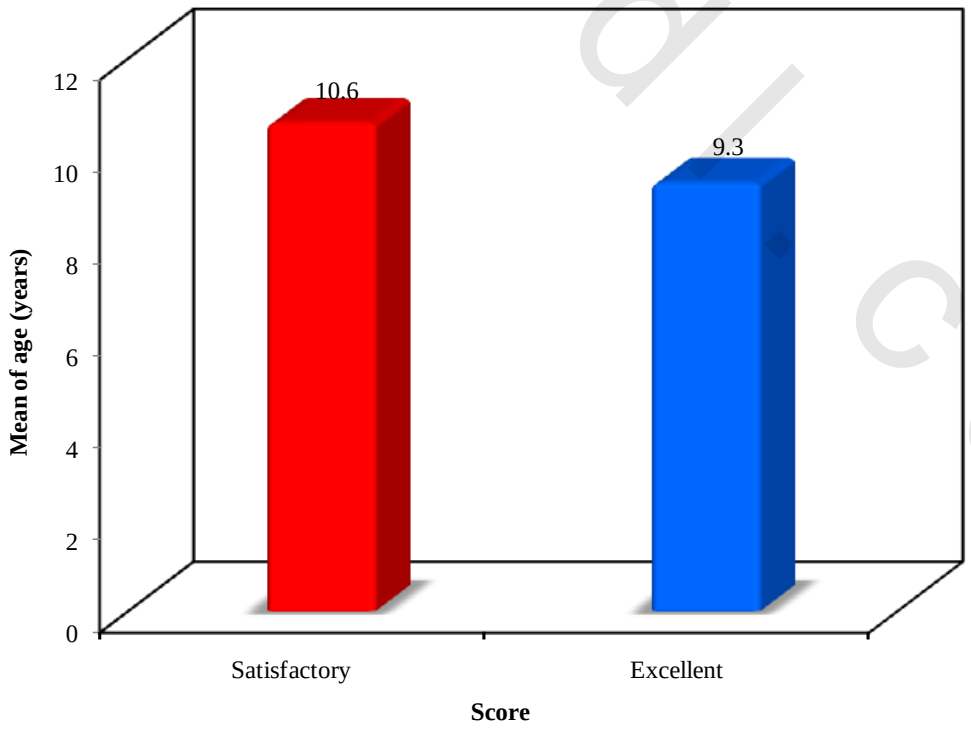


Fig. [28]: Relation between score and age

2. Sex:

Out of thirteen boys included, nine boys (69.23%) had excellent results, and four boys (30.77%) had satisfactory results. while out of seven girls included, six girls (85.71%) had excellent results and one girl (14.29%) had satisfactory results. There was no statistically significant relation between the sex of the patients and the final score. **(Table XVI)**.

Sex	Score				χ^2	^{FE}p
	Satisfactory (n = 5)		Excellent (n = 15)			
	No.	%	No.	%		
Boys	4	30.8	9	69.2	0.659	0.613
Girls	1	14.3	6	85.7		

χ^2: value for Chi square
FE: Fisher Exact test

Table (XVI): Relation between score and sex

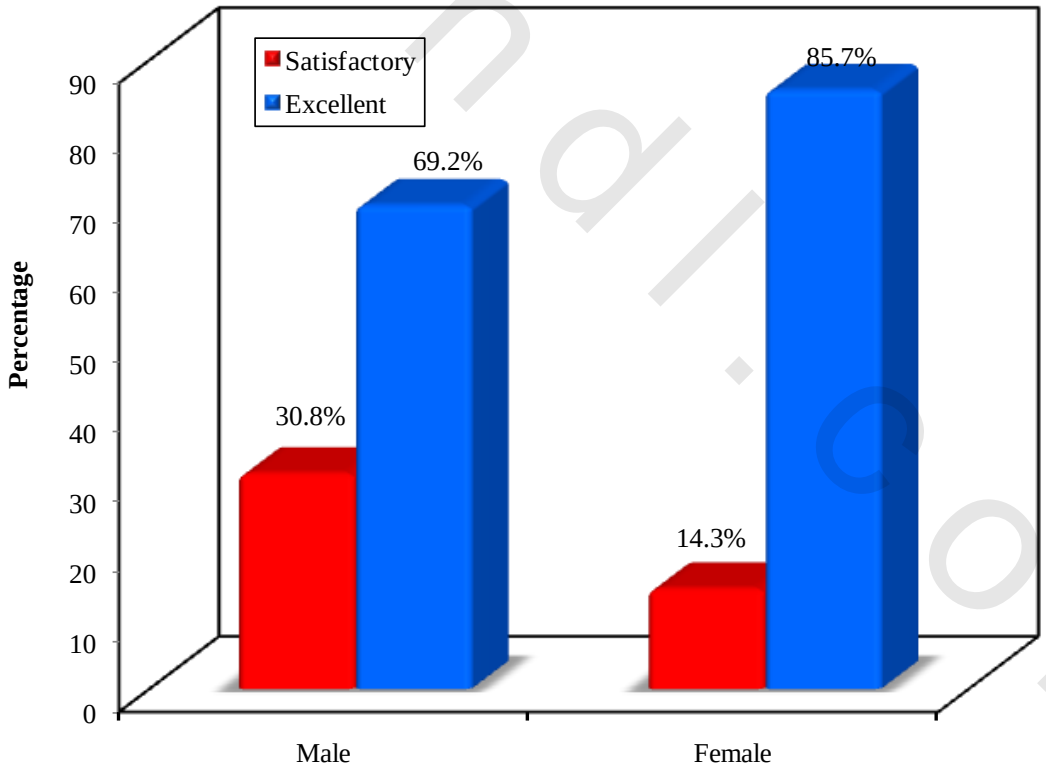


Fig. [29]: Relation between score and sex

3. Side affected:

There was no statistically significant relation between side affection and the final score. **(Table XVII)**

Side	Score				χ^2	^{FE}p
	Satisfactory (n = 5)		Excellent (n = 15)			
	No.	%	No.	%		
Right	2	20.0	8	80.0	0.267	1.000
Left	3	30.0	7	70.0		

