Functional Cast Bracing in Selected Cases of Tibial Shaft Fracture in the Population of Odisha - A Prospective Study

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ABSTRACT

BACKGROUND

Tibial shaft fracture is one of the commonest fractures encountered in orthopaedic clinics today. With recent trend being surgical management, it has increased the economic burden in developing countries like India. Thus, interest in functional cast bracing can manage many of the fractures safely with less cost and shorter hospital stay with equally good results.

METHODS

This prospective study included 30 patients with closed tibial shaft fracture with minimal displacements who were treated with 3 weeks of initial long leg cast followed by functional cast bracing as described by Sarmiento in 1967 with a below knee patellar tendon bearing (PTB) cast with encouraged progressive weight bearing for 6 to 9 weeks. Our goal was to achieve shortening of < 10 mm, angulations of less than 5 degrees in any plane with full range of motion at knee as per Sarmiento.

RESULTS

Union was seen in 25 (83 %) cases. Angulations of < 5 degrees was noted in any plane in 79 % cases. Varus and apex posterior angulations were the most common deformity. Shortening 10 mm was noted in 72 % cases with almost complete ROM of knee joint in all patients. Non-union was noticed in 2 (7 %) cases.

CONCLUSIONS

Functional cast bracing can still be an ideal method of management for many of the tibial shaft fractures and with better understanding of the technique and proper application, it can safely be used on other long bones as well.

KEYWORDS

Closed Fracture Tibia, Functional Cast Brace

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BACKGROUND

Talking about conservative management of any fracture in present day of medicine sounds foolish, but a surgeon who is experienced in this field undoubtedly believes and accepts nonoperative or conservative management as an ideal modality of treatment, provided the decision taken should be judicious enough to justify it.

Tibia is probably the commonest bone of the body that has been experimented with all sorts of methods of fracture fixation starting from a simple cast to recent trends like intra medullary (IM) nails and plates. Its incidence is 19.6 for one lakh population with AO type 42 – A-1 being the most common type with 34 % of all types of tibial shaft fractures. Males are more commonly affected, 21.5 as compared to females, 12. 53 per one lakh population with peaks in 10 - 20 years age group in males and 30 - 40 years in females.[1]

Conservative treatment with toe to groin long leg cast is still an accepted method by many surgeons.[2] Newer techniques of open or close reduction and internal fixation with plates or IM nails are the most acceptable modalities of management in present day orthopaedics.[3,4] An alternative form of management is external fixation as it allows joint motion with immobilisation of the fracture fragments.[5]

All the methods have their own pros and cons. Conservative management is associated with malunion and stiffness of the joints that needs prolonged rehabilitation, whereas surgery has its own complications like infection, osteomyelitis, nonunion, implant failure and is costly.[6,7,8]

As joint motions and normal function is restricted in plaster cast, upgrading it by use of functional cast brace after subsidence of acute symptoms as described by August Sarmiento in 1967, perfect healing of fracture along with preservation of joint function with much cheaper cost than any surgical method can be achieved.[9]

The philosophy of functional bracing is based on "inner splint" caused by circular compression to the muscular compartments which in conjunction with external stabilisation, functional bracing and effects of gravity leads to fracture alignment. Thus, immobilisation of adjacent joints is unnecessary rather early functional activity and active contraction of the muscles around the fracture leads to physiologically controlled micro motion. There is increased blood flow and mineral deposition at the fracture site. These factors appear to stimulate osteogenesis and provide a desirable physiological environment conducive to rapid healing. Hence, braces don't immobilize joints or fracture fragments but control fracture range of motion and encourage the patients to progressively increase the weight bearing on the affected extremity thus aids in rapid healing of the fracture without stiffness of the joints.[10]

This study was undertaken to apply the principle of functional bracing in selected cases of tibial shaft fracture and to assess its efficacy in terms of union time, malalignment, shortening and adjacent joint motions, with a presumption to recommend it as still a modality of management in the era of operative surgery in orthopaedics.

METHODS

This prospective study was conducted from December 2017 to December 2019 after obtaining the institutional ethical committee clearance and written consents from the patients. This included 30 patients [$n = z^2pq / d^2$, z-confidence coefficient = 1.96, p-proportion of outcome 0.5, q (1 - p) = 0.5, d-absolute precision 0.2, n = 24. With expected 25 % drop out (= 6) total sample size = 24 + 6 = 30] of more than 18 years of age who were able to understand and speak local languages with unilateral closed undisplaced or minimally displaced tibial shaft fracture of less than 10 days duration with ipsilateral fibula fracture. Convenience sampling was done as per the availability and accessibility of the patient. Bilateral fracture, open fracture, fractures associated with neurovascular complications and patients with poly-trauma, chronic illness or bed ridden patients were excluded from the study. All patients were admitted through OPD and emergency department of the institution, evaluated with routine haemogram and anteroposterior and lateral radiograph of the affected leg including knee and ankle. After studying the fracture pattern carefully, patients were enrolled for this study of initial period of conservative management followed by functional cast bracing. During acute stage, fracture was immobilised with a groin to toe long leg posterior slab for 3 days with limb elevation for subsidence of swelling. Then it was converted to a groin to toe long leg cast on the 3rd day. The patient was discharged on the 3rd day of admission with an advice to follow up after 3 weeks. Once the acute symptoms were subsided a well molded snuggly fitting below knee total contact patellar tendon bearing cast (PTB Cast) as described by Sarmiento was applied. (Figure 1).

