Chapter VIII !

RESULTS

RESULTS

The available evaluation systems of the results for cases of limb lengthening procedure in the literature are not satisfactory . *Faber , et al., (1991)* pointed out that a lengthening procedure was considered satisfactory when the planned lengthening was achieved without permanent damage to joints ; bone ; nerves and muscles . In case of very large discrepancies (more than 8cm.) , reduction of 50 percent or more in one procedure without permanent disabling damage was considered satisfactory . This evaluation indeed needs a long term follow up to consider treatment of the complications whether corrective osteotomy for axial deviation or other surgical procedures for muscle contracture not responding to physiotherapy . Also , in large discrepancies to achieve only 50 percent or more and considering it satisfactory is not fair evaluation .

Cattaneo , et al ., (1990) used the following criteria for aesthetic and functional evaluations of cases of humeral lengthening .

***Criteria of Aesthetic Evaluation :**

-Excellent (E) : If a discrepancy of less than 3 cm was achieved and if there were good axial alignment .

-Good (G) : If a discrepancy of more than 3 cm and / or angulation of less than 10 degrees were present .

-Poor (P) : If a discrepancy of more than 3 cm and / or angulation more than 10 degrees .

***Criteria For Functional Evaluation :**

-Excellent (E) : Preservation of or improvement over pre-operative function .

-Good (G) : Minimal diminution in function .

-Poor (P) : A significant decrease in joint range of motion or permanent neurological injury .

This aesthetic evaluation system is not suitable for management of leg length discrepancy .

From our point of view , we suggest a modification of *Cattaneo et al ., (1990)* guideline using *Paley's opinion (1990b)* :

-Excellent : if the planned lengthening was fully achieved .

and / or : if there was no axial deviation .

and / or : if there was preservation or improvement over pre-operative function .

-Good : if 70 % or more of the planned lengthening was achieved .

and / or : if there were axial deviation less than 5 degrees .

and / or : if there was minimal diminution in function .

-Poor : If less than 70 % of the planned lengthening was achieved .

and / or : if there was axial deviation more than 5 degrees .

and / or : if there was a significant decrease in joint range of motion or permanent disabling complications .

According to the above mentioned guidelines , excellent results were achieved in 16 cases (64%) . Good results were achieved in 4 cases (16%) and poor results in 5 cases (20%) (Fig. 56) .

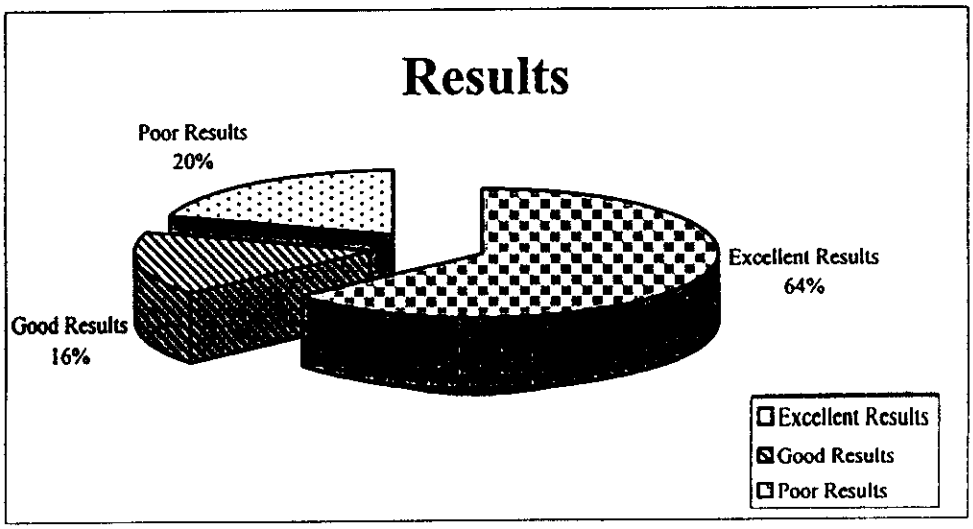

Fig.(56) : Results

All lengthened segments healed without the need for bone graft and without changing the frame applied at the time of osteotomy . Also , bleeding was minimal and none of the patients required blood replacement and there were no neurovascular problems and deep infections .

The mean operative time was 69 min. However , for transverse corticotomy , it was 57 min. and for oblique osteotomy , it was 94 min. (Fig. 57) .