χ^2: value for Chi square
FE: Fisher Exact test

Table (XVII): Relation between score and side

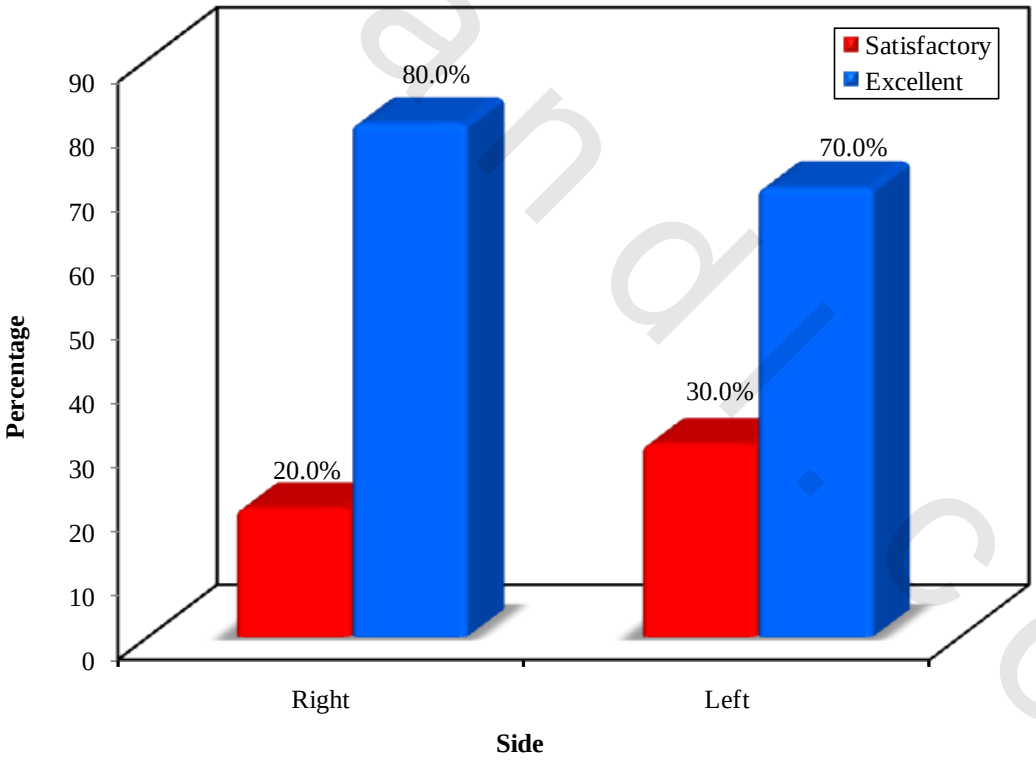


Fig. [30]: Relation between score and side

4. Time lapse before surgery:

There was no statistically significant relation between the time lapse before surgery and the final score. **(Table XVIII)**

Time lapse before surgery (day)	**Score**		**Z**	**p**
	Satisfactory (n = 5)	**Excellent (n = 15)**		
Min. - Max.	0.50 – 7.0	1.0 – 8.0		
Mean ± SD.	3.10 ± 2.79	2.87 ± 2.56	0.091	0.928
Median	2.0	2.0		
r_s(p)	0.021 (0.931)			

Z: Z for Mann Whitney test
r_s: Spearman coefficient

Table (XVIII): Relation between score and time lapse before surgery (day)

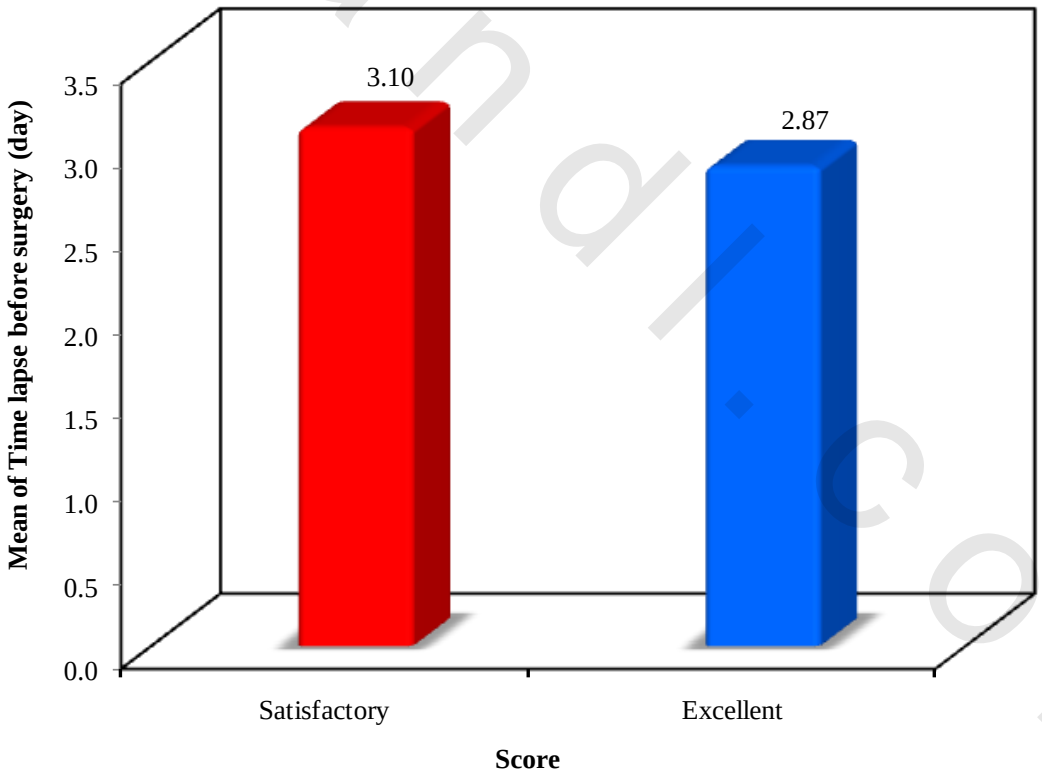


Fig. [31]: Relation between score and time lapse before surgery

5. Nail diameter used:

There was no statistically significant relation between the nail diameter used and the final score. **(Table XIX)**

Nail diameter (mm)	Score		t	p
	Satisfactory (n = 5)	Excellent (n = 15)		
Min. - Max.	3.0 – 3.50	2.50 – 3.50		
Mean ± SD.	3.10 ± 0.22	2.93 ± 0.37	0.938	0.361
Median	3.0	3.0		
r_s(p)	-0.222 (0.346)			

t: Student t-test
r_s: Spearman coefficient

Table (XIX): Relation between score and nail diameter (mm)

