Functional Bracing in the Mangment of Diaphysial Fractures of Tibia

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ABSTRACT:

BACKGROUND:

Tibia is the most commonly fractured long bone in the body, because its particular blood supply and high complications rate we always try to find out the best method to manage such fracture with minimal disturbance to its blood supply and early mobilizations. The fracture brace is one of the best methods of treatment of fractures regarding safety and early mobilization. We used the brace in closed and compound (Gustillo I and II) in adult, and shows its advantage over other methods regarding safety, mobility, and low complication rate.

PATIENTS AND METHODS:

Nineteen patient with tibial shaft fracture was investigated during the treatment with tibial castbrace Fractures were classified according to AO/ASIF classification.

Patients were treated primarily by back slab followed by plaster application from toes to above the knee Fracture brace was applied after the pain and swelling had subsided. Serial x-ray films were taken regularly in a fixed dates to observe and prevent any unacceptable misalignment cast brace was discarded after union, when it found safe to walk independently**.**

RESULTS:

The average time needed for application of the cast after injury was (4.8) weeks for closed fractures and (6.1) weeks for open Fractures. Union occurred in an average of (17.2) weeks for type A1 (AO/ASIF), (16.2) weeks for A2, and the longest healing time (22.2) weeks was obtained in type C .Neither a significant shortening was obtained with a range of (8.6-13.4 mm.) nor an angulations range of (1-7.5°) if compared with the acceptable figures .

CONCLUSION:

Functional bracing is another method in accomplishing the goal of early introduction of function after bone union . It does not replace other methods of treatment which have its specific indications. Functional bracing is successful in type A, and can be used in type B and C of AO/ASIF classification .The misalignments obtained are mostly within acceptable range if compared with the standard figures.

KEY WORDS :tibia, castbrace, misalignment .

INTRODUCTION:

We have still along way to go before the best method of treating a fracture of the shaft of the tibia can be stated with finality. Sir John Charnly. [(1)] The goal in treatment of tibial shaft fracture is attainment of bony union with a resultant fully functional and painless extremity. This is achieved by obtaining and maintaining an acceptable reduction of the fracture fragments. Fracture bracing is a non operative treatment of fractures using braces. This method is thought to have originated in the medical school of ancient china, and has been reintroduced by Dehne, Sarmiento, and Latta [(2)]. Closed treatment with functional bracing is an effective method for many tibial shaft fractures that avoids the potential complications of surgical intervention. The principle is that; in the closed system of the brace the dislocating forces are transformed into compression forces activated by the muscles, if closed treatment is to succeed, the cast or brace must maintain acceptable fracture alignment and the fracture pattern must allow early weight bearing [(3)]. Conservative treatment of a fracture by brace is governed by generally accepted principles; in the first place absolute rest in the fractured region by inactivating the injured limb and adja cent joints. Hence, delayed healing of

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a fracture and formation of psuedoarthrosis are attributed to shear forces. On the other hand, the non surgical functional fracture treatment developed by Sarmiento, considered unrest in the fractured area as an essential stimulus to osteogenesis of the Fracture bracing is not a panacea and the application of technique must be preceded by a clear understanding of its rationale, indications, considerations, limitations and contraindications. [4]

THE AIM OF THE STUDY

Is to evaluate the union rate, and alignment in treatment of low energy fracture tibia in adult by the functional brace.

PATIENTS AND METHODS:

Nineteen patients with tibial shaft fracture have been treated by cast bracing in Al-Yarmouk teaching hospital; department of orthopedics and fracture surgery, during the period from June 2004 to January 2007.

The age of the patients ranged from 17 yrs to 45 yrs, with mean of 29 yrs. twelve patients were males and seven were females. The majority of our patients were initially treated in, after being referred from our emergency room. The remaining patients received their initial care elsewhere and were referred to us for follow up, many patients involved in high energy accidents with multiple injuries, Fractures were classified according to AO/ASIF classification(Tab1), and those with ipsilateral femoral fracture were often managed by operative stabilization of their fractures, others who were excluded from our study:

1. Fractures with neurovascular injury.
2. Fractures with compartment syndrome.
3. Open fracture with sever soft tissue loss.
4. Diabetic patients with neuropathy.
5. Ipsilateral femoral fracture.
6. Multiple injured patients.
7. Fracture with incomplete follow up.

