ISSN NO. 2320-5407

Journal Homepage: -www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI:10.21474/IJAR01/6969
DOI URL: http://dx.doi.org/10.21474/IJAR01/6969

RESEARCH ARTICLE

MANAGEMENT OF COMPLEX LOWER LIMB DEFORMITIES USING THE TAYLOR SPATIAL FRAME.

Gamal Ahmed Hosny[1],Khaled Mohamed Hassan[2], Mahmoud Mohamed Ibrahem Matter[3], Ahmed Mohamed Ahmed Nahla[4] and Osam Mohamed Metwally Hassan[5].
Orthopaedic Surgery Department in Zagazig University and Banha University.

……………………………………………………………………………………………………....

Manuscript Info

……………………….

Manuscript History

Received: 17 February 2018
Final Accepted: 19 March 2018
Published: April 2018

Keywords:-
Taylor spatial frame, complex lower limb deformity, varus, valgus.

Abstract

…………………………………………………………………

Objective: The aim of this study is to evaluate the results of using the TSF in treatment of complex lower limb deformities around the knee joint.
Subjects and Methods: This study is prospective study was conducted involving 21patients who underwent correction of the mechanical axis using TSF and bone osteotomy in a complex knee deformity.
Results: Using Schoenecker's criteria there were 95.23% good result in term of good results in terms of pain and radiological criteria in our patients, 0 % fair results and there were 4.76% poor results.
Conclusion: TSF is an excellent tool for the correction of multiple plane deformity around the knee joint in children and adolescents and significantly expands our ability to correct precisely the most difficult deformities.

……………………………………………………………………………………………………....

Introduction:-

The main problem in the correction of complex deformities with classic circular external fixators is the modifications needed in the fixator for residual deformities that occur. Moreover, in the classic systems, the hinges must be installed perfectly on the patient in order to achieve a complete correction. However, in the TSF procedure, all components of the deformity may be corrected simultaneously, and the correction may be performed to provide the best clinical outcome by observing the rotational problems detected with clinical measurements during patient follow-up. In addition, residual deformities that may occur may be re-programmed to obtain a perfect correction **(Fadel M, Hosny G,2005)**

1 Professor of Orthopedic Surgery, Faculty of Medicine, Banha University, Egypt, 2,3 Professors of Orthopedic Surgery, Faculty of Medicine, Zagazig University, Egypt, 4 Lecturer of Orthopedic Surgery, Faculty of Medicine, Zagazig University, Egypt, 5 Assistant Lecturer of Orthopedic Surgery, Faculty of Medicine, Zagazig University, Egypt,

Software creates a prescription adjusting the rate and direction of A prescription is derived by entering 13 measurements of deformity, dimensions of the strut- ring used and location of TSF on the extremity in the computer software. change for the struts' length and composes a virtual hinge system. After the prescription is applied within the planned time, re-planning is possible via the computer software. (**Kucukkaya M, et al., 2009)**

Corresponding Author:-Osam Mohamed Metwally Hassan.
Address:-Orthopaedic Surgery Department in Zagazig University.

Patient and Methods:-

This study was carried out in Orthopedic Surgery Department, Faculty of Medicine, Zagazig University hospitals in the period between June 2014 and may 2017, a prospective study was conducted involving 21 patients with 28complex metaphyseal and diaphyseal tibial and femoral deformities around the knee joint that were managed by the Taylor spatial frame in conjunction with bone osteotomy.

There were 18 males and 3 females; their ages were ranged between 14 and 40 years. The mean age was 18.2 years
The deformities were located at the proximal metaphysis in 23 tibias , and in 5 femurs at the distal metaphysis
The mean hospital stay was 3.5 days (Range 3–5 days). A fibular osteotomy was performed in all tibial cases. Patients were corrected on average0.75 mm (Range0.5-1mm).