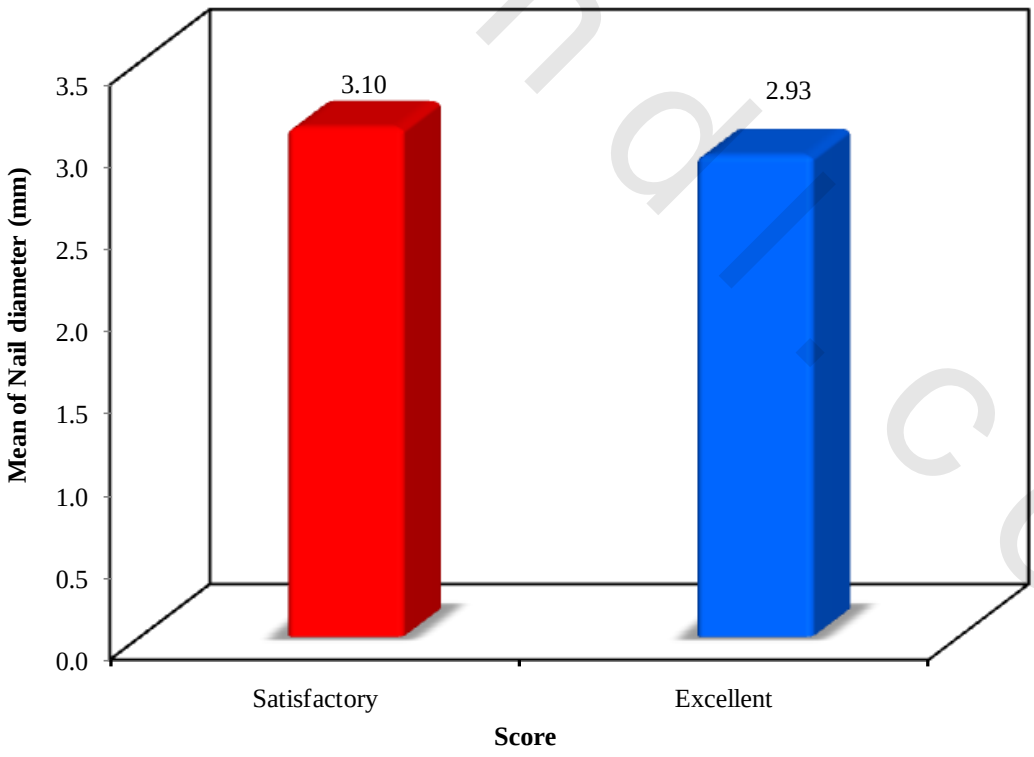


Fig. [32]: Relation between score and nail diameter (mm)

6. Intra-operative image intensifier time:

In those patients with an excellent outcome the mean intra-operative image intensifier time was 50.67 ± 12.08 seconds, whereas in those patients with a satisfactory outcome the mean intra-operative time was 45.0 ± 14.14 seconds. This difference was found statistically insignificant. **(Table XX)**

Image time (sec.)	Score				Test of sig.	p
	Satisfactory (n = 5)		Excellent (n = 15)			
	No.	%	No.	%		
<50	2	25.0	6	75.0	χ^2= 0.0	^{FE}p= 1.000
≥50	3	25.0	9	75.0		
Min. - Max.	30.0 – 60.0		30.0 – 70.0		t= 0.873	0.394
Mean ± SD.	45.0 ± 14.14		50.67 ± 12.08			
Median	50.0		50.0			
r_s(p)	0.203 (0.392)					

χ^2: value for Chi square
FE: Fisher Exact test
t: Student t-test
r_s: Spearman coefficient

Table (XX): Relation between score and image time

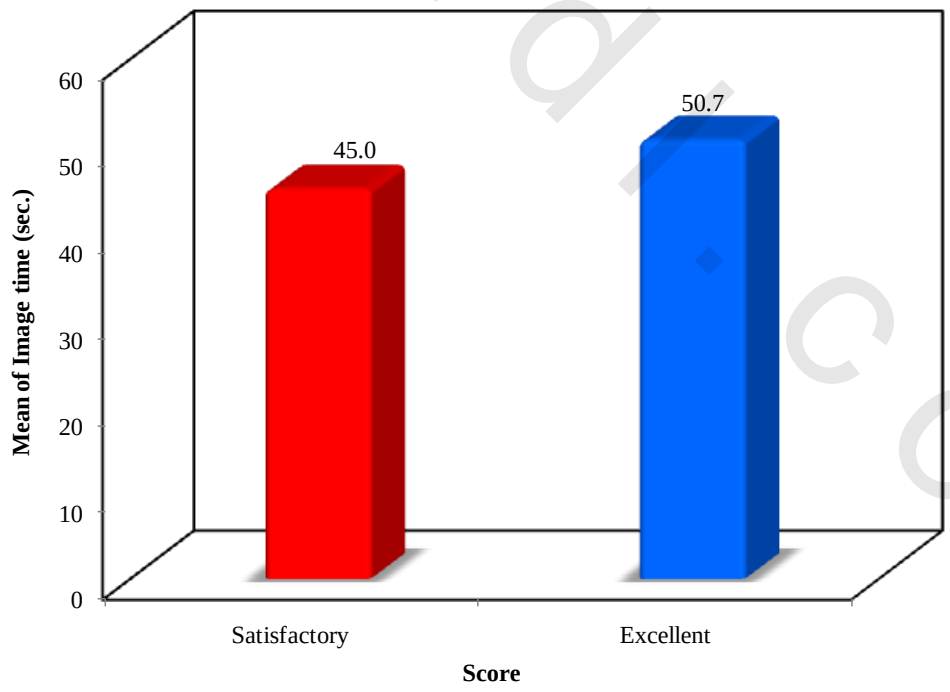


Fig. [33]: Relation between score and image time

7- Mechanism of trauma:

There was no statistically significant relation between the mechanism of trauma (MOT) and the final score. **(Table XXI)**

Method of trauma	Score				χ^2	^{FE}p
	Satisfactory (n = 5)		Excellent (n = 15)			
	No.	%	No.	%		
RTA	3	33.3	6	66.7	0.606	0.617
Sport injuries	2	18.2	9	81.8		

χ^2: value for Chi square
MC: Monte Carlo test

Table (XXI): Relation between score and method of trauma

8. Type of fracture:

There was only two patients with an open grade II fracture who had an excellent outcome. Out of the eighteen closed fractures; 13 patients (72.22%) had an excellent outcome and five patients (27.78%) had a satisfactory outcome. There was no statistically significant relation between the type of fracture and the final score. **(Table XXII)**

Type of fracture	Score				χ^2	^{FE}p
	Satisfactory (n = 5)		Excellent (n = 15)			
	No.	%	No.	%		
Closed	5	27.8	13	72.2	0.741	1.000
Open	0	0.0	2	100.0		

