Original Research
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Outcomes of the isolated closed tibial shaft fractures treated nonsurgically

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Abstract

Background: Fractures of the tibia are important for their commonness and controversy in their management. Both conservative and surgical techniques have been introduced in an effort to speed time to union while minimizing the occurrence of complications. Standard treatment for low-energy tibial shaft fractures includes closed reduction and cast immobilization. The purpose of our study was to analyze retention of reduction after cast immobilization of simple isolated closed tibial fractures.

Methods: All cases of the diagnosed isolated closed tibial shaft fracture treated non-surgically at Shafa Yahyaeian Hospital, between 2006 and 2009 were retrieved from medical records. We reviewed all medical records and radiographs of these patients to inquire about the patients' demographic data used to analyze the outcomes of the non-surgical treatment.

Results: Of the 26 patients examined, males were more commonly affected. The mean age was 27.46 (SD=7.58). The most common causes of injury were direct blow and motorcycle to pedestrian accident. Follow-up duration for each patient had an average of 9.12 months (SD=2.36). Using AO/OTA classification, distributed as 38.5% A1.1, 26.9% A2.1 and 34.6% A3.1 fractures. Most fractures were sustained in the lower third of the tibia (53.85%). All fractures eventually healed in an average of 13.7 weeks (SD=3.24). There was one case of delayed union in the 22nd week. In 92.3% of patients, shortening of bone was less than 1 cm, while in 7.7% patients, was more than 1.5 cm. We observed an anterior or posterior angulation > 10° in 2 (7.69%) patients. Moreover, in 4 (15.38%) patients we found varus angulation > 5°. Therefore, final deformity was observed in 8 (30.77%) patients. No patient had non-union, rotational malalignment of more than 10 degrees, an infection, or a compartment syndrome.

Conclusion: Our non-surgical treatment's outcomes were not satisfactory, despite applying all principles for conservative treatment and selecting patients satisfying restricted criteria. Moreover, considering long-term physical disability with longer follow-up period, it seems that there still is a controversy in the treatment selection even for the simple tibial fractures.

Keywords: Tibial shaft fractures, closed fractures, nonsurgical treatment, cast treatment.

Introduction

Fractures of the tibia are important for two reasons. First, they are common; and the second they are controversial *1*]. Due to its superficial location, the tibial shaft represents the most common site of long-bone fractures.

Management of tibial shaft fractures is often complex and disagreement exist about the optimal method of treatment. Both conservative and surgical techniques have been introduced in an effort to speed time to union while minimizing the occurrence of complications. Standard treatment for low-energy tibial shaft fractures includes closed

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reduction and cast immobilization 2,5. However, in many studies it have been shown that immobilization in a plaster cast cannot guarantee sufficient stability for all low-energy fractures 68. Factors which may influence the outcome include the morphology of the fracture, soft tissue damage and an intact fibula 1.

Current recommendations for the management of open tibial shaft fractures support operative care 9,10. For surgical management of closed or open tibial shaft fractures, the preferred approach is intramedullary nailing, with large preference split between reamed or undreamed nailing 11. Plating is the most difficult method for treating tibial fractures. However, in recent years application of percutaneous plating has been proposed by Oh et al. with satisfactory results 12.

The aim of our study was to analyze retention of reduction after cast immobilization of simple isolated closed tibial fractures. We retrospectively reviewed radiographs and medical records from a time-period when the treatment of choice still was a non-operative attempt in case of closed fractures. The degree of displacement on the initial radiographs has been also analyzed as a potential predictor of successful retention.

Methods

All cases of the diagnosis isolated closed tibial shaft fracture in patients 16 years of age and older treated non-surgically at the department of Orthopedics, Shafa Yahyaeian Hospital, between 2006 and 2009 were retrieved from medical records. A total of 28 patients with two-fragment isolated closed tibial shaft fracture were found to be admitted for non-operative treatment. We reviewed medical records and radiographs of these patients. However, the initial radiographs were missing for two patients and

Table 1. Patients information with various type of fractures and related parameters