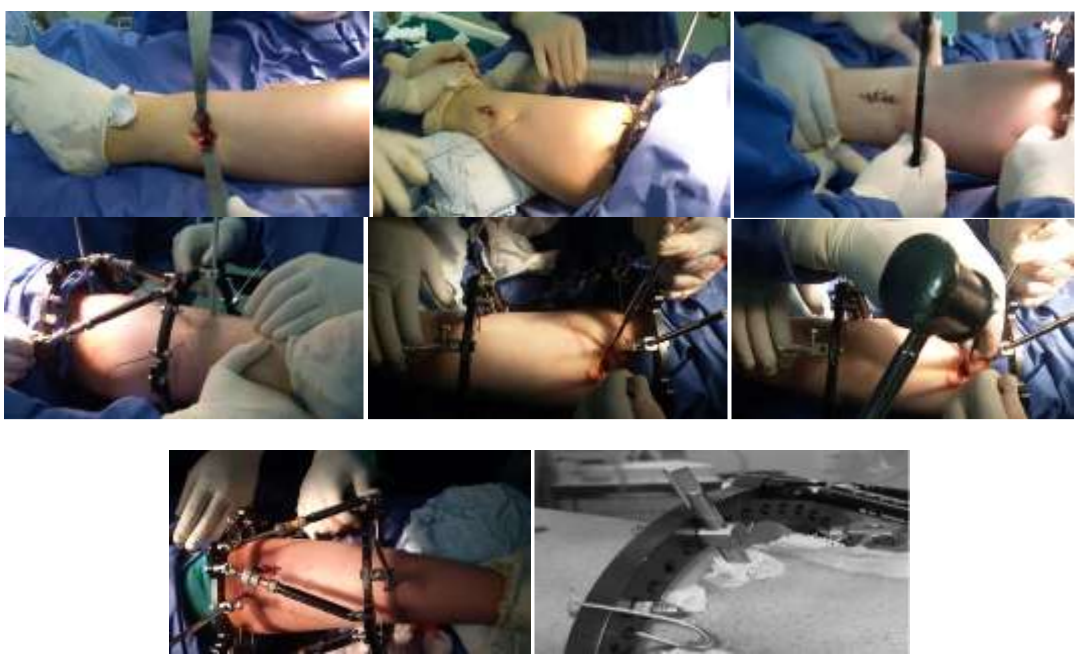
Varus deformities constitute the main deformity in this study as it were presented in 23 limb segments "22 tibias and 1 femoral cases (78.58%), valgus deformities were presented in 5 limb segments "1 tibial and 4 femoral cases" (21.42%)

Operative Technique:-
Mechanical axis deviation is determined with use of the malalignment test as described by Paley. The lateral distal femoral angle, medial proximal tibial angle, and posterior proximal tibial angle are measured to analyze deformities around the knee.

The Center of Rotation of Angulation CORA is identified by locating the intersection of the proximal and distal mechanical axes. Often this point is chosen to be the origin as well. (In TSF terminology, the origin)

An osteotomy site is selected, typically at the apex of the deformity. If the bone is very sclerotic at the apex, then an adjacent alternative site is used to maximize bone-healing potential. When making an osteotomy at a site other than the center of rotation of angulation, one must translate the bone to reestablish alignment.

These values are entered into the computer as deformity parameters to ensure that the distal fragment will be well aligned at the completion of the adjustment period.



During application of the frame

Result:-

We divided our patients into two groups:- varus and valgus
Comparison of some data of varus and valgus groups