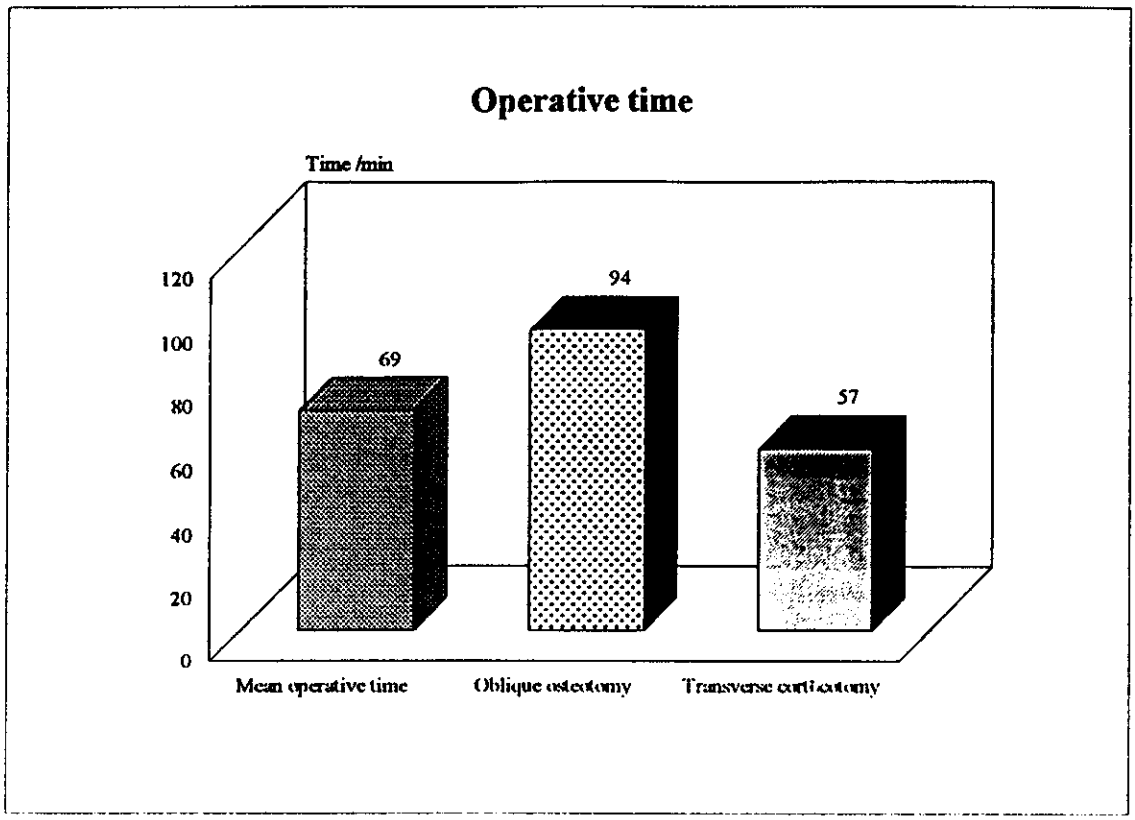

Fig.(57) : Mean operative time

The mean distraction period for our cases was 54.9 days and the mean consolidation period was 139.2 days which represent 2.5 times the mean distraction period (Fig. 58) .

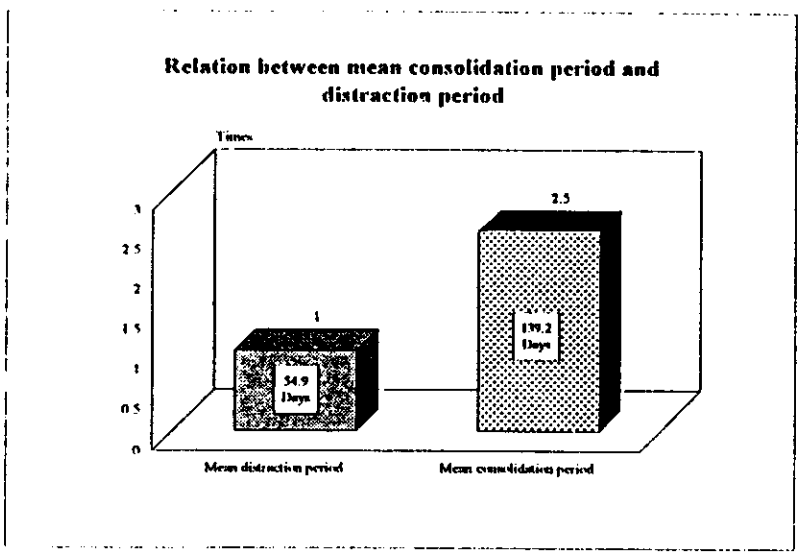

Fig.(58) : The mean distraction and consolidation period

In our old poliomyelitis cases (22 cases), the mean distraction period was 51.4 days and the mean consolidation period was 147.5 days (the mean consolidation period was 2.8 times the mean distraction period) . However , the mean distraction period in congenital shortening of long bones (3 cases) was 82.3 days and the consolidation period was 94.6 days (the mean consolidation period was 1.1 times the mean distraction period) (Fig. 59) (Table 1) .

Table (1): Relation between the consolidation period (C.P.) and distraction period (D.P.) in poliomyelitis and congenital cases (Fig.59)

Variable	Polio cases (no = 22)	Congenital cases (n=3)	P value
D.P. ± SD	51.4 ± 13.9	82.3 ± 39.4	< 0.01
C.P. ± SD	147.5 ± 54.4	94.6 ± 61.5	> 0.05
D.P. / D.P. ± SD	2.8 ± 1.1	1.1 ± 0.54	< 0.01

Unpaired t.test P-value < 0.01 highly significant, < 0.05 significant, > 0.05 non significant, SD standard deviation

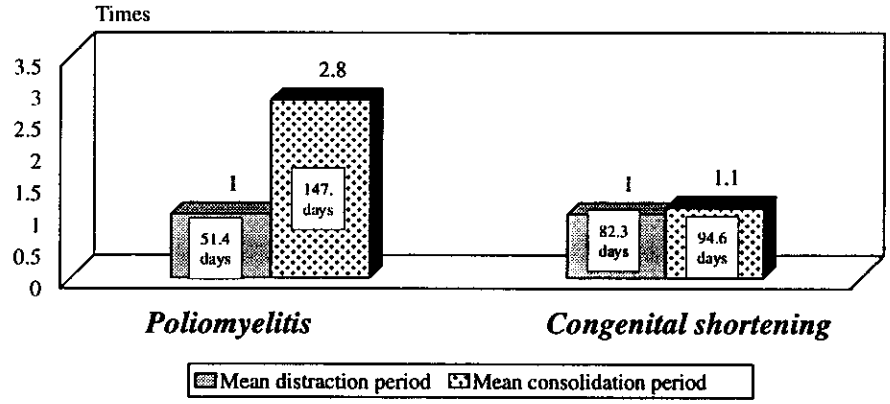

Fig.(59) : Relation between the mean distraction and consolidation period in poliomyelitis and congenital long bone shortening