χ^2: value for Chi square
FE: Fisher Exact test

Table (XXII): Relation between score and type of fracture

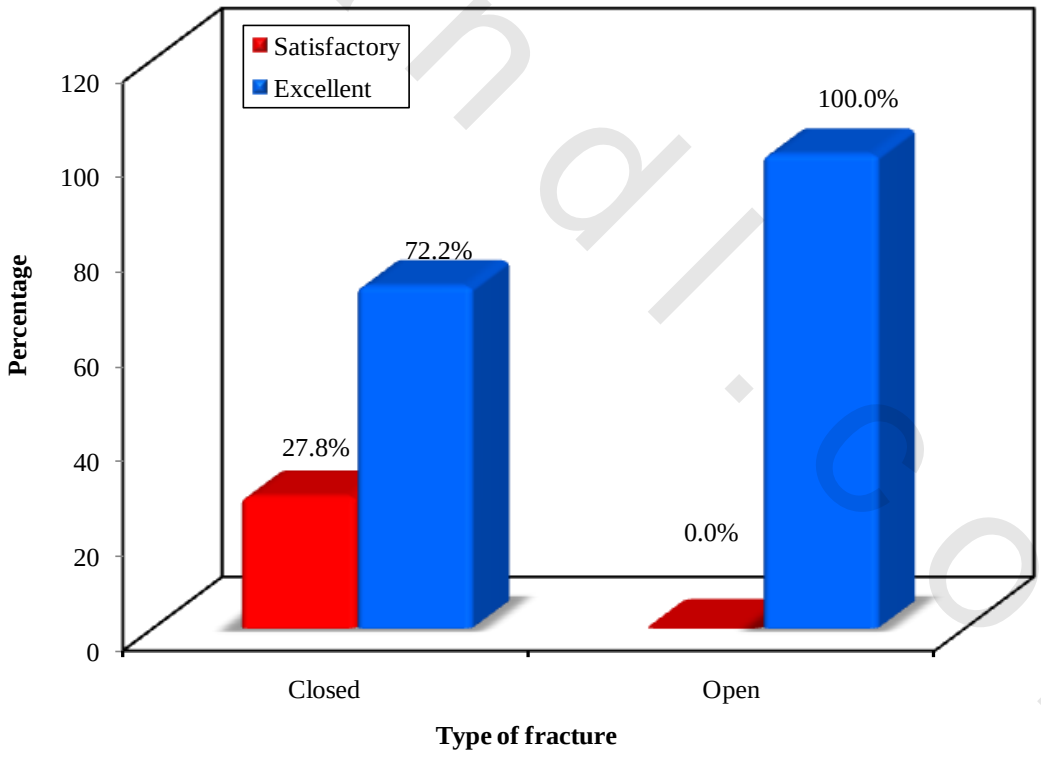


Fig. [35]: Relation between score and type of fracture

9. Level of fracture:

Eleven patients (55%) had middle third fractures; seven of them (63.64%) had an excellent outcome and four patients (36.36%) had a satisfactory outcome. Four patients (20%) had upper third fractures; three of them (75%) had an excellent outcome and one patient (25%) had a satisfactory outcome. Five patients (25%) had a lower third fracture and all of them had an excellent outcome. There was no statistically significant relation between the level of the fracture and the final score. **(Table XXIII)**

Level of fracture	Score				χ^2	^{MC}p
	Satisfactory (n = 5)		Excellent (n = 15)			
	No.	%	No.	%		
Middle	4	36.4	7	63.3	2.201	0.318
Upper	1	25.0	3	75.0		
Lower	0	0.0	5	100.0		

χ^2: value for Chi square
MC: Monte Carlo test

Table (XXIII): Relation between score and level of fracture

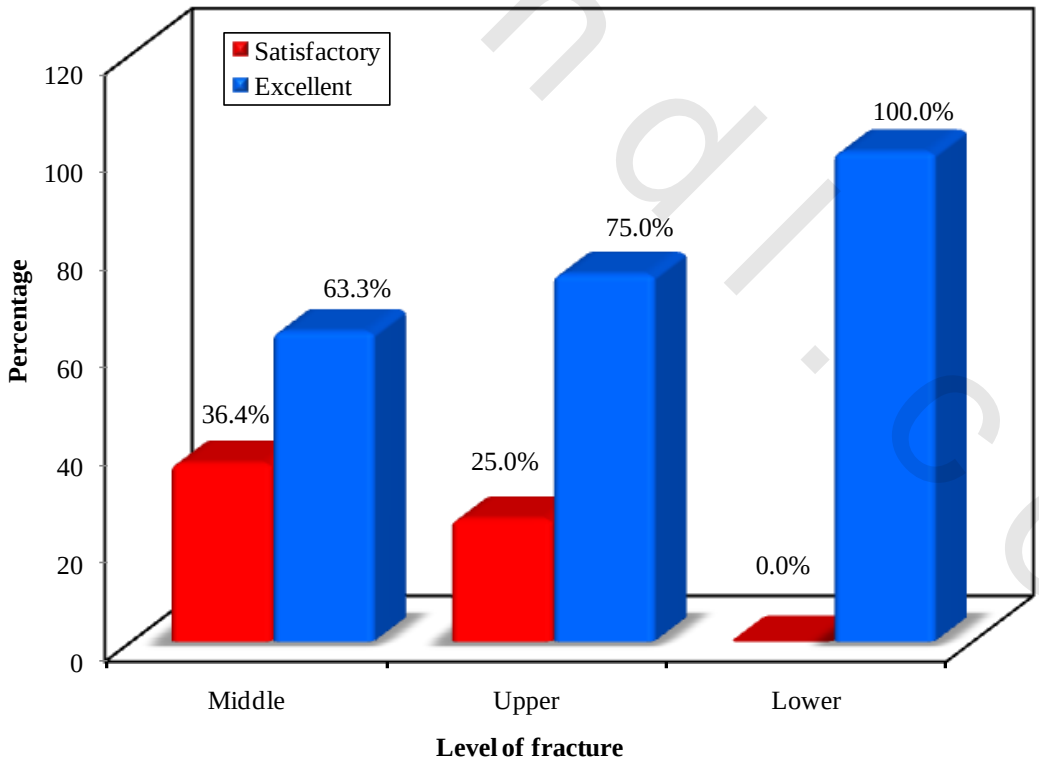


Fig. [36]: Relation between score and level of fracture

10. Shape of fracture:

Five patients (25%) had transverse fractures, all of them had an excellent outcome. Eight patients (40%) had comminuted fractures; five of them (62.5 %) had an excellent outcome and three patients (37.5%) had a satisfactory outcome. Seven patients (35%) had oblique fractures ; five of them (71.43%) had an excellent outcome and two patients (28.57%) had a satisfactory outcome. There was no statistically significant relation between the shape of the fracture and the final score. **(Table XXIV)**

Shape of fracture	Score				χ^2	^{MC}p
	Satisfactory (n = 5)		Excellent (n = 15)			
	No.	%	No.	%		
Transverse	0	0.0	5	100.0	2.191	0.357
Comminuted	3	37.5	5	62.5		
Oblique	2	28.6	5	71.4		