Most of these patients were assessed in the emergency room for general condition, other associated serious injuries, and neurovascular injuries, x-ray films of two film anteroposterior and lateral views were taken for the fractured limb, and back slab was applied initially for closed fracture, which was changed to long leg cast from the groin to the toes with manipulation under anesthesia for displaced fractures, and under analgesia for undisplaced fractures, the cast was applied with knee flexion of fifteen degree and neutral ankle joint or slight equines about ten degree to control the posterior angulations in some cases .Open fracture was treated by irrigation and wound debridement, and if the soft tissue cover is adequate the cast was applied with window over the wound has been done, antibiotics was administered for 72 hours. All patients were instructed to elevate the limb and never dangle it, with passive and active exercises from the start to control the swelling and decrease the pain .When the acute pain and swelling subsided, the functional brace was applied originally orthoplast (Johnson and Johnson)braces were molded individually, or prefabricated or a custom made polypropylene braces and simple modification can be made to accommodate any patient who is hard to fit (Fig 1a-d). The brace should be extend from just below the patella to above the malleoli with smooth trim end, foot piece was added in some cases to control rotation, slight correction of alignment was done during the application of the brace, it should be fit snugly but not so much to restrict venous return. Walking was permitted after the bracing with two elbow crutches with partial weight bearing which was increased gradual Patients were taught how to fit the brace and how to change the sockets or the bandage and how to care of the wound, the patient had been seen after a week to show him how to take care of the limb and how to apply the brace. Serial x-ray films were taken in day 15, one month, and two month, to check the alignment, angulations of the fragments and union [2] .

Union was defined as the time when bridging callus was identified radiological, and the fracture site was painless during weight bearing, brace was then discontinued.

RESULT:

The mechanisms of injury were mostly due to gunshot and pedestrian motor vehicle accident as shown in(Tab 1). There were seven (36.8%) cases with open fractures and those were classified according to Gustillo classification; five (26.3%) of them were type I and two (10.4%) type II.

The average onset of application of the brace after the injury was in average of 4.8 weeks for closed fracture range from (3-6 weeks), and of average of 6.1 weeks for open fracture range from (4-8 weeks). Segmental fracture required the longest period of immobilization about 6.8 weeks . Union occurred in all our cases in an average duration of 18.6 weeks range (7-30 weeks). In closed fracture it was about 18.1 weeks from (6-26 weeks), while in open fracture it was about 21.1 weeks range from ((7-30 weeks). This included two cases of delayed union Fig (3). Fractures were classified according to AO/ASIF classification (Tab2) .Union was in average of 17.2 weeks in type A1 (AO/ASIF). 16.2 weeks for A2, and the longest

time to union 22.2 weeks found to be in type C1 fig (4),

four of our cases had intact fibula, two were of type A1, one was of A2, and one was of A3. Most of fracture sites in our study was midshaft tibia as shown in table (5).Midshaft fracture united in average of 18.1 weeks, distal third in average of 18.5, proximal third was in average of 18.9 weeks, while in segmental fracture an average of 19.6 . There was no significant shortening in our cases with average of (9.7mm) with a range of (5.6-13.4). On the final assessment there were eight cases (42%) healed with angulations. Five of them were varus angulations approximately (25%), one case was with valgus angulations (5%), and two cases approximately (10%) with posterior angulations and there were no malrotations (Fig6). No skin maceration under the brace was observed. No infection was discovered in closed fractures and only one case with open fracture developed a superficial infection which had been responded oral antibiotics.

DISCUSSION:

Success with the use of functional bracing is dependant on a clear understanding of its principle and rigid adherence to the mechanical details .

The extent of injury to the soft tissue surrounding the fracture site provides the key to fracture alignment and healing . [17,18]

The degree of soft tissue injury appeared to have most influence on the speed of fracture healing .

Fracture comminution , initial displacement , condition of the fibula and the time from injury to bracing also appeared to affect the seed of healing. Angulations at the fracture is prevented by the encasement of the soft tissues around the fracture site by the brace .Sarmiento ,Gersten and Sobol agreed that varus and posterior angulations were the most common deformities encountered at union [11].

We achieved low rate of angulations (42%) of cases compared to various studies presented by Sarmiento et al where there is between (67.1-90%) of cases showed angulations deformities. between (6-8°).(5,6,7,8,9)(Our studied cases showed up to 7.5° varus angulations in 50% of cases, and (3-5º) valgus , (5-7.5°) posterior angulations each in 25% of cases.(Fig 8) .We found that the higher rate presented in our series (50%) was varus angulations is due to the presence of intact fibula which is a relative contraindication to fracture bracing [8] .