The mean consolidation period was 1.4 times the mean distraction period for cases of 10 years of age or less , 2.8 times the mean distraction period for cases more than 10 years of age up to 20 years of age and 2.3 times the mean distraction period for cases more than 20 years of age (Fig. 60) (Table 2,3)

Table (2): Relation between the consolidation period (C.P.) and distraction period (D.P.) in cases ≤ 10 years & cases > 10 to 20 years (Fig. 60)

Variable	Cases ≤10 years (n=4)	Cases > 10 -20 years (n=18)	P value
D.P. ± SD	48 ± 16.6	55.4 ± 20.7	> 0.05
C.P. ± SD	69.2 ± 29.9	157.1 ± 53.5	< 0.01
D.P. / D.P. ± SD	1.4 ± 1.3	2.8 ± 1.1	< 0.05

Unpaired t.test P-value < 0.01 highly significant, < 0.05 significant, > 0.05 non significant, SD standard deviation

Table (3): Relation between the consolidation period (C.P.) and distraction period (D.P.) in cases >10 to 20 years& cases > 20 years (Fig. 60)

Variable	Cases > 10 -20 years (n=18)	Cases >20 years (n=3)	P value
D.P. ± SD	55.4 ± 20.7	62.6 ± 24.7	> 0.05
C.P. ± SD	157.1 ± 53.5	141.3 ±17.1	> 0.05
D.P. / D.P. ± SD	2.8 ± 1.1	2.3 ± 0.9	> 0.05

Unpaired t.test P-value < 0.01 highly significant, < 0.05 significant, > 0.05 non significant, SD standard deviation

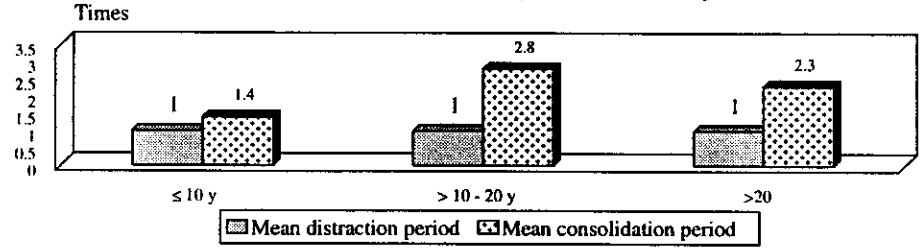

Fig.(60) : Relation between the mean consolidation period and the mean distraction period in different age groups.

The mean consolidation period was 2.9 times the mean distraction period in 17 cases of poliomyelitis lengthened through the diaphysis and it was 2.5 times the distraction period for 5 poliomyelitis cases lengthened through submetaphyseal region (Fig 61) (Table 4).

The mean length gained was 5.1cm ranging from 2.4cm to 11cm . While , the mean of the percentage of length gained was 14.9% ranging from 7% in case no. 1 to 39.2% in case no. 23 . Whereas , the mean fixator period was 206.6 days ranging from 84 days to 373 days .

Table (4): Relation between the consolidation period (C.P.) and distraction period (D.P.) in polio cases according to osteotomy site (Fig. 61)

Variable	Diaphyseal osteotomy (n=17)	Submetaphyseal osteotomy (n=5)	P value
D.P. ± SD	52.7 ± 13.4	46.8 ± 16.3	> 0.05
C.P. ± SD	155.7 ± 57.3	119.6 ± 33.7	> 0.05
D.P. / D.P. ± SD	2.9 ± 1.1	2.5 ± 0.7	> 0.05

Unpaired t.test P-value < 0.01 highly significant, < 0.05 significant, > 0.05 non significant, SD standard deviation

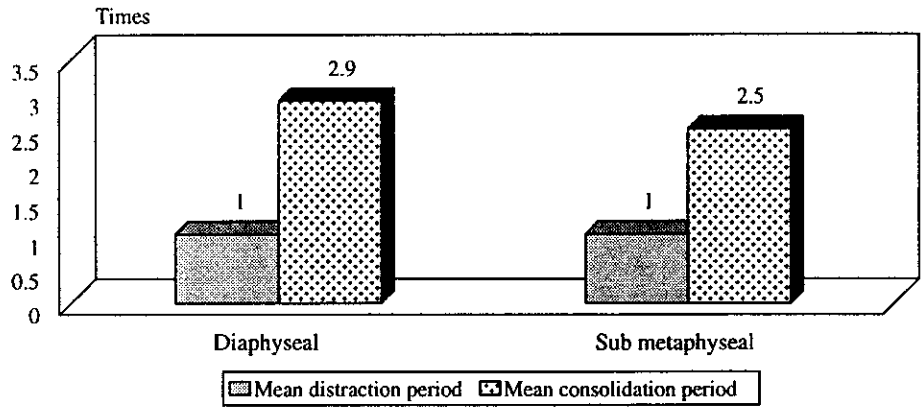

Fig.(61) : Relation of the mean consolidation period to the mean distraction period in diaphyseal and submetaphyseal osteotomies.

The mean healing index for our cases was 42.7 days . The mean healing index for 22 old poliomyelitis cases was 45.2 days , while , for three cases of congenital short long bones , it was 24.3 days per one cm. (Fig. 62) (Table 5) .