CASE	Sex	Age (Yrs)	AO/OTA classification	Location of tibia fracture	Initial displacement	Follow-up (months)	Deformity
1	M	29	A2.1	Mid. third	< 25%	6	—
2	M	20	A3.1	Dist. Third	< 25%	12	—
3	M	28	A2.1	Dist. third	< 25%	8	—
4	M	30	A1.1	Mid. third	> 25%	7	Ant. angulation=12°
5	M	25	A2.1	Dist. third	< 25%	10	—
6	F	24	A1.1	Mid. third	< 25%	6	Varus = 6°
7	M	20	A3.1	Dist. Third	> 25%	8	Post. angulation=11°
8	M	19	A3.1	Dist. third	< 25%	8	Varus = 10°
9	M	28	A1.1	Mid. third	> 25%	7	Varus = 8°
10	M	22	A3.1	Dist. third	< 25%	6	—
11	M	47	A1.1	Dist. third	> 25%	10	—
12	F	32	A1.1	Mid. third	< 25%	12	—
13	M	22	A2.1	Dist. third	> 25%	10	Shortening = 1.9 cm
14	F	30	A3.1	Prox. third	> 25%	12	—
15	M	20	A3.1	Mid. third	< 25%	10	—
16	F	25	A1.1	Dist. third	< 25%	12	—
17	M	22	A3.1	Dist. third	> 25%	8	Varus = 7°
18	M	23	A1.1	Mid. third	< 25%	10	—
19	M	32	A1.1	Mid. third	> 25%	11	—
20	M	17	A2.1	Dist. third	< 25%	12	—
21	F	47	A1.1	Dist. third	> 25%	5	—
22	M	42	A3.1	Dist. third	< 25%	6	—
23	M	30	A2.1	Mid. third	< 25%	9	—
24	M	24	A3.1	Prox. third	< 25%	5	—
25	F	26	A1.1	Dist. third	< 25%	12	—
26	M	30	A2.1	Mid. third	> 25%	11	Shortening = 2.7 cm

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therefore they were excluded.

Inclusion criteria are as follows: (a) fractures with a true diaphyseal localization 14, hence, fractures involving joints have been excluded (b) fractures in C0 or C1 grades of Tscherne's classification of soft-tissue injury 13 (c) isolated closed tibial shaft fracture (d) records of patients who have been admitted for closed reduction and cast immobilization treatment. Regarding to these criteria we studied 26 patients. Utilizing patients' radiographs, the fractures were classified according to the AO classification 14. Based on criterion (c), our selected patients were type A (AO/OTA classification) which includes A1.1 spiral fracture-intact fibula, A2.1 oblique fractures-intact fibula (30° inclination or more), A3.1 transverse fractures-intact fibula (less than 30° inclination) 15. The location of the fracture has been defined as the proximal, middle, or distal third of the tibia. Initial displacement was more than 25% of the diameter of the shaft in 10 (38.5%) patients, and less than 25% of the diameter in 16 (61.5%). Patients' details are shown in Table 1.

We classified the fractures and assessed the displacement and angulation from radiographs. Displacement was described as percent of the diaphyseal width at the fracture site when measured on the radiographic view showing the most pronounced displacement (see Fig. 1) 16. The initial angulation was measured on the radiographic view disclosing the most pronounced angulation. The final result with respect to fracture position and angulation was measured on the final radiographs taken in the follow-up reviews.

The fractures were reduced if necessary, and immobilized in a long-leg padded plaster cast, in most cases under general anesthesia. Then, the initial radiographs in cast were taken. The reduction was considered acceptable if there was at least 25 percent cortical apposition, angulation ≤ 5° varus or valgus or 10° antero-posterior on the lateral film, and no more than 1.5 centimeters of shortening. The above-the-knee cast was worn for a mean of 8.7 weeks (range, 6 to 14 weeks)

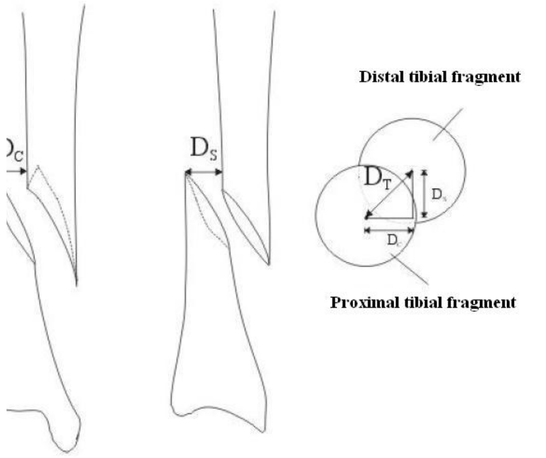

Fig. 1. True initial displacement was calculated as follows:

$D_T = \sqrt{D_C^2 + D_S^2}$ *, coronal (D_C) and sagittal (D_S) displacement measured on anterioposterior and lateral X-rays, respectively.*

20. If the fracture position was acceptable, additional radiographic examinations were done at regular intervals (1–2 weeks) until alignment accomplished. Angulation was occasionally corrected by cast wedging (2 patients). The patients were allowed to partially bear weight, in some more stable fractures, at approximately 4–6 weeks after the injury. In these cases, the knee casts were converted to below knee patellar bearing casts.