χ^2: value for Chi square
MC: Monte Carlo test

Table (XXIV): Relation between score and shape of fracture

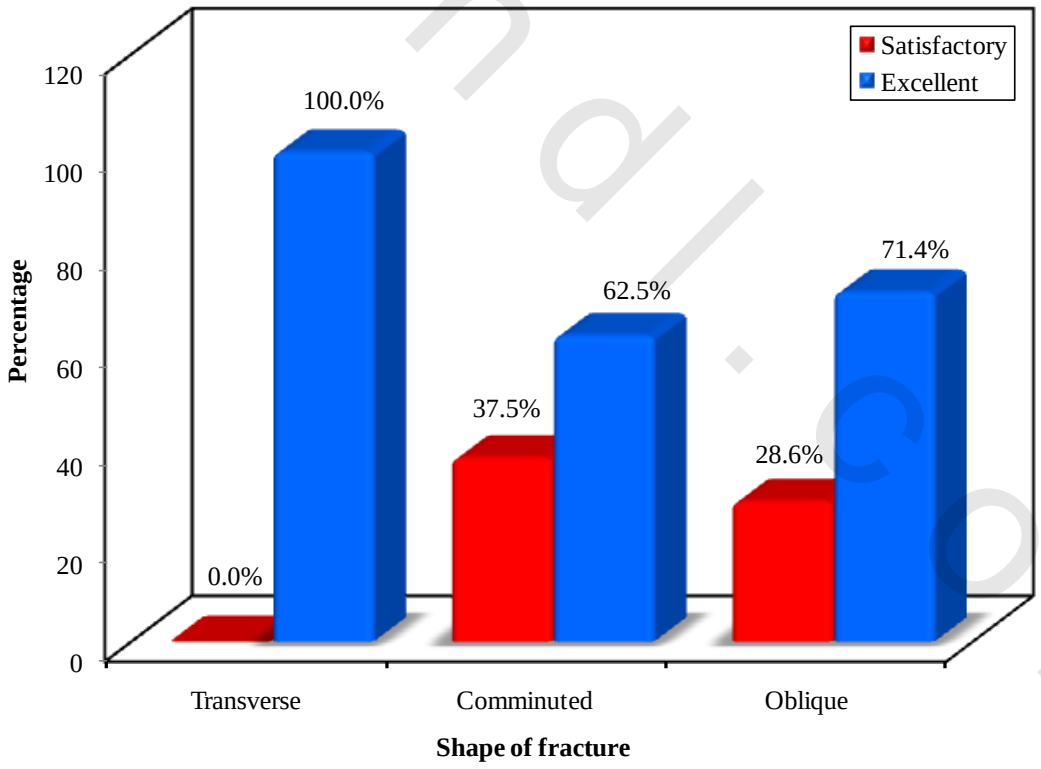


Fig. [37]: Relation between score and shape of fracture

11. Associated injuries:

There was no statistically significant relation between the presence of associated injuries and the final score. **(Table XXV)**

Associated injuries	Score				χ^2	^{MC}p
	Satisfactory (n = 5)		Excellent (n = 15)			
	No.	%	No.	%		
No	3	23.1	10	76.1		
Head injuries	0	0.0	1	100.0	0.881	1.000
Other bone fractures	2	33.3	4	66.7		

χ^2: value for Chi square
MC: Monte Carlo test

Table (XXV): Relation between score and associated injuries

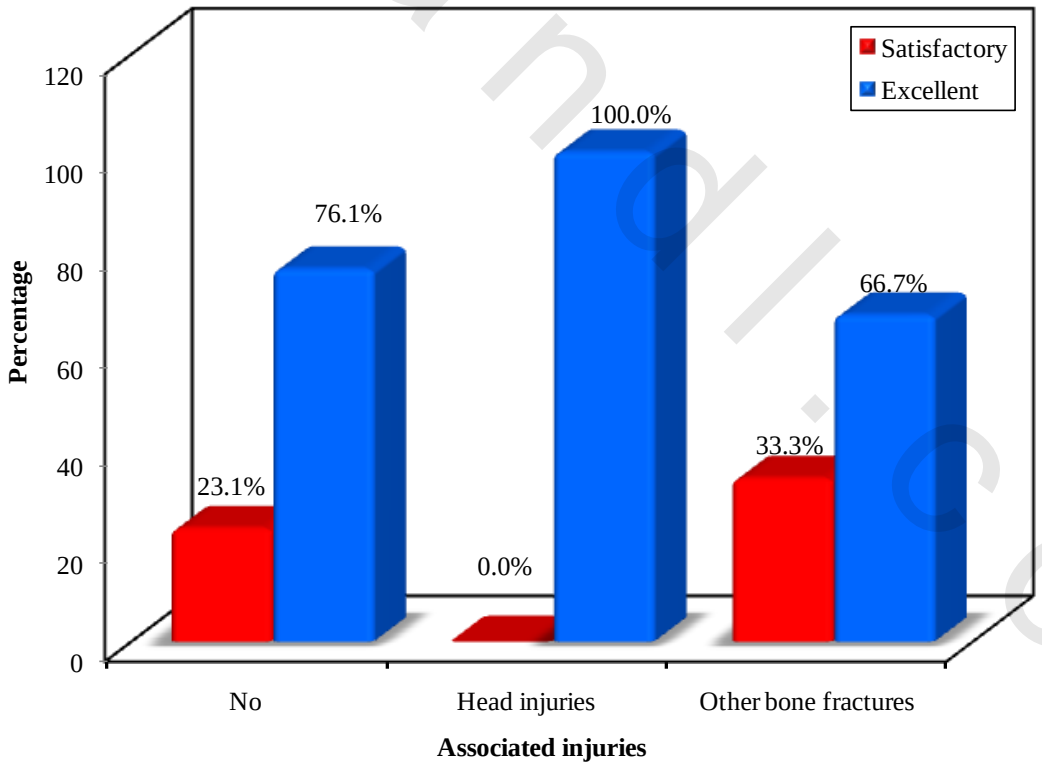


Fig. [38]: Relation between score and associated injuries

Complications

1) Pain at nail insertion site:

Pain or irritation at the insertion site of the nail occurred in five (25%) out of twenty patients. This symptom was associated with nail ends that were prominent more than 10mm from the side of the tibia, specially the antromedial nail as it is a subcutaneous one. Nails that are left too long in the proximal tibia can irritate skin causing limited knee motion. All of the five patients also had their nails removed as soon as radiographs confirmed solid fracture healing (about three months postoperative). After nail retrieval the symptoms improved.

2) Malunion: (Angulation)

After removal of the nails from the 20 united patients, two had radiographic angulation (one patient had less than 10° varus angulation , and one patient had average 10° anterior angulation). These angulations were partially corrected by remodelling after 6 months and were considered accepted. None of these patients had any evidence of clinical deformation.

3) Limb-length inequality:

Two patients had lengthening less than 2 cm, while one patient had shortening less than 1.5 cm. None of these patients had functional limitations secondary to the limb-length inequality (Fig. 39).