	Valgus group		Varus group	
	N	%	n	%
Gender:				
Male	3	100	15	83.3
Female	0	0	3	16.7
Diagnosis:				
Adolescent tibia vara	0	0	16	88.8
Posttraumatic arrest with knee varus	0	0	1	5.6
Neglected Varus knee	0	0	1	5.6
Resistant hypophosphtemicricket	1	33.3	0	0
Valgus knee	2	66.7		
Site:				
Left tibia	0	0	8	44.4
Right tibia	0	0	8	44.4
Bilateral Tibias	0	0	1	5.6
Tibia and femur	1	33.3	1	5.6
Bilateral Femurs	1	33.3	0	0
Left femur	1	33.3	0	0
Bilaterality				
No	2	66.7	16	88.8
Yes	1	33.3	2	11.2
Operation				
Proximal tibial osteotomywith fibular osteotomy	2	66.7	17	94.4
Distal femoral osteotomy			0	0
Distal femoral osteotomy and Proximal tibial osteotomywith fibular osteotomy	1 0	33.3 0	1	5.6
Complications:				
Superficial Pin tract infection	2	66.7	16	88.8
Superficial Pin tract infection with undercorrection	0	0	1	5.6
Superficial Pin tract infection with overcorrection	1	33.3	0	
Superficial Pin tract infection with transient peroneal nerve palsy	0	0	1	5.6
Age				
mean±SD	16±2		18.33±5.91	
median (range)	16(14-18)		16.5(14-40)	
Height				
mean±SD	155.67±15.14		163.28±8.32	
median (range)	165(130-172)		164(140-176)	
Weight				
mean±SD	69±1.28		88.67±1.58	
median (range)	72(55-80)		89.5(60-115)	
Time in frame				
mean±SD	17.33±1.15		14.33±1.24	
median (range)	18(16-18)		14(12-16)	
Preoperative limb length discrepancy				
mean±SD	17.33		20.5±7.85	
median (range)	24(0-28)		23 (0-27)	

Time in frame:-

The mean of total time that the fixator was on the patients prior toremoval was 14.8 weeks (standard deviation [SD] ± 1.7) range from 12 to 18 weeks.

Clinical diagnosis and type of operation of studied cases:-

Variables	N(%)
Diagnosis	
Adolecent tibia vara	16(76.2)
Post traumatic arrest é knee varus	
Resistant hypophosphatemicricket	1(4.8)
Valgus knee	
Neglected Varus knee	1(4.8)
	2(9.5)
	1 (4.8)
Site of lesion	
Both Femurs	1(4.8)
Left femur	1(4.8)
Right femur and tibia	1(4.8)
Left tibia	8(38.1)
Rt tibia	8 (38.1)
Both tibiaes	1 (4.8)
Tibia and Femur	1 (4.8)
Laterality of lesion:	
Unilateral	18(85.7)
Bilateral	3 (14.3)
Site of osteotomy:	
Proximal tibial osteotomy with fibular osteotomy	
Distal femoral osteotomy	17(81)
Proximal tibial osteotomy with fibular osteotomy and distal femoral osteotomy	2(9.5)
	2(9.5)

Varus group

Mechanical Axial Deviation (MAD):-

Mean preoperative to postoperative changes of Mechanical AxisDeviation (MAD) from 33.29mm (range 13–53 mm) medial to tibial spine with SD ±8.8 improved to 5.76 mm (range 1-20 mm) medial with SD ±4.44With case number 17, the femoral component on the right side was not corrected so the MAD was 20 mm medial to tibial spine.

Medial proximal tibial angle (MPTA):-

Mean preoperative to postoperative changes of medial proximal tibialangle from 75.24° (range 62-89 °) with SD ±5.49 improved to 86.09° (range 80-89 °) with SD ±2.74.

Posterior Proximal Tibial Angle (PPTA):-

Mean preoperative to postoperative changes of posterior proximaltibial angle from 75.19° (range 69-92°) with SD ±5.17changd to 81.9(range 69-88 °) with SD ±3.92.

anatomical Posterior Femoral Distal Angle: (aPFDA):-

Mean preoperative to postoperative changes of angle of aPFDAfrom 81.19° (range 69-85°) with SD ±4.71 to 75(range 79-85 °) with SD ±24.99.

mechanical Lateral Distal Femoral Angle:(mLDFA):-

Mean preoperative to postoperative changes of mLFDAfrom 91.81° (range 87-108°) with SD ±4.93improved to 90.9 (range 87-108 °) with SD ±4.88.