PTB cast is a below knee cast extending to the upper pole of patella and with a firm molding over the medial flare of the tibia, the patellar tendon and popliteal space in a triangular manner of the upper end of tibia. Sarmiento in 1967 stated that PTB cast stabilised the proximal fracture fragment of tibia, left the knee free to move and allowed early ambulation as the weight bearing force should be transmitted from the ground to the proximal end of tibia, virtually by passing the fracture site and suspending the fracture fragments.[9]

But the laboratory studies revealed that neither the patellar tendon nor the tibial condyle participated in avoidance of shortening. It is the soft tissue within the closed compartment surrounding the fracture site firmly compressed by the inner walls of the brace which prevented shortening and angulations by the principle of incompressibility of fluids.[9] Thus, functional brace is an orthosis with an antero posterior prefabricated shell that is contoured to accommodate the musculature. Fracture stabilisation was accomplished via hydraulic compressive forces of the fracture surrounding soft tissue and was not dependent on the rigidity of splinting materials.

After the initial 3 weeks period of long leg cast all patients were treated with functional cast that is PTB cast up to 12 weeks. From 3 to 6 weeks partial weight bearing with brace and crutches was encouraged for minimal duration, next 6 to 9 weeks duration, weight bearing was

increased as per the patients' comfort. From 9 to 12 weeks full weight bearing with braces was advised and brace was discontinued after clinical and radiological confirmation of minimum three cortices showing union in x-ray. (Table 1)

Figure 1A. Undisplaced Fracture Mid Shaft Tibia

Figure 1B. Long Leg Cast

Figure 1C. PTB Cast

Figure 1D. Fracture Healed at 10 Weeks

Weeks	Treatment
0 - 3	Complete bed rest with long leg cast
3 - 6	Partial weight bearing for minimal duration with functional cast brace
6 - 9	Partial weight bearing for more duration with functional cast brace
9 - 12 (till union)	Full weight bearing with functional cast brace

Table 1. Treatment Protocol

All patients were followed up at 6, 12 and 24 weeks then at 3-month intervals. Range of motion of knee, angulation at the fracture site and shortening was measured after fracture union. Shortening of < 10 mm with angulations of less than 5 degrees in any plane with full range of motion at knee was our goal to achieve as per Sarmiento.[11]

Statistical Analysis

Statistical analysis was done using Microsoft Excel 2013. Mean & percentage mean was calculated from the available data.

RESULTS

Out of 30 patients, 22 (73 %) were males and 8 (27 %) were females with an average age of 36.8 ± 11 years (range 16 - 60) at the time of injury. Right side was more commonly injured, in 20 (67 %) patients than left side in 10 (33 %) patients. Road traffic accidents (RTA) was the mode of injury in 20 (67 %) patients, trivial trauma in 8 (27 %) patients and assault in 2 (6 %) of the cases. Out of 30 patients, 3 (10 %) cases were lost to follow up, 2 (7 %) cases had nonunion. Union was achieved in 25 (83 %) cases with an average period of 10 ± 2 weeks (range 6 - 14). (Table 2)

	Patients (N)	30
	Mean age (years)	36.8 ± 11 years (range = 16 - 60)
	Female patients	8 (27 %)
	Male patients	22 (73 %)
	Female: Male	1:2.75
Affected side	• Right	20 (67 %)
	• Left	10 (33 %)
Mode of injury	RTA	20 (67 %)
	Fall	8 (26 %)
	Assault	2 (7 %)
	Loss to follow up	3 (10 %)
	Non union	2 (7 %)
	Union	25 (83 %)
	Average union time	10 ± 2 (range = 6 - 14)

Table 2. Demographic Profile

Out of 25 united cases, 21 (84 %) cases united with varus angulations and 4 (16 %) cases with valgus. Less than 5 degrees of mediolateral angulation was noted in 16 (64 %) cases and 9 cases (36 %) with more than 5 degrees. For sagittal plane angulations, 18 (72 %) cases united with apex posterior angulations and 4 (16 %) cases had apex anterior and 3 (12 %) cases had no sagittal plane deformity. Less than 5 degrees of sagittal plane deformity was noted in 20 (80 %) cases and more than 5 degrees in 5 (20 %) cases. No rotational malalignment was noted in 15 (60 %) cases, less than 5 degrees in 8 (32 %) cases and more than 5 degrees in 2 (8 %) cases. Thus, overall, less than 5 degrees of deformity was noted in 79 % and more than 5 degrees in 21 % of cases. Shortening of less than 10 mm was noted in 18 (72 %) cases and more than 10 mm in 7 (28 %) cases. (Table 3).