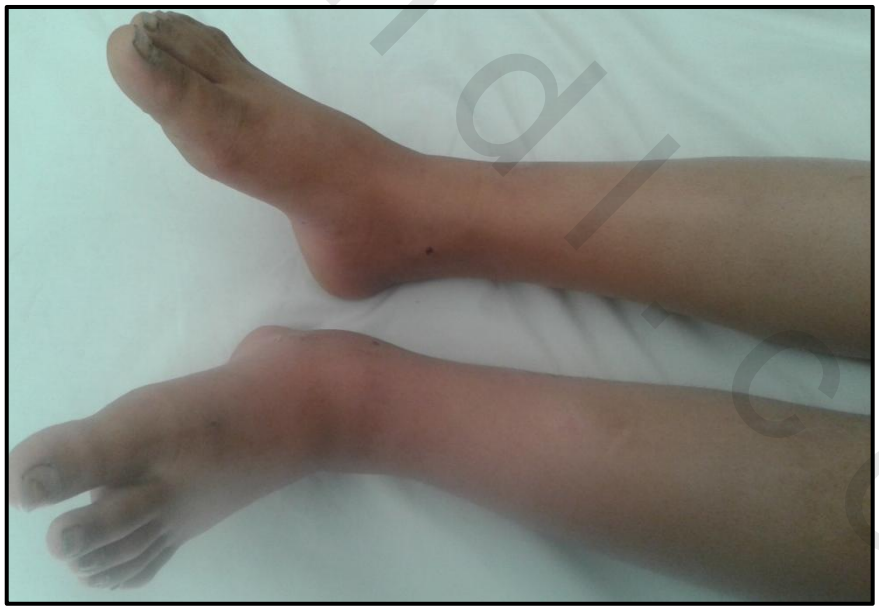


Fig. [39]: Limb-length inequality.

4) Limitation of knee motion:

As the knee was not immobilized in all the patients of our series, the range of knee motion returned to normal in less than 5-8 weeks according to patient`s pain tolerability and knee exercises in 75% of patients, while in the other five patients with prominant proximal end of the nails, knee range of motion returned to normal after nail removal

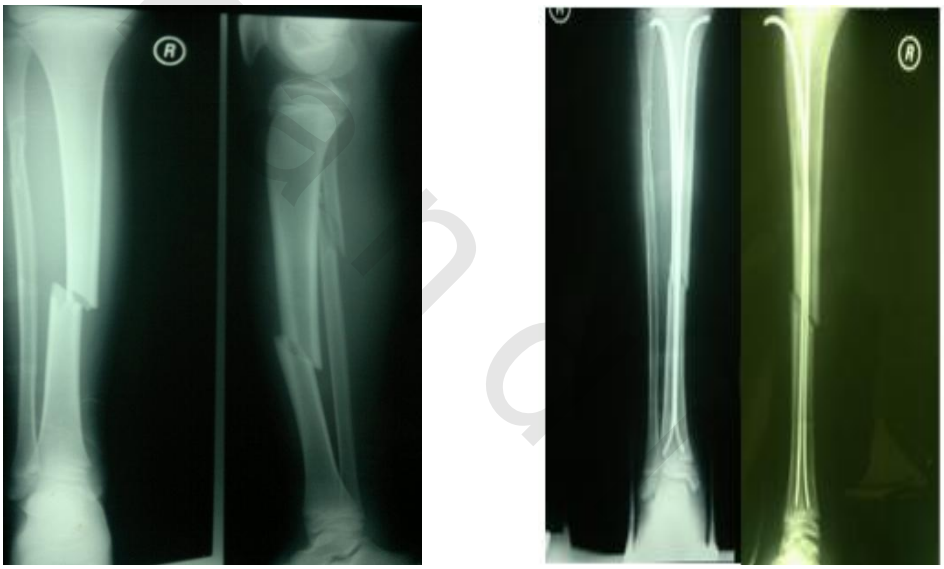
- **Rotatory deformities:** No significant rotational deformity was encountered in any patient.
- **Infection:** No infection was encountered in any patient.

Patient Series

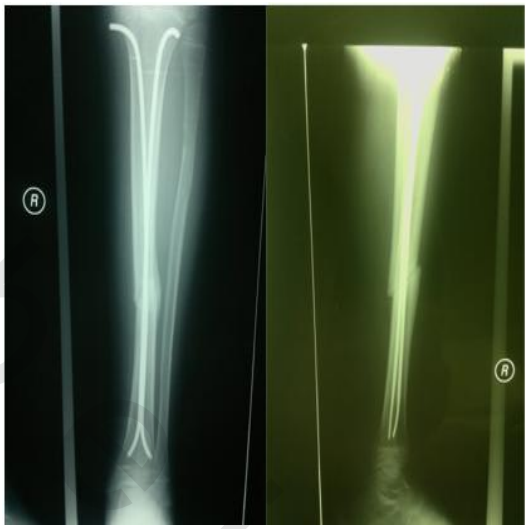
Patient (1)

A twelve years-old girl, admitted to El Hadara University Hospital after a road traffic accident on October 2013. She had a short oblique fracture of the middle third of the right tibia. Surgery was performed two days after trauma, closed reduction and fixation using two flexible intramedullary titanium nails (diameter: 3.5 mm).

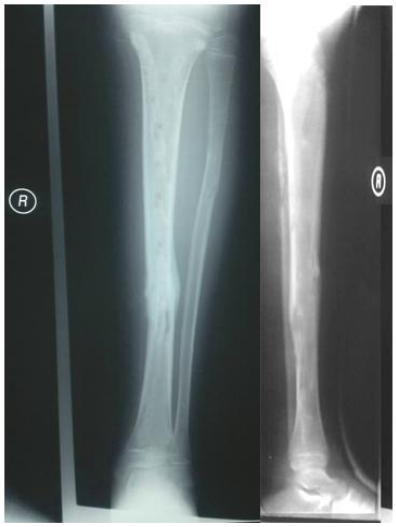
Post-operatively below knee cast was done, she was encouraged to gradually start active exercises in bed. After two weeks, the stitches were removed and partial weight bearing with support was allowed. At seven weeks follow up, X-rays showed development of a bridging callus, and full weight bearing was allowed. At 12 weeks follow up, X-rays showed solid fracture healing. And she was admitted for removal of the nails at 20 weeks. Follow up continued for six months and the outcome was excellent. (Fig.40)



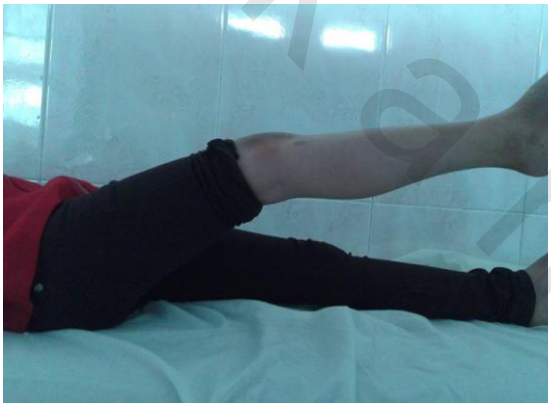
(a) Pre-operative AP and lateral views **(b)** Post-operative AP and lateral views



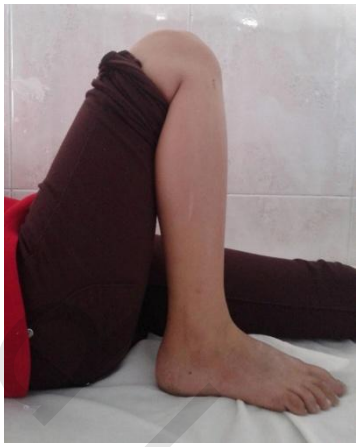
(c): AP and lateral views after 4 weeks.