Joint Line Convergence Angle: (JLCA):-

Mean preoperative to postoperative changes of JLCA the tibial plateau from 2 (range 0-8) with SD ±2.57 changed to 0.91(range 0-2) with SD ±0.99.

Limb length discrepancy:(LLD):-

Table 13:- Range preop (0-27) postop (0-15)

LLD	Mean±SD	p
Preoperative	20.5±7.85	
Postoperative	2.06±4.26	<0.001

With case number 9 &17 corrected unilaterally so there was partial correction of the discrepancy.

Valgus group:-

Mechanical Axial Deviation (MAD):-

Mean preoperative to postoperative changes of Mechanical AxisDeviation (MAD) from 107.5mm (range 30–300mm) lateral to tibial spine with SD ±129.71 to 11.75mm (range 6-17 mm) medial with SD ±4.11.

The case number 18 was overcorrected into varus due to negligence in patient follow up.

Medial proximal tibial angle (MPTA):-

Mean preoperative to postoperative changes of medial proximal tibial angle from 86.25° (range 77-92 °) with SD ±6.65 to 88.25° (range 86-91°) with SD ±2.63.

Anatomical Posterior Proximal Tibial Angle (Appta):-

No Mean preoperative to postoperative changes of posterior proximaltibial angle from 81° (range 67-82°) with SD ±1.14 to 81(range 79-82 °) with SD ±1.14.

Anatomical Posterior Femoral Distal Angle: (Apfda):-

Mean preoperative to postoperative changes of aPFDAfrom 68° (range 62-75°) with SD ±5.72improved to 79.25(range 76-82 °) with SD ±3.2.-

mechanical Lateral Distal Femoral Angle:(mLDFA):-

mLDFA from 72.75° (range 67-76°) with SD ±3.95 improved to 91(range 88-97 °) with SD ±4.08.

Joint Line Convergence Angle:(JLCA):-

4.6 (range 0-8°) with SD ±2.97 to 0.8(range 0-1°) with SD ±0.83

Limb length discrepancy:(LLD):-

Table 20:-Range preop (0-28) postop (0-10)

LLD	Mean±SD	P
Preoperative	19.25±12.95	
Postoperative	2.5±5	0.063

Post operative complications:-

Complications	**N(%)**
Superficial Pin tract infection	21(100)
Undercorrection	0
Overcorrection	1(4.8)
Transient peroneal nerve palsy.	1(4.8)

As per Schoenecker's criteria:-

Overall results were:

Good: 20/21; twenty patients out of twenty one had good results.