Table (5): Relation between th e healing index (H.I) in polio myelitis and congenital cases (Fig. 62)

Variable	Polio cases (no = 22)	Congenital cases (n=3)	P value
H.I. ± SD	45.2 ±10.4	24.3 ± 6.6	< 0.01

Unpaired t.test P-value < 0.01 highly significant, < 0.05 significant, > 0.05 non significant, SD standard deviation

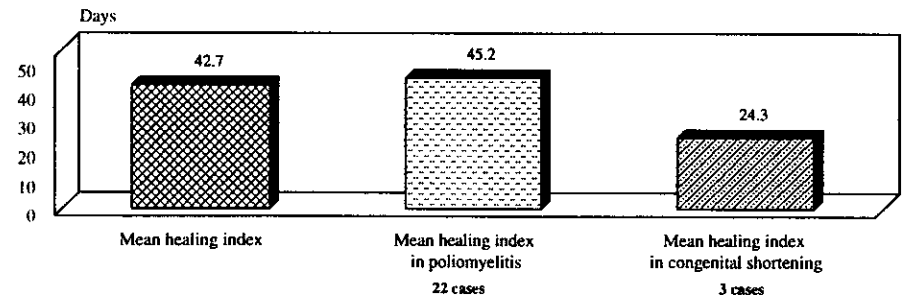

Fig.(62) : The mean healing index

Also , our results showed that mean healing index in poliomyelitis case done by diaphyseal corticotomy and osteotomy (17 cases) was 45.5 days , while , in the other 5 cases of poliomyelitis lengthened by submetaphyseal corticotomy , the mean healing index was 44.4 days (Fig. 63) (Table 6).

Table (6): Relation between th e healing index (H.I) in polio cases according to the osteotomy site (Fig. 63)

Variable	Diaphyseal osteotomy (n=17)	Submetaphyseal osteotomy (n=5)	P value
H.I. ± SD	45.5 ±10.8	44.4 ±10.2	> 0.05

Unpaired t.test P-value < 0.01 highly significant, < 0.05 significant, > 0.05 non significant, SD standard deviation

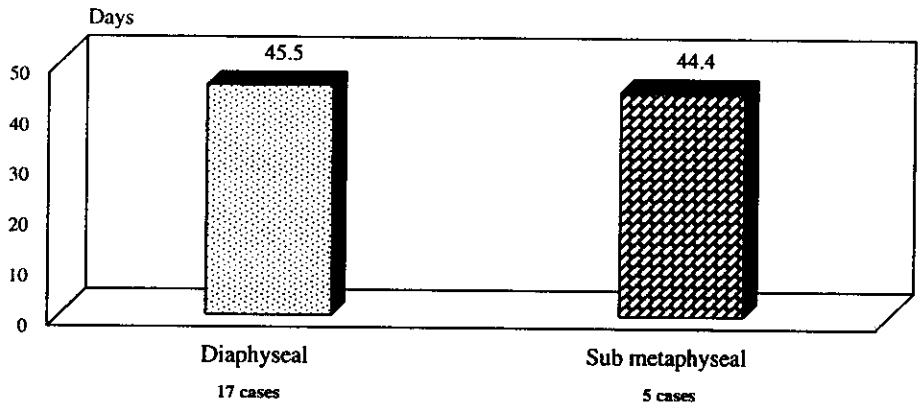

Fig.(63) : The mean healing index in diaphyseal and submetaphyseal osteotomies in poliomyelitis .

As regards the mean healing index in cases of transverse corticotomy (17 cases) , it was 44.7 days . While , in cases lengthened by oblique osteotomy , it was 38.3 days (Fig. 64)(Table 7).

Table (7): Relation between th e healing index (H.I) in transverse corticotomy & oblique osteotomy (Fig. 64)

Variable	Transverse corticotomy (n=17)	Oblique osteotomy (n=8)	P value
H.I. ± SD	44.7 ±12.3	38.5 ±11.2	> 0.05

Unpaired t.test P-value < 0.01 highly significant, < 0.05 significant, > 0.05 non significant, SD standard deviation

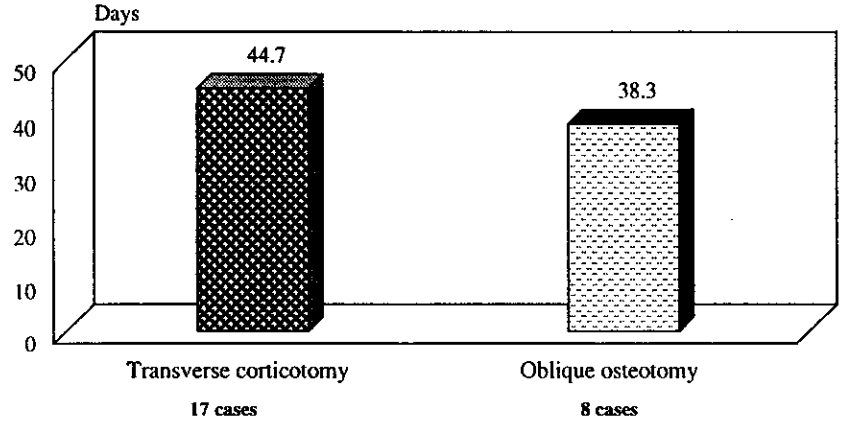

Fig.(64) : The mean healing index in transverse and oblique osteotomies

Our results showed that the relationship between the mean healing index and different age groups as follows :

-Cases of 10 years or less (4 cases) . The mean healing index was 33.7 days .

-Cases of more than 10 and up to 20 years (18 cases) , the mean healing index was 45.1 days .