Bone shortening is determined by the degree of soft tissue damage at the time of initial injury and neither increased by weight bearing nor it is affected by bracing [10,6,8,18,19].We have estimated the range of shortening of tibia betwee (5.6-13.4mm.) with an average of (9.7mm.) .Sarmiento has given different figures for shortening of tibia in his various studies ranging between (0-25mm.) ,but he stressed on the acceptable shortening to be not exceeding 12mm. [11,10,5,6,12,7] .

The acceptable amount of shortening is controversial , Sarmiento and Latta strived to achieve less than 8º angular deformities in any plane in 90% of his studied cases, 95% of fractures healed with less than 12mm. shortenings [7] .

Average time for application of the brace after injury was 4.8 weeks for closed fractures and 6.1 weeks for open fractures which showed no big difference from figures given by Sobol and Sarmiento with average time of 3.9 weeks for closed fractures and 5.0 weeks for open fractures [8].

Early motion with functional brace seams to lead to more rapid callus formation ,to avoid joint stiffness and muscular atrophy [20,21,22] .Suman R.K. reported that cast brace minimize the incidence of joint stiffness and allows for rapid bone healing [13] .Pun W.K. and Chow S.P. stated that although the stiffness decreased with time a significant number of patient were left with some residual joint stiffness [14] .It seems that we are lucky to accomplish our study with no appreciable joint stiffness in our patients .

The average time for union for fracture tibia is difficult to establish since an adequate definition of fracture has not been agreed .There is always clearly a delay of union for open (compound) , fracture with average 21.1 weeks as compared with the closed one 18.1weeks .This is certainly due to high energy force the open fracture has been exposed to , as has been clearly shown in our study ,where the union average was 17.2 weeks type A1 (A.O. classification) and the maximum average time to union (23.3) weeks were found in type C . (Fig 4) .

No significant deference between the sites of fractures regarding the speed of healing (Fig 5) .There was no association between the age of the patients and the speed of healing, Therefore neither the age of the patient nor the location of the fractures have any influence on the speed of healing or the occurrence of nonunion (12,7) , as there is no case of nonunion was demonstrated in our series , though we have two cases of delayed union attributed to other causes like the degree of soft tissue injury (Fig 3) .

CONCLUSION:

- Fracture management is not altogether a new concept but a system of applying time honored principles through modern technological means, functional fracture bracing is simply another step in accomplishing the goal of early introduction of function.
- Braces replace the cumbersome casts and splints; they are designed to be light weight, small, cosmetic, not very embarrassing to the patient and compatible with normal garments .
- Fracture bracing does not replace other methods of treatment which have specific indications .Bracing of fracture tibia is successful in type A, and can be used in some of types B and C, when the alignment can be maintained in initial reduction.
- Soft tissue status in the fracture site is the most important factor in using the brace.

Table (1): Mechanism of injury

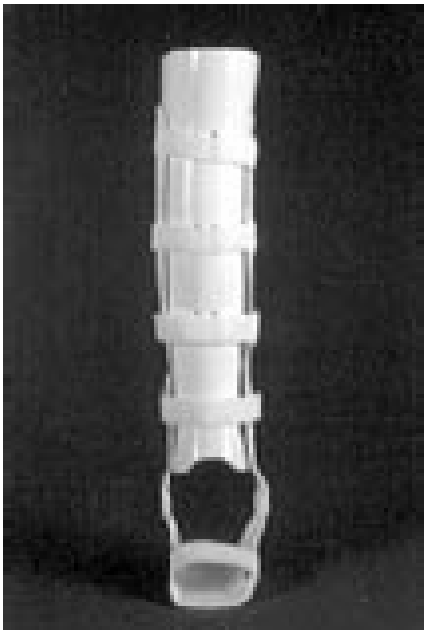
Mechanism of injury	No.	%
Gunshot	6	31.5
Pedestrian vehicle accident	5	26.3
Motor vehicle accident	4	21
Fall from height	3	15.7
Others	1	5.2
Total	19	100

Table (2): Types of fractures AO/ASIF classification

Type of fracture	No.	%
A1	5	26.3
A2	6	31.5
A3	3	15.7
B1	3	15.7
C1	2	10.4
Total	19	100