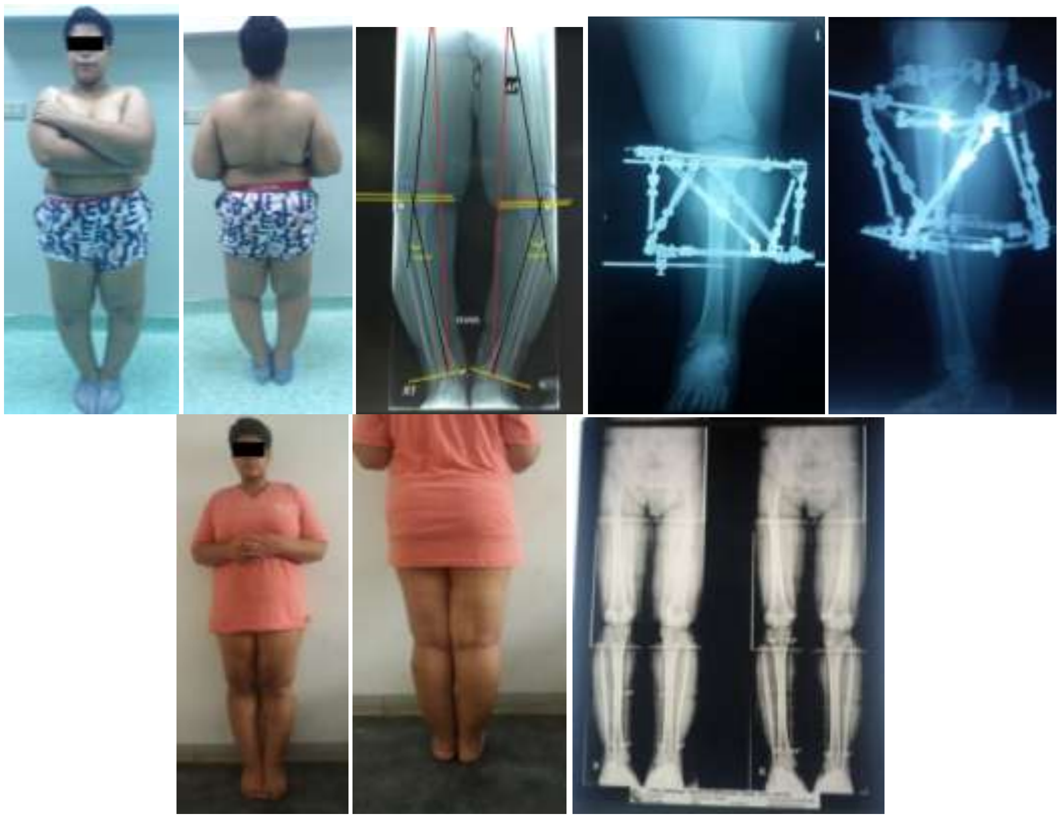
Fair: 0/21; No patient had fair result.

Poor: 1/21; one patient had poor result.

As per Schoenecker's criteria there were 95.23% good result in term of good results in terms of pain and radiological criteria in our patients, 0 % fair results and there were 4.76% poor results.

There was about 21 patients had pin site infection treated by intravenous antibiotics for about 1 week.

No cases of osteomyelitis, non-union, knee malorientation, compartment syndrome, bone grafting not required, one case has nerve palsy (Case 20)



Case of bilateral tibia vara before and after correction

Discussion:-

The main problem in the correction of complex deformities with classic circular external fixators is the modifications needed in the fixator for residual deformities that occur. On the other hand, the Taylor spatial frame can provide perfect anatomical reduction and stability with the help of the computer software in complicated deformities. The important advantages of TSF are being a very stable external fixator, correcting all components of the deformity.

Hosny used the TSF in 22 patients for the correction of lower-limb deformities including lengthening in three patients with congenitally short femurs, and deformity correction and lengthening in one with a posttraumatic femoral fracture. Although the findings from this small subgroup of patients could not be isolated, the overall results were 18 excellent, two good, and two fair. In another study, 13 of 44 TSFs were applied to the femurs of pediatric patients to address angular deformities and limb length inequalities

Eidelman et al. reviewed their experience on the use of TSF in both tibia and femur. Complications included pin tract infections in two, fracture of the regenerated femur after frame removal in two, femoral fracture after a fall in one, delayed union in one, and residual femoral deformity in a patient with skeletal dysplasia. After experiencing three fractures, the authors suggested that removing the frame relying on radiographic evidence is inadequate for determining the extent of bone healing, and advocated dynamizing the frame to prevent fractures. One way of dynamizing a Taylor spatial frame is to replace the TSF struts with Ilizarov rods and loosen them to have dynamization. Another option could be to remove one of the struts, and allow the patient full weight-bearing on the frame. Since this will break the hexagonal construct and make the whole frame unstable, removing one or more struts of the TSF is subject to fractures if the bone is not healed enough. It does not act as the dynamization in Ilizarov devices or the monolateral external fixators which brace the regenerate while allowing the patient to fully weight bear. In our series we did not have any fractures related to early frame removal or dynamization.

Metin KUCUKKAYA, et.al. studied correction of complex lower extremity deformities with the use of the Ilizarov-Taylor spatial frame, The mean duration of external fixator was 24.5 weeks (range 18 to 37 weeks) in 13 tibial and five femoral segments. In all cases, correction was applied until the mechanical axis reached normal limits. Complete consolidation was achieved in all osteotomized bone segments.