	Plane of Deformity	Lower Limits	Upper Limits
Mediolateral plane	Varus 21 (84 %) Valgus 4 (16 %)	< 5 degrees in 16 (64 %)	> 5 degrees in 9 (36 %)
Sagittal plane	Ápex anterior 4 (16 %) Ápex posterior 18 (72 %) No deformity 3 (12 %)	< 5 degrees in 20 (80 %)	> 5 degrees in 5 (20 %)
Rotational	No deformity 15 (60 %)	< 5 degrees in 8 (32 %)	> 5 degrees in 2 (8 %)
	Overall deformity in any plane	< 5 degrees in 79 %	> 5 degrees in 21 %
	Shortening	< 10 mm in 18 (72 %)	> 10 mm in 7 (28 %)
	ROM of knee	> 120 in 8 (32 %)	> 130 in 15 (60 %)

Table 3. Angulations, Shortening and ROM of Knee

Residual stiffness is as important as union and deformity in estimating the efficacy of functional bracing and has been assessed by means of range of motion (ROM) of knee joint. No stiffness was noted in any patient with almost near normal motion in all. More than 130 degrees of knee ROM was noted in 15 (60 %) cases, more than 120 degrees in 8 (32 %) cases and less than 120 degrees in 2 (8 %) of the cases. (Figure 2).

Figure 2A. Mid Shaft Undisplaced Fracture Tibia

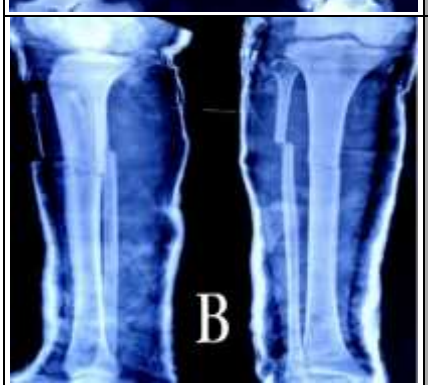

Figure 2B. Fracture with Functional Cast Brace

Figure 2C. Healed with Callus

Figure 2D. Full ROM of Affected Leg

DISCUSSION

Sarmiento et al. (1989) with his results of fracture with functional bracing for 780 tibial fractures noted average period of union as 17.4 weeks for closed fractures and 21.7 weeks for open fractures with 90 % of less than 10 mm of shortening and nonunion in 2.1 % cases. Varus and posterior angulation were the most common deformity pattern.[11]

Figure 3A. Mid Shaft Displaced Short Oblique Fracture

Figure 3B. With Long Leg Cast

Figure 3C. Fracture in Functional Cast Brace

Figure 3D. PTB Cast Brace

Figure 3E. United Fracture

Figure 3F. Function of Affected Leg

Digby JM et al. (1983) in 103 patients of tibia fracture treated with functional brace found full range of motion in all patients with average shortening of 0.5 cm and angulations greater than 10 degrees in one patient.[12]

Sarmiento et al. (2008) published results of segmental tibia fracture treated with functional brace. All fractures healed with a median time of 15.3 weeks, less than 5.9 degrees (0 - 19) angulations noted in mediolateral plane and average shortening of 4, 3 mm.[13]

This study showed union in 83 % cases with less than 5 degrees of angulations in any plane in 79 % and varus and apex posterior angulations were the most common deformity. Shortening of 10 mm was noted in 72 % cases with all most complete ROM of knee joint in all patients and nonunion noticed in 2 cases. (Figure 3)

The result of this study was lower than other studies as described above. This was due to smaller number of cases enrolled in this study and only selective cases were included. Among these patients very few of them actually accepted conservative management over surgical treatment.

None of the patients had any issues regarding pain or stiffness of knee joints and thus had high level of satisfaction when treated with functional bracing which was also much cheaper than surgery. Deformity of less than 5 degrees and shortening of less than 10 mm was not encountered due to the remodeling potential of bone. Rest of the patients were happy with mild shoe raise on the affected limb without noticeable limping. Two cases with nonunion (no union after 9 months) were managed surgically with IM nail and bone grafting. In rest of the patients functional bracing was a boon economically with high acceptance rate and early return to work without surgery.

CONCLUSIONS

The recent interest in functional bracing is undoubtedly the reflection of the economics of the medical care especially in a developing country like ours and innumerable complications of surgery like infection, nonunion and implant failures witnessed by senior surgeons. This study recommends judicious case selection and sound knowledge of the technique as many of the tibial shaft fractures can safely be managed with functional bracing with very good results keeping surgical interventions reserved for more specific indications or complications.

Limitations

The results of this study were not compared to other studies and the results can be improved by further research with a greater number of cases enrolled. Comparison of results with operative methods can confirm the results more accurately to accept this treatment as a modality of management.

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