The radiographic healing was defined as presence of bridging callus as seen on both anteroposterior and lateral radiographs. Rotational alignment was assessed both clinically and with use of radiographs of the knee and the ankle. The normal union was defined as union occurring within 20 weeks and delayed union as lack of union after 20 weeks 17. A fracture that had not united at 9 months or has shown no visible progressive sign of healing for 3 months was considered a non-union 18.

Statistical Analysis: Statistical analyses are performed using the Microsoft Excel software package. Means and standard deviations (SD) are derived to describe the measured continuous data, and frequency and percentage are used to describe the qualita-

Table 2. Duration periods for union of fractures.

Weeks to union	Number of patients (percentage)
< 14 weeks	23 (88.5%)
14-20 weeks	2 (7.7%)
> 20 weeks	1 (3.8%)

tive variables of the study.

Results

Of the 26 patients examined, 20 (76.9%) were men and 6 (23.1%) women. Hence, males were more commonly affected than females. The mean age for our patients was 27.46 (SD=7.58, ranged 17 to 47 years). The most common mechanisms of injury in our selected patients were direct blow, motorcycle and pedestrian accident. Our follow-up duration had an average of 9.12 months (SD=2.36, ranged from 5 to 12 months). 26 patients were categorized as 10 (38.5%) A1.1, 7 (26.9%) A2.1 and 9 (34.6%) A3.1 fractures. Hence, the most common one was A1.1. More fractures were sustained in the lower third of the tibia (53.85%) and middle third involved in 38.46% and proximal third in 7.69%.

All 26 fractures eventually healed in an average of 13.7 weeks (SD=3.24). There was one case of delayed union in the 22nd week (see Table 2). Duration of union in patients is shown in Table 2. In 3 patients union took more than 14 weeks, with the fracture occurred in middle third occurred in 2 and in distal third in one patient. Fracture in these patients eventually healed by conservative treatment with functional brace.

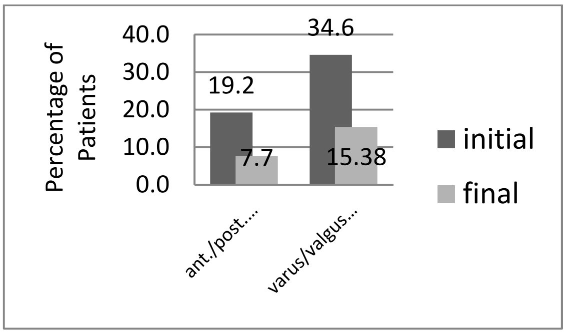

Fig. 2. Initial versus final angulations.

In 24 (92.31%) of our patients, shortening was less than 1 cm and in 2 (7.69%) more than 1.5 cm (one with 1.9 cm and the other one with 2.7 cm). We observed an anterior or posterior angulation > 10° in 2 (7.69%) patients, one with antereior angulation=12° and one with posterior angulation =11°. Moreover, in 4 (15.38%) patients we found varus angulation > 5° (with exact values 6°, 7°, 8° and 10°). Therefore, final deformity was observed in 8 (30.77%) patients. In Fig. 2, percentage of patients with initial angulation is compared with percentage of patients with final alignment.

In one patient, the refracture occurred 3 months after he was left free of plaster (because he was united), and then, he underwent for an operation. No patient in our study had non-union, rotational malalignment of more than 10 degrees, infection, or compartment syndrome. Radiographs for two cases of our patients are shown in Fig. 3