-Cases more than 20 years (3 cases) , the mean healing index was 40.3 days (Fig. 65) (Table 8,9)

Table (8): Relation between th e healing index (H.I) in) in cases £ 10 years & cases > 10 to 20 years (Fig. 65)

Variable	Cases ≤ 10 years (n = 4)	Cases > 10 -20 years (n=18)	P value
H.I. ± SD	33.7 ±17.8	45.1 ±10.2	< 0.05

Unpaired t.test P-value < 0.01 highly significant, < 0.05 significant, > 0.05 non significant, SD standard deviation

Table (9): Relation between th e healing index (H.I) in in cases >10 to 20 years& cases > 20 years (Fig. 65)

Variable	Cases > 10 -20 years (n=18)	Cases >20 years (n=3)	P value
H.I. ± SD	45.1 ±10.2	40.3 ±13.5	> 0.05

Unpaired t.test P-value < 0.01 highly significant, < 0.05 significant, > 0.05 non significant, SD standard deviation

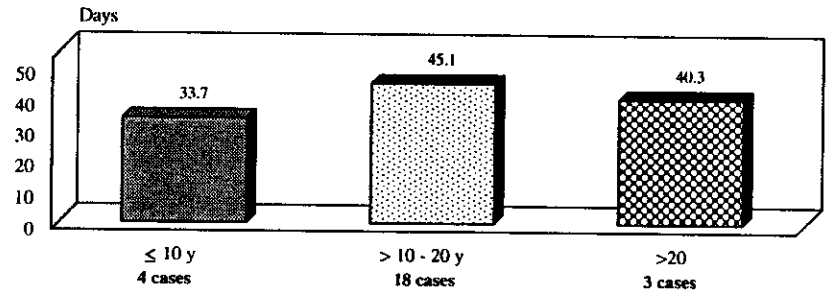

Fig.(65) : The mean healing index in different age groups .

The mean healing index for cases of femoral lengthening was 43.2 days , for cases of tibial lengthening was 40.5 days (Fig. 66) . (Table 10) .

Table (10): Relation between th e healing index (H.I) in femoral & tibial lengthening (Fig. 66)

Variable	Femoral lengthening (n=21)	Tbial lengthening (n=4)	P value
H.I. ± SD	43.1 ±11.5	40.5 ±16.8	> 0.05

Unpaired t.test P-value < 0.01 highly significant, < 0.05 significant, > 0.05 non significant, SD standard deviation

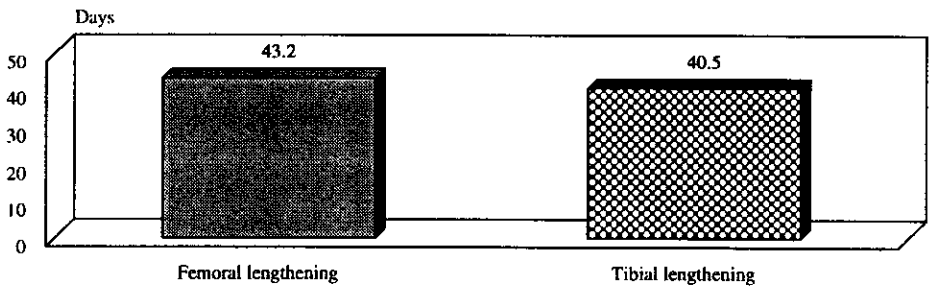

Fig.(66) : The mean healing index for femora and tibiae .

The results had shown that the mean healing index for cases distracted at a rate of 1mm once per day (19 cases) was 42 days , while , the mean healing index for cases distracted at a rate of 1.5 mm once / day (6 cases) was 45.2 days (Fig. 67) (Table 11) .

Table (11): Relation between th e healing index (H.I) in different distraction rates (Fig. 67)

Variable	Distraction 1mm/day (n=19)	Distraction 1.5 mm/day (n=6)	P value
H.I. ± SD	42 ±14.1	45.1 ±5.8	> 0.05

Unpaired t.test P-value < 0.01 highly significant, < 0.05 significant, > 0.05 non significant, SD standard deviation

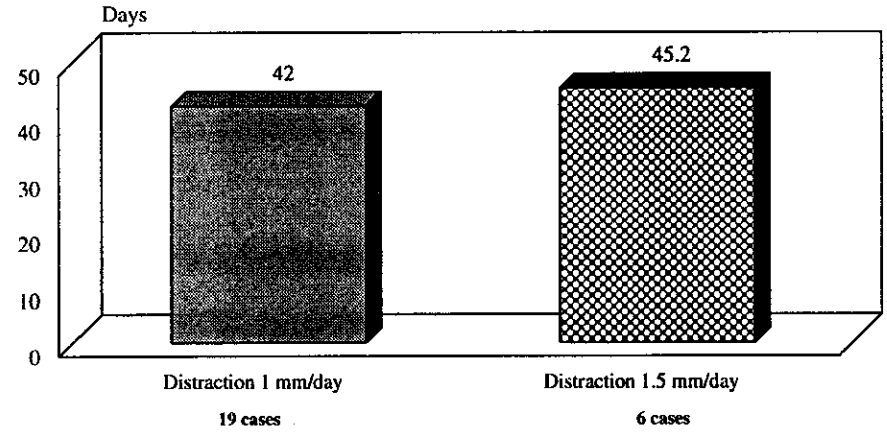

Fig.(67) : The mean healing index in different distraction rates .

The mean follow up period was 5 months ranging from 2 - 12 months .

*Complications :

In this work , complications were reported as recommended by *Paley (1990b)* They were in the form of :

A-Problems : is defined as a potential expected difficulty that arises during the distraction or fixation period that is fully resolved by the end of the treatment period by non-operative means .

B-Obstacles : is defined as a potential expected difficulty that arises during the distraction or fixation period that is fully resolved by the end of the treatment period by operative means .

C-Complications : include any difficulty during distraction or fixation that remains unresolved at the end of the treatment period , and any early or late post-treatment difficulty .