Table (3):Fracture site

Site	No.	%
Proximal	3	15.7
Midshaft	13	69.6
Distal	3	15.7
Total	19	100



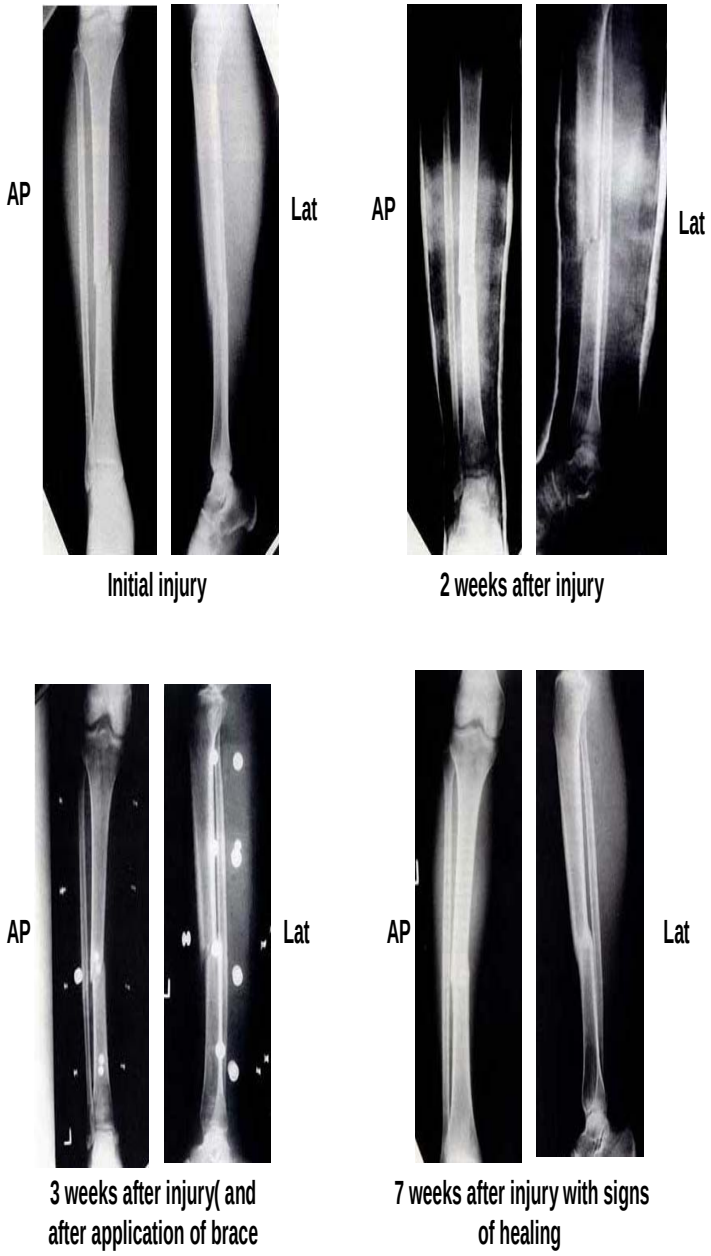
(1a)

(1b)

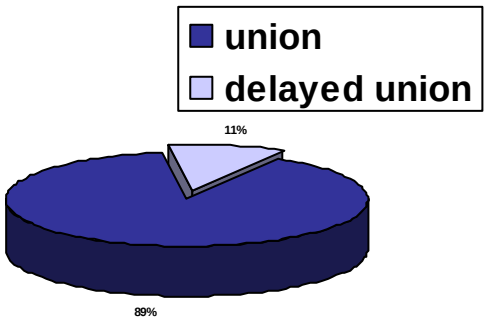
(1c)

(1d)