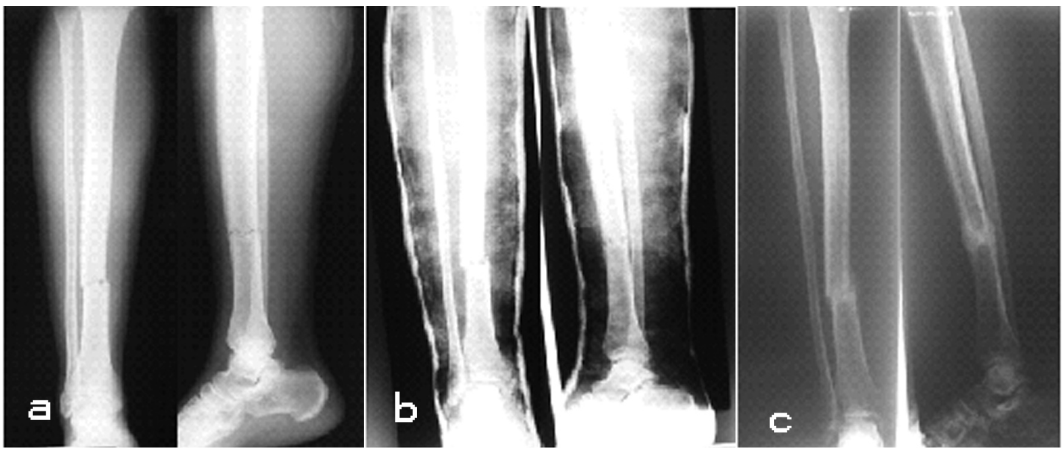

Fig. 3. Case1: 19 years old male, (a) initial radiography, type A3.1 (b) after casting, (c) after 4 months, 10° varus and 3° posterior bowing.

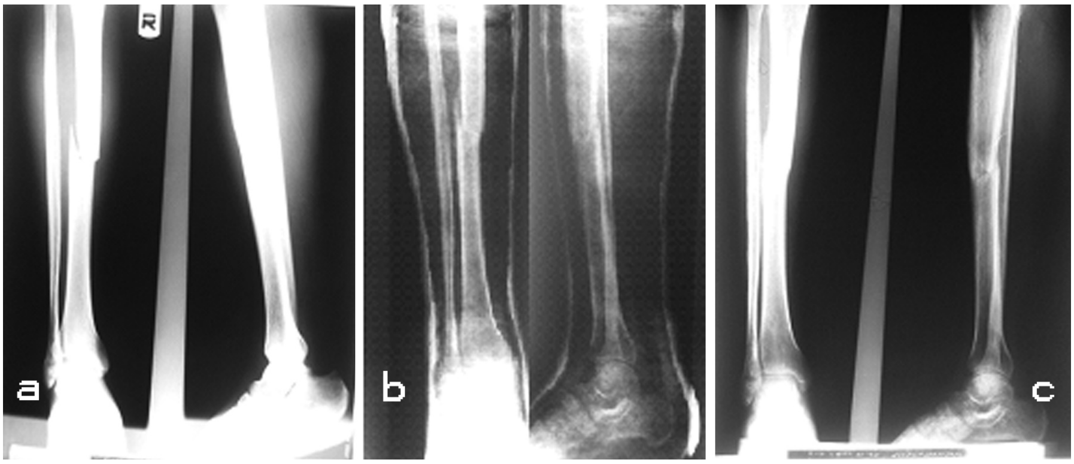

Fig. 4: Case2: 24 years old female, (a) initial radiography, type A1.1 (b) after casting, (c) after 6 months, 6° varus and 4° anterior bowing.

and 4.

Discussion

The results of this study showed that, men were more commonly affected compared to women. This result has been reported in the literature19, where the male incidence was reported 41 per 100,000 per year whereas female incidence 12 per 100,000 per year [15]. We found 27.46 years for the mean age in our patients. In the literature, the average age of a tibial fracture population was about 37 years 19. However, this age variation depends highly on the mechanism of injury. For example, it was 23.5 years for sport injuries, and 57.4 years for fallings 19.

Our patients' distribution in A1.1, A1.2 and A1.3 types is approximately similar to the result which was obtained by Borg et al. in 20. Moreover, the fracture level distribution of our work agrees with the results in the literature 21. Average time to union for the closed fractures varies in the previous studies. It was reported as 13.6 weeks by Sarmiento et al. 22, while Bone et al. achieved union in the mean time of 26 weeks in 18. Therefore, our derived 13.7 weeks for the average time to union conforms to the previous results.

Conclusion

Isolated tibial shaft fractures are complex injuries, which require long periods of convalescence, and associated with high rates of complications and secondary procedures. Treatment with plaster cast of tibial shaft fractures can be technically difficult and requires considerable skill especially when reduction is indicated. Noting the fact that most patients were young, active and healthy prior to their injury, long-term physical disability by cast treatment and longer follow-up periods could prevent their physically demanding occupations. Therefore, patients must be informed before the treatment selection.

Despite that we applied all principles for conservative treatment and selected patients satisfying restricted criteria which include isolated closed tibial shaft fractures with low grade soft-tissue injury, our non-surgical treatment's outcomes were not satisfactory (e.g., final deformity was observed in 30.77% patients). Moreover, considering long-term physical disability and longer follow-up period, it seems there still is a controversy in the treatment selection even for the simple tibial fractures. We remark that due to the few patients in our study, in order to make the results of this paper reliable for treatment guidance, further comprehensive investigations are needed.

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