Haridimos Tsibidakis, evaluates the use of the Taylor Spatial Frame (TSF) for the correction of acquired and congenital tibial deformities in children. 86 tibia deformities were corrected in 66 children during a period of 7 years and were classified according to anatomical and dominant type of deformity. Follow up was 54.2 months. Gradual correction was performed according to the individualized time schedule. Significant correlation was found between patient's age and number of difficulties.

Mohammed Anter Meselhy evaluate's management of adolescent tibia vara using Taylor Spatial Frame "TSF" in seven males and four females with a final follow up (average 15 (±2) months), the mean post-operative mPTA was 87 (±4) degrees (range 81 to 93 degrees), where the mean preoperative mean mPTA was 68 (±9) degrees (range 49 to 77 degrees) (p value 0.003). The mean postoperative MAD was 12.2(±11.4) mm, range (-1 to 26 mm), where preoperative mean MAD was 75.7(±14.7 mm), range (60 to 107mm) (p value 0.003). The mean postoperative PPTA was 80(±2) degrees, range (77 to 83 degrees), while the preoperative mean PPTA was 72 (±12) degrees, range (42 to 82 degrees) (p value 0.028).

Keshet D, Eidelman M studied clinical utility of the Taylor spatial frame for limb deformities, and conclouded that standard TSF with 6 oblique struts fixed on to bone model can provide comparable stiffness on axial loading and better stiffness on torsional loading to conventional Illizarov external fixator " IEF " with 4 threaded rods. The mechanical properties are theoretically favorable for both fracture healing and new bone formation. Changing to stronger hollow connecting bars or increasing the number of threaded rods did not significantly increase the stability against torsional forces. That findings suggest that TSF may provide a better alternative to conventional IEF as far as mechanical property is concerned.

In general, despite many challenging cases, our results are comparable to the good results achieved by other published series of TSF treatments.

Obvious disadvantages of TSF are a deficit of small rings and struts for the correction of deformities in small children, which is otherwise difficult or impossible. Another problem is the high cost of TSF equipment.

Nevertheless, in our opinion, TSF is the most accurate and stable fixator available today, with a relatively short learning curve.

Instability because of using only two rings and few pins was never seen in our patients. TSF gives excellent stability. Based on our results, we think that the TSF allows safe gradual correction and is accurate and well tolerated. Our results compare favorably with the published literature.

The results overall were good.

We now use the TSF as the first line of treatment of complex lower limb deformities.

Conclusion:-

We believe that the TSF is an excellent tool for the correction of multiple plane deformity around the knee joint in children and adolescents and significantly expands our ability to correct precisely the most difficult deformities.

References:-

1. **Fadel M, Hosny G.** The Taylor spatial frame for deformity correction in the lower limbs. Int Orthop 2005; 29(2): 125-129.
2. **Kucukkaya M, Karakoyun O, Armagan R.** Correction of complex lower extremity deformities with the use of the Ilizarov-Taylor spatial frame. Acta Orthop Traumatol Turc 2009;43(1):1-6.
3. **Eidelman M, Bialik V, Katzman A**. Correction of deformities inchildren using the Taylor Spatial Frame. J Pediatr Orthop B.2006; pp 15:387–395.
4. **Haridimos Tsibidakis, Anastasios D. Kanellopoulos**: The role of Taylor Spatial Frame for the treatment of acquired and congenital tibial deformities in children *Acta Orthop. Belg.*, 2014, **80**, 419-425.
5. **Mohammed Anter Meselhy** Management of adolescent tibia vara using Taylor spatial frame *Acta Orthop. Belg.*, 2016, **82**, 745-753.
6. **Keshet D, Eidelman M,** Clinical utility of the Taylor spatial frame for limb deformities, 2017 Volume 2017:9 Pages 51-61.