(Fig.1a-d): The castbrace



Serial X-Ray Films (Fig 2) left – right, up - down



Fig(3):Pie chart showing distribution of union

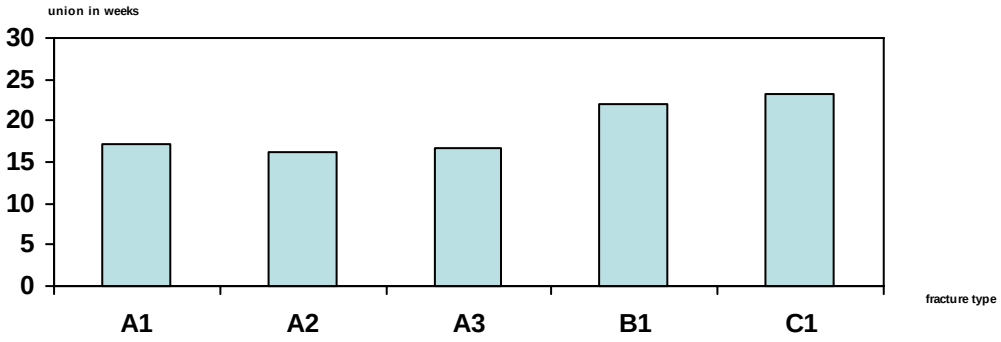
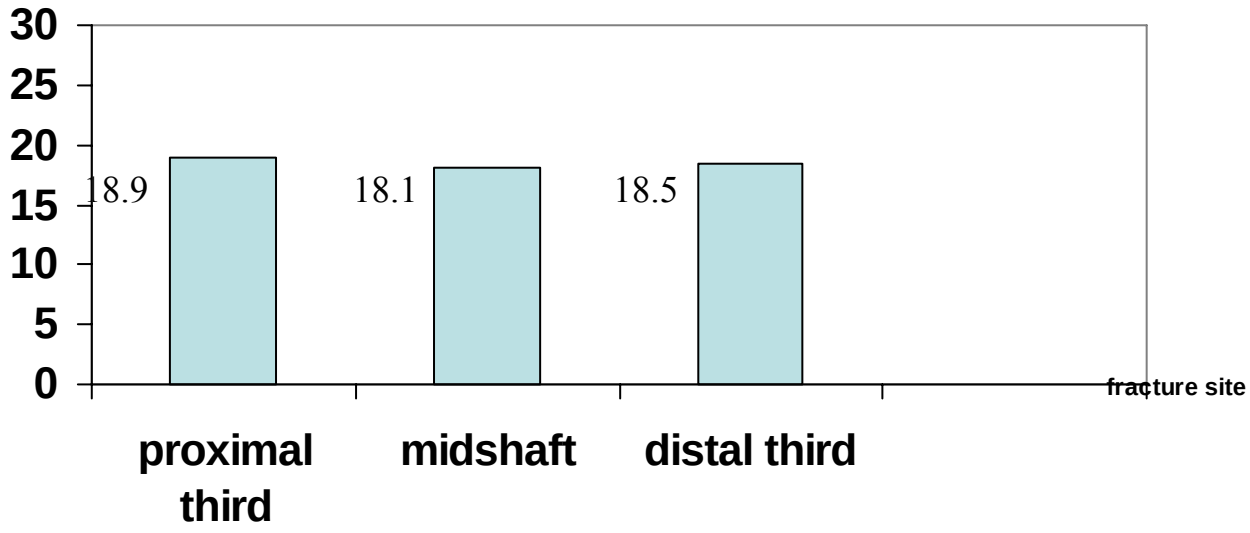
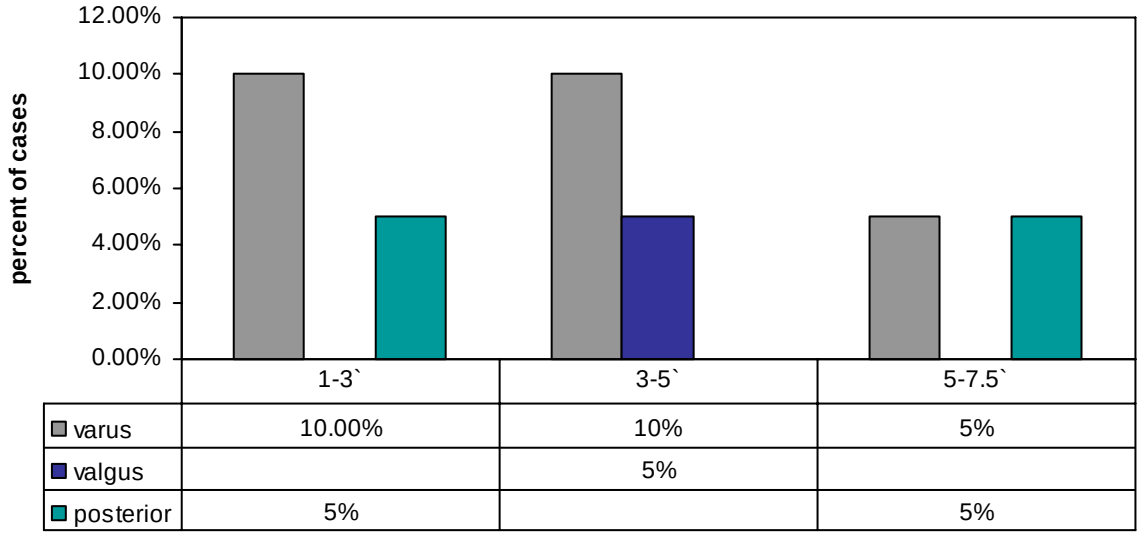