A-Problems : (Fig. 68)

1-Pin tract infection : occurred in 14 cases (56%) of cases .

2-Transient knee flexion contracture : occurred in 6 cases (24%) of cases .

3-Transient ankle equinus contracture : occurred in one case only (case no. 1) (4% of cases) .

4-Dermatitis : occurred in one case . No. 1 (4% of cases) .

5-Delayed consolidation : occurred in 5 cases (20%) case no. 1 , 7 , 9 , 13 and 21 .

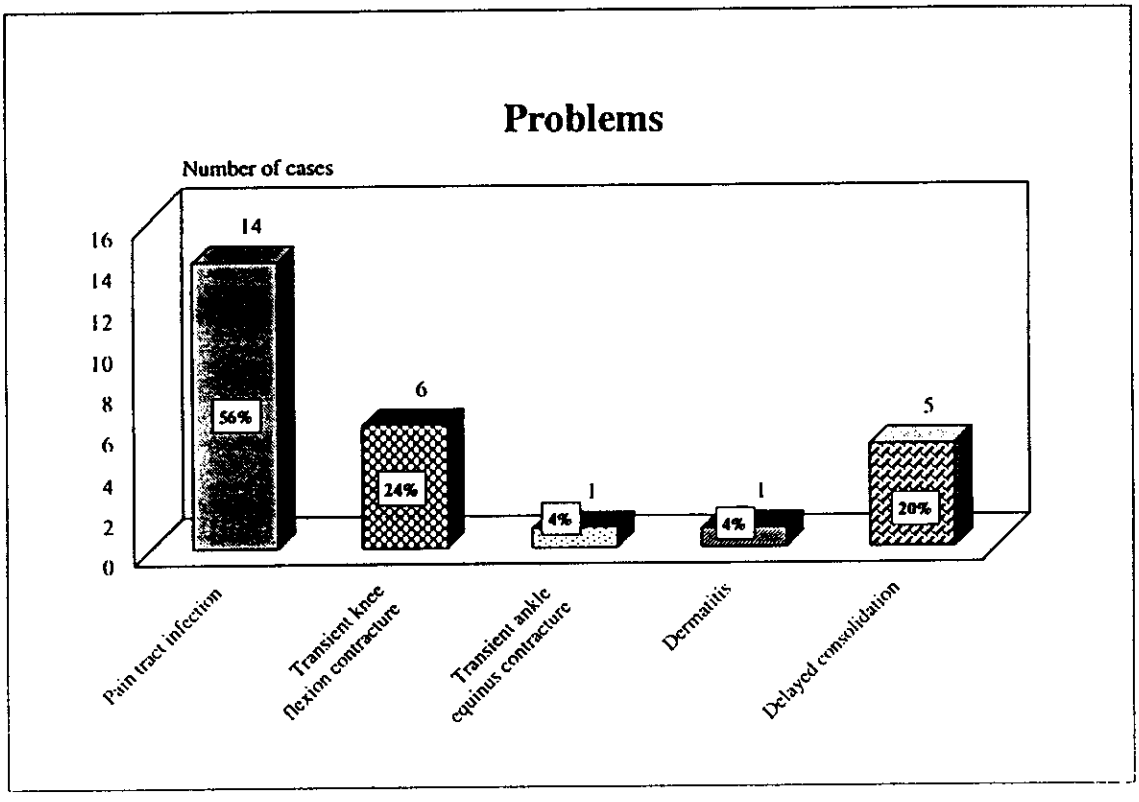

Fig.(68) : Problems

B-Obstacles : (Fig. 69)

1-Fracture at the most proximal pin (in case no. 1) (4%) after a fall with lateral angulation , reduced under general anesthesia and hip spica was applied .

2-Varus deformity in case no. 9 (4%) about 8^{o} . Corrected by manipulation under general anesthesia with adjustment of the fixator .