(d): AP and lateral views after removal of nail



(e): Knee extension after nail removal



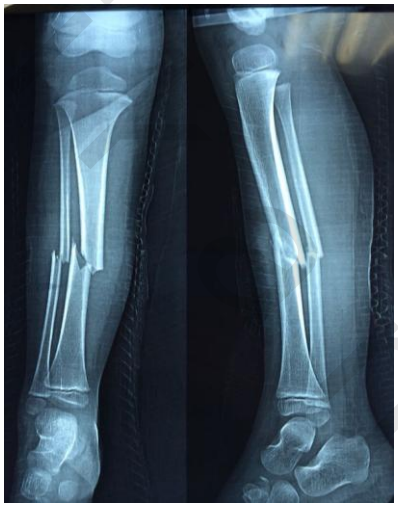
(f): Knee flexion after nail removal

Fig. [40]: Case (1)

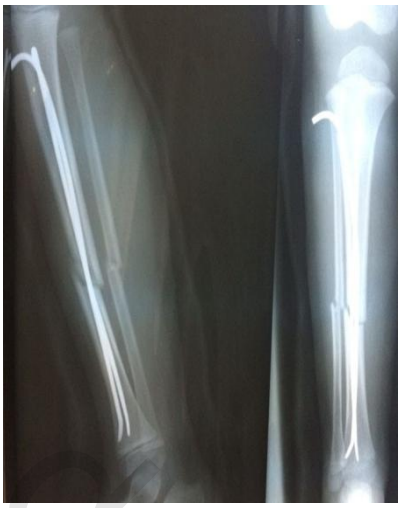
Patient (2)

A six year-old boy, admitted to El Hadara University Hospital after road traffic accident on February 2014. He had a middle third fracture of the left tibia. And suprachondylar fracture of right humerus .Surgery was performed one day after trauma, closed reduction and fixation using two flexible titanium nails (diameter: 2.5 mm).for the tibia, and pinning for the s.c fracture humerus was done.

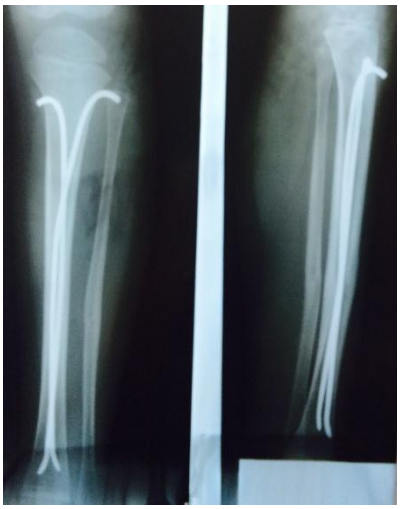
Post-operatively, he was encouraged to gradually start active exercises in bed. After two weeks, the stitches were removed and below knee cast was done. At six weeks partial weight bearing with support was allowed. At eight weeks follow up, X-rays showed development of a bridging callus, and full weight bearing was allowed. At 12 weeks follow up, X-rays showed solid fracture healing and he was admitted for removal of the nails. Follow up continued for six months and the outcome was excellent.(Fig. 41)



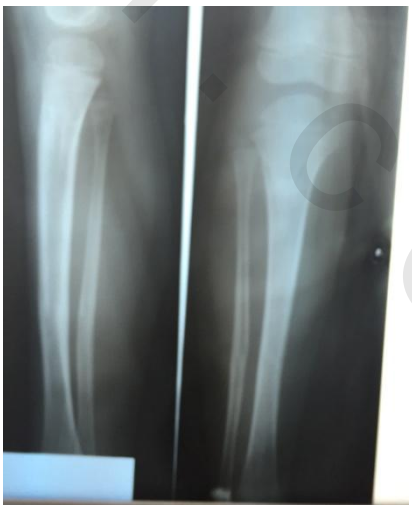
(a): Pre-operative AP and lateral views



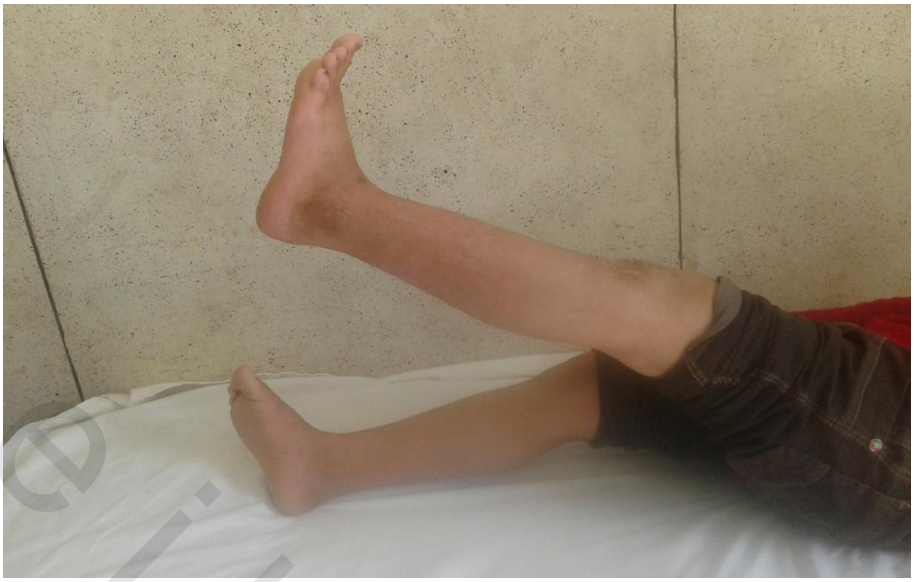
(b): Post-operative AP and lateral views



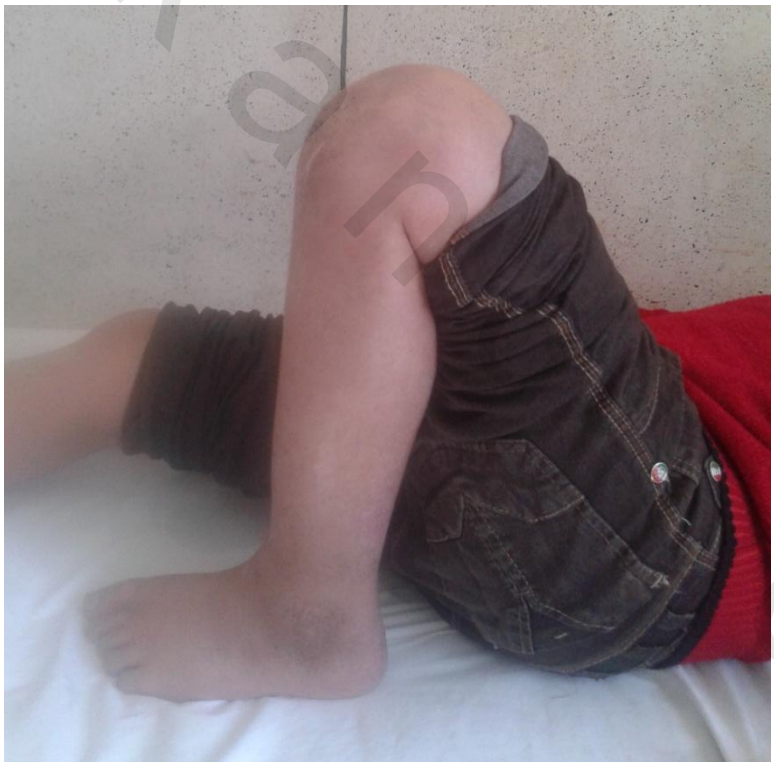
(c): AP and lateral views after union.



