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Treatment of low-energy tibial shaft fractures: plaster cast compared with intramedullary nailing

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Abstract We analyzed data from 87 patients who had displaced closed or open grade I simple or spiral wedge tibial shaft fractures caused by low-energy impact. Fifty-four patients were treated with plaster cast and 33 with intramedullary locking nail (IMLN). Delayed union only occurred in 8 patients after plaster cast treatment. Forty-two patients in the IMLN group and one in the plaster cast group suffered from anterior knee pain. Final treatment outcome, healing time, hospitalization time and duration of sick leave were assessed on the basis of 25 matched pairs of patients. Mean healing time, hospitalization time and sick leave in the plaster cast and IMLN groups were 19 (SD 6.7) and 12 (SD 4.4) weeks (P<0.001); 8 (SD 4.8) and 7 (SD 2.7) days (P=0.686); and 195 (SD 81) and 106 (SD 31) days (P=0.001), respectively. No difference was found between plaster cast and IMLN groups when the outcome was evaluated using the criteria of Johner and Wruhs.

Résumé Nous avons étudié rétrospectivement 87 malades présentant une fracture de la diaphyse tibiale avec déplacement minime ou modéré. Parmi eux, 53 ont été traités par immobilisation plâtrée (groupe 1) et 34 par un enclouage intramédullaire (IMLN) (groupe 2). Un retard de consolidation a été observé seulement dans groupe 1 (8 patients). Une séquelle douloureuse du genou a été observée chez un patient du groupe 1 et chez 42 patients du groupe 2. La durée de consolidation a été respectivement 19 (SD 6.7) semaines et 12 (SD 4.4) semaines (P<0.001), la durée d'hospitalisation 8 (SD 4.8) jours et 7 (SD 2.7) jours respectivement (P=0.686), et la durée du congé maladie 195 (SD 81) et 106 (SD 31) jours (P=0.001). En évaluant le résultat final selon les critères de Johner et Wrush, il n'y a pas de différence significative entre les deux groupes.

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Introduction

There is general agreement that the intramedullary locking nail (IMLN) is justified in the treatment of comminuted [17] and markedly displaced fractures [4, 9, 12]. However, our previous studies [20, 21] were also in favor of intramedullary nailing in the treatment of low-energy, closed or open grade I [8], simple or spiral wedge [17] fractures displaced less than 50% of the shaft diameter. To our knowledge, there are no previous studies comparing the long-term outcome after plaster cast treatment and intramedullary nailing of such fractures [18]. The purpose of this retrospective study was to compare the outcome of the plaster cast treatment and intramedullary nailing of displaced closed or open grade I, AO type 42A or stable B1 tibial shaft fractures caused by low-energy impact.

Patients and methods

In Tampere University Hospital, 210 patients who had sustained isolated and displaced, closed or open grade I [8], simple or spiral wedge (AO type 42A and 42B1) tibial shaft fractures in the mid or lower third of the tibial shaft (both tibia and fibula were fractured) were treated between 1991 and 1995 either with an IMLN or a plaster cast. To avoid the biasing effect of mixed treatment 57 patients, whose cast treatment was converted to another within 20 weeks of injury, were excluded as were 29 alcohol abusers, 10 diabetic patients, 9 mentally retarded and 3 rheumatoid patients. Fifteen patients were lost from follow-up (2 died from unrelated causes, and 13 refused to attend for review). Our retrospective material group thus comprised 87 patients, all of whom were reviewed by one of the authors (J.A.K.T). The follow-up period was at least 24 months.

After examining the present patients it proved possible to match 25 fractures treated with plaster cast to 25 treated with IMLN. The criteria used to form the matched pairs were sex and age±15 years (the patient must be at least 20 years old).

Anterior-posterior and lateral radiographs were used to determine the location, magnitude of displacement and comminution, fracture configuration, malunion and non-union. At the review visit, radiographs were taken of both legs, with both knee and ankle joint being visible. Shortening was measured with the aid of a scale on the radiograph. Rotational alignment was defined both on clinical examination and