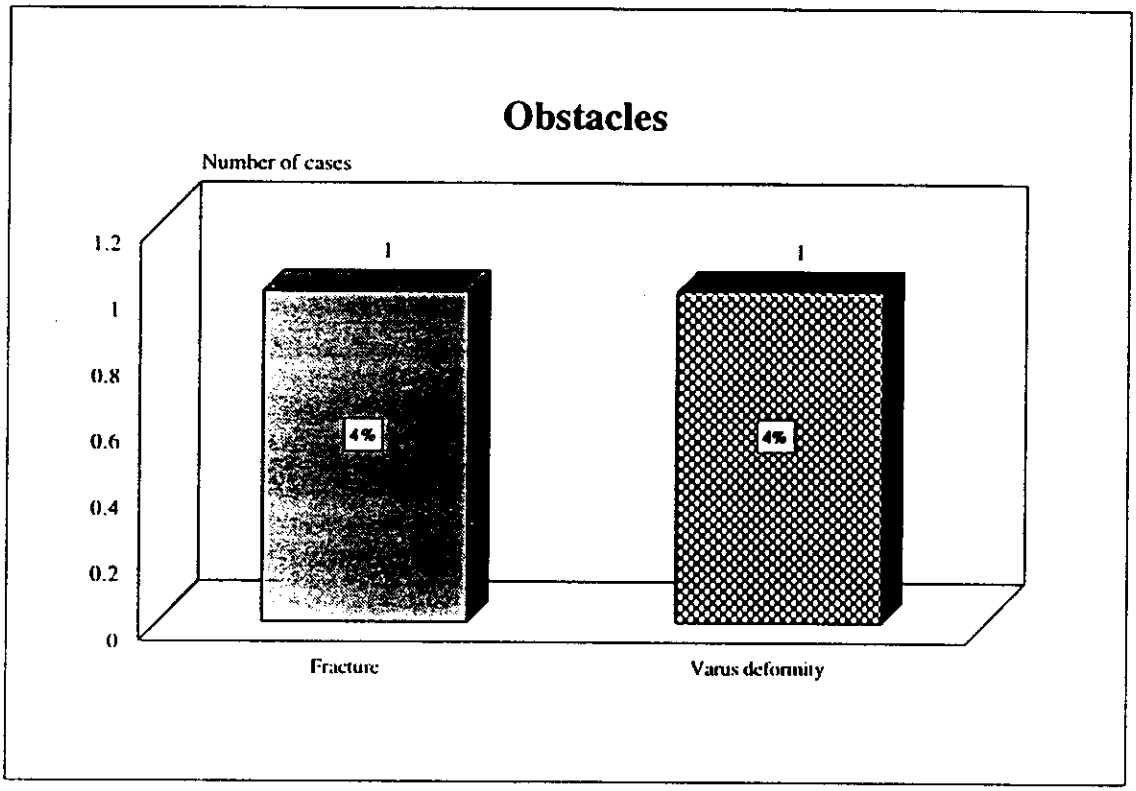

Fig.(69) : Obstacles

C-Complications : (Fig. 70)

1-Axial deviation : occurred in 5 cases (case no. 1 , 2 , 5 , 7 , 8) (20%) .

2-Residual limitation of joint range of motion : occurred in 5 cases (case no. 5 , 12 , 15 , 23 , 24) (20%) all in the knee joints .

3-Residual shortening : occurred in two cases (case no. 1 , 23) (8%) .

4-Late fracture : one month after fixator removal , it was occurred in case no 1 , 17 (8%) .

5-Sublaxation of one hip (case no. 2) (4%) .

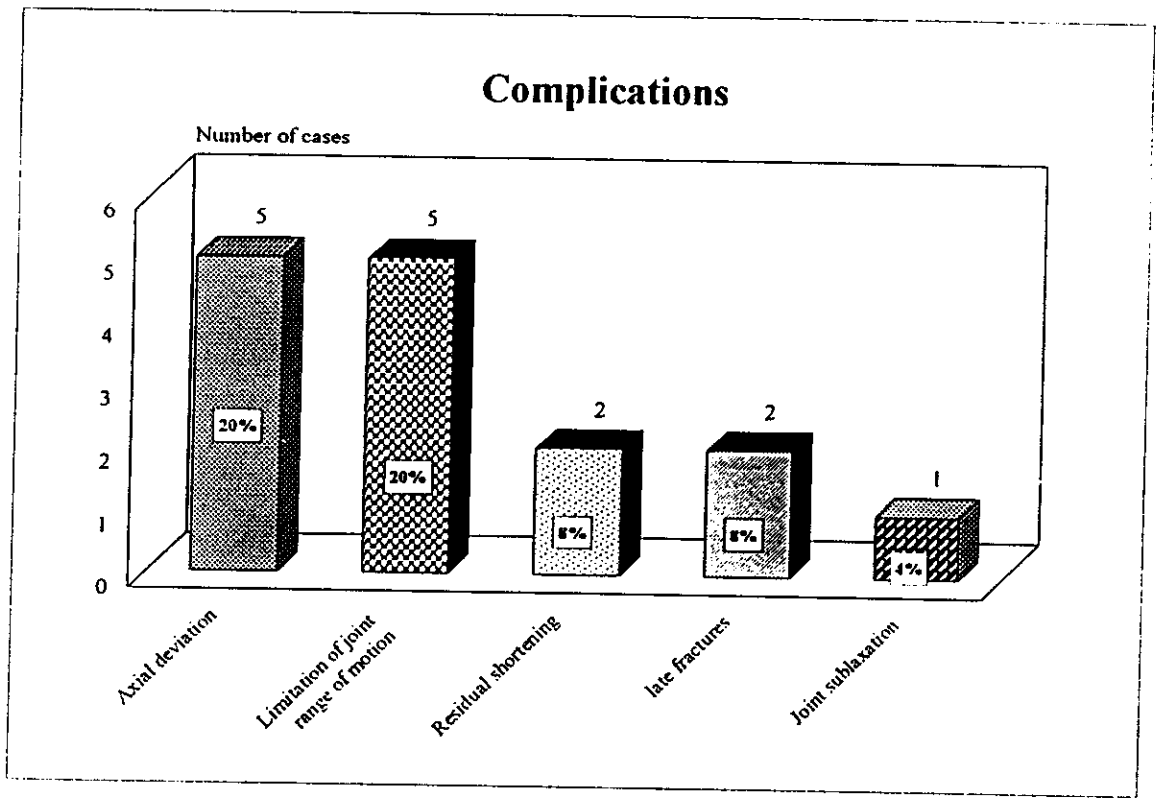

Fig.(70) : Complications

Table (12) Master sheet of cases .