Fig (4):Time of union related to Fracture



Fig(5): Rate of union in weeks related to fracture



Fig(6): Degrees of Angulations

REFERENCES:

1. Watson Jones .R . "Fracture of shaft of long bones with displacement " Churchill Livingstone 1998;10th.ed.,12,1078 .
2. Hackstock H "Functional bracing of fractures" Orthopedics 1988 ;17,41-51 (abstract) .
3. Terry Canale S.: "Tibial shaft fracture" . Campbell's Operative orthopedics,,2003; 51 ,2754-2782, 55,3082-3087, 56, 3125-3141.
4. Balfour GW; Mooney V., Ashby MF. "Diaphyseal fracture of the Humerus treated with a ready made fracture brace " .JBJS Am. 1982; 64,11-3 .
5. Martinez A; Sarmiento A; Latta LL "Closed fractures of the proximal tibia treated with a functional brace" Clin Orthop Relat Res. 2003;417,293-302 .
6. Sarmiento A; Latta LL" Functional fracture bracing". J Am Acad Orthop Surg. 1999;7,66-75 .
7. Sarmiento A; Sobol PA; Sew Hoy AL; Ross SD; Racette WL; Tar RR "Prefabricated functional braces for the treatment of fracture of the tibial diaphysis" J bone Joint Surg Am.1984;66,1328-39 .
8. Sarmiento A; Sharp FE; Ebramzadeh E; Normand P; Shankwiler J "Factors influencing the outcome of closed tibial fractures treated with functional bracing" Clin Orthop Relat Res. 1995;(315),8-24 .
9. Sarmiento A; Latta LL" 450 closed fractures of distal third of the tibia treated with functional brace". Clin Orthop Relat Res.2004;428,261-71 .
10. Sarmiento A." On the behavior of closed tibial fractures: clinical/radiological correlations" .J Orthop Trauma 2003;14,199-205 .
11. Sarmiento A; Gersten LM; Sobol PA; Shankwiler JA; Vangsness CT ,"Tibial shaft fracture treated with functional braces. Experience with 780 fractures." J Bone Joint Surg Br. 1989;71,602-9 .
12. Sarmiento A; Burkhalter WE; Latta LL" Functional bracing in the treatment of delayed union and non-union of tibia" Int Orthop.2003;27,26-9 .
13. Suman RK." Functional bracing in lower limb fracture". Ital J Orthop Traumatol .1983; 9,201-9 .
14. Pun WK; Chow SP; Fang D ; Ip FK; Leong JC ;Ng C."A study of function and residual joint stiffness after functional bracing of tibial shaft fractures". Clin Orthop Relat Res. 1991;,267,157-63 .
15. Beaty JH. (Ed) Orthopedic knowledge update .American academy of orthopedic surgeon,2002;7 ,3-31 .
16. Sarmiento A; Latta LL; Tar RR . "Principles of fracture healing part II. The effect of function on fracture healing and stability" . Instructional course lectures presented at 51st American academy of orthopedic surgeons meeting. Louise CV Mosby 1984 .
17. Sarmiento A; Swettoy AL; Sobol RA; Ross SDK; Racett W." Prefabricated functional braces for the treatment of tibial fractures". J bone Joint Surg.1985 ;66 Am:1328-34 .
18. Sarmiento A; Latta LL; Ziliot A; Sinclair WF. "The role of soft tissues in the stabilization of tibial fractures ".Clinic orthop Relat Res.1974;105,116-21 .
19. Wagner K; Tarr RR; Resnick C; SArmiento A. "The effect of simulated tibial deformities on the ankle joint during gait cycle" Clinical orthop relat Res .1988;5,131-41.
20. Sarmiento A; Kinmann PB; Galvin EG; Schmitt RH; Philips JG ."Functional Bracing of fractures of the shaft of humerus " J Bone Joint Surgery.1977;59 Am,696-702 .
21. Sarmiento A: Schaefer JF; Beckerman L; Latta LL; Enis JE." Fracture healing in rat femora as affected by functional weight bracing" J Bone Joint Surg .1977;59 Am,369-75 .
22. Sarmiento A; Latta LL." Closed functional treatment of fractures " Berlin etc; Springer-Verlage,1981;3,382-94 .
23. Zyek GA; Zagorosky JB; Latta LL; McCullough NC II." Modern concepts in functional fracture bracing of lower limb.AAOS .instructional course lectures .St. Louis ,CV Mosby Co. 1987;5, 403-24.