(d): AP and lateral views after removal of nail



(e): Knee extension after nail removal



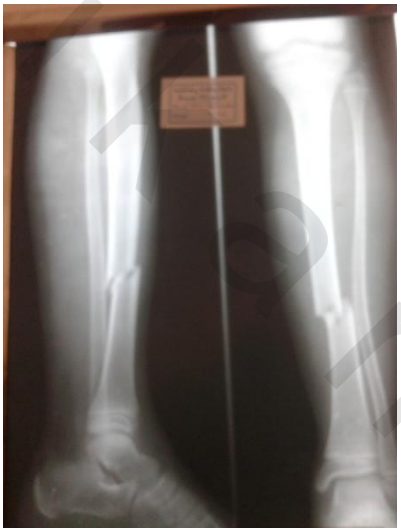
(f): Knee flexion after nail removal

Fig. [41]: Case (2)

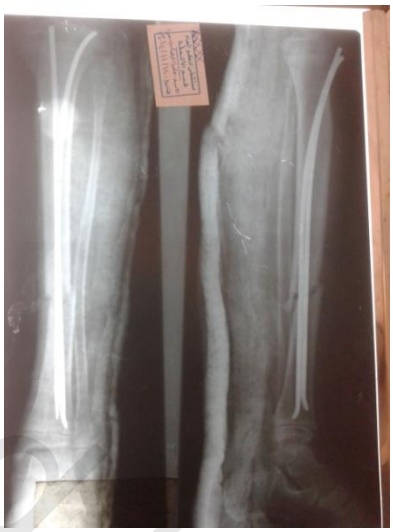
Patient (3)

A ten years-old boy, admitted to El Hadara University Hospital after sport injury on March 2014. He had a comminuted middle third fracture of the left tibia. Surgery was performed two days after trauma, closed reduction and fixation using two flexible titanium nails (diameter: 3.5 mm).

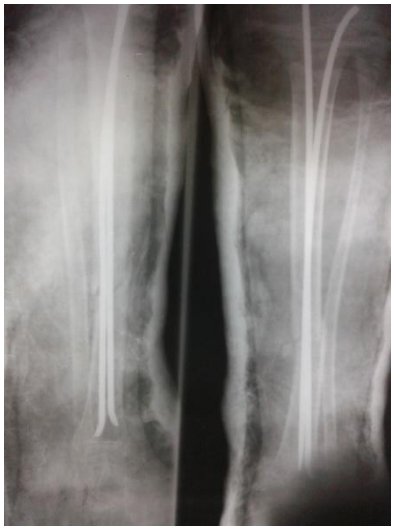
Post-operatively, he was encouraged to gradually start active exercises in bed. After two weeks, the stitches were removed and below knee cast was done. At six weeks partial weight bearing with support was allowed. At 10 weeks follow up, X-rays showed development of a bridging callus, and full weight bearing was allowed. The patient complained of pain at nail insertion site and varus angulation less than 10°. He was admitted for removal of the nails at 14 weeks. Follow up continued for six months and the outcome was satisfactory. (Fig.42)



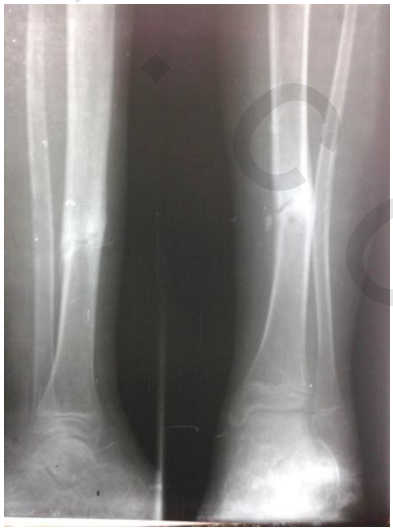
(a): Pre-operative AP and lateral views



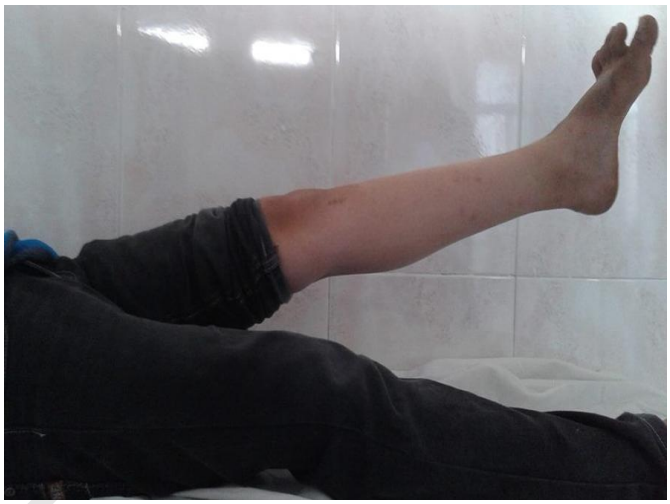
(b): Post-operative AP and lateral views



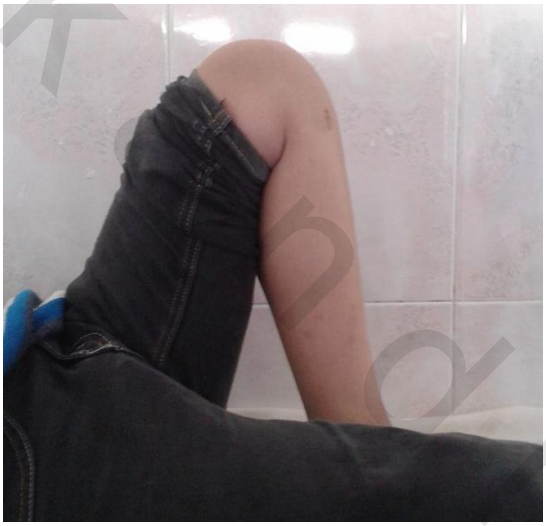
(c): AP and lateral views at 6 weeks.



(d): AP and lateral views after removal of nail



(e): Knee extension after nail removal



(f): Knee flexion after nail removal

Fig. [42]: Case (3)