No	Age	Sex	Diag.	Segment		Discrep. (cm.)	Osteotomy		Fixator used	Latency Period	Rate of Distraction	D.P	C.P	Fixator period	Length gained (cm.)	% of L.G.	Healing index
				Type	Length		Type	Site									
1	10	M	old polio	femur	34	6	trans.	diaph.	Kazem	10 days	1mm/day	29	107	146	2.4	7%	60 days
2	7	F	old polio	femur	26.5	6	trans	diaph.	Wagner	10 days	1mm/day	57	65	132	5.2	19.6%	25 days
3	19	F	old polio	femur	38	5	trans.	submet	Kazem	14 days	1.5mm/day	41	101	156	4	10.5%	39 days
4	17	F	old polio	femur	37	6	trans.	diaph.	Wagner	14 days	1mm/day	58	197	255	5	13.5%	51 days
5	8	M	old polio	femur	29	6.5	trans.	diaph.	Wagner	10 days	1mm/day	66	71	147	5	17.2%	29 days
6	19	F	old polio	tibia	33	5	trans.	diaph.	Kazem	14 days	1.5mm/day	39	127	180	4	12.1%	45 days
7	11	F	old polio	tibia	26.5	6	trans.	diaph.	Wagner	10 days	1mm/day	48	214	276	4.5	16.9%	61 days
8	20	F	old polio	femur	39	7	oblique	diaph.	Kazem	10 days	1.5mm/day	47	189	246	5	12.8%	49 days
9	14	M	old polio	femur	34	6	trans.	diaph.	Wagner	10 days	1mm/day	52	194	256	4.5	13.2%	57 days
10	8	M	cong.short tibia	tibia	21	4	trans.	diaph.	Wagner	10 days	1mm/day	40	34	84	4	19%	21 days
11	12	F	old polio	femur	33	5	trans.	diaph.	Wagner	10 days	1mm/day	51	95	156	4	12.1%	39 days
12	19	M	old polio	femur	37	8	trans.	diaph.	Wagner	14 days	1mm/day	79	280	373	7	18.9%	53 days
13	11	M	old polio	femur	31.5	5.5	trans.	diaph.	Wagner	10 days	1mm/day	60	183	243	4.5	14.2%	54 days
14	16	M	old polio	femur	37	7	oblique	diaph.	Wagner	10 days	1mm/day	73	187	270	6	16.2%	45 days
15	16	F	old polio	femur	38.5	5.5	trans.	diaph.	Kazem	14 days	1.5mm/day	44	183	241	4.5	11.7%	53 days
16	21	F	old polio	femur	37.5	6.5	oblique	diaph.	Wagner	10 days	1mm/day	59	123	182	5.5	14.6%	33 days

17	24	M	old polio	femur	38	4.8	oblique	submet	Wagner	14 days	1mm/day	40	144	198	3.5	9.2%	56 days
18	22	M	cong.short femur	femur	40	8	oblique	diaph.	Wagner	10 days	1mm/day	89	157	256	8	20%	32 days
19	13	M	old polio	tibia	31	5	trans.	submet	Wagner	10 days	1mm/day	45	83	143	4	12.9%	35 days
20	19	M	old polio	femur	37.5	6	oblique	diaph.	Kazem	10 days	1.5mm/day	39	138	191	5	13.3%	38 days
21	14	F	old polio	femur	32	5.5	trans.	submet	Wagner	10 days	1mm/day	75	165	250	4.5	14%	55 days
22	15	M	old polio	femur	36	5	trans.	submet	Wagner	10 days	1mm/day	33	105	148	4	11.1%	37 days
23	14	F	cong.short femur	femur	28	15	oblique	diaph.	Wagner	10 days	1mm/day	118	93	221	11	39.2%	20 days
24	15	F	old polio	femur	37	6	trans	diaph.	Kazem	14 days	1.5mm/day	35	188	237	5	13.5%	47 days
25	19	M	old polio	femur	38.5	6.7	oblique	diaph.	Wagner	10 days	1mm/day	61	107	178	5	12.9%	35 days

D.P. : Distraction period. **C.P. : Consolidation period.** **Diag. : Diagnosis.** **Discrep. : Discrepancy.** **% of L.G. : % of length gained.**
Diaph. : Diaphyseal **Submet. : Submetaphyseal .** **Cog. : Congenital** **M : Male** **F : Female**

Table(13) Master sheet of complications .

No.	Problems	Obstacles	Complications	Evaluation
1	-Pin tract infection . -Dermatitis . -Delayed consolidation	-Fracture at the most proximal pin . Closed reduction under general anesthesia and spica cast .	-Residual shortening 3.6cm. & lateral angulation at the most proximal pin 20^{o} & post-angulation 7 degrees at corticotomy site . -Late fracture .	Poor
2	-Pin tract infection .		-11 degrees varus & sublaxation of the hip .	Poor
3	-Transient knee flexion contracture 30^{o} .			Excellent
4	-Pin tract infection . -Transient knee flexion contracture 10 degrees .			Excellent
5			-12 degrees varus & limited range of motion (10^{o} - 90^{o}) .	Poor
6	-Pin tract infection . -Transient ankle equinus contracture 15 degrees .			Excellent
7	-Pin tract infection . -Proximal tibial pins loosening . -Delayed consolidation		-10 degrees vulgus & 13 degrees anterior angulation . -Refracture after one month after fixator removal .	Poor
8	-Pin tract infection .		-Varus 11 degrees .	Poor
9	-Pin tract infection . -Transient knee flexion contracture 20 degrees .	-Varus 8 degrees reduced by manipulation under general anesthesia .		Excellent
10	-Pin tract infection .			Excellent
11				Excellent
12	-Pin tract infection .		-Limited range of motion (0^{o} - 60^{o}) .	Good
13	-Delayed consolidation .			Excellent
14	-Pin tract infection . -Transient knee flexion contracture 20			Excellent

15	-Pin tract infection .		-Limited range of motion (0^{o} - 70^{o}) .	Good
16				Excellen
17	-Pin tract infection . -Transient knee flexion contracture 15 degrees .			Excellen
18				Excellen
19				Excellen
20	-Pin tract infection .			Excellen
21	-Delayed consolidation .			Excellen
22				Excellen
23			-Limited range of motion (0^{o} - 50^{o}) & residual shortening 4 cm..	Good
24	-Pin tract infection .		-Limited range of motion (0^{o} - 70^{o}) .	Good
25	-Transient knee flexion contracture 10 degrees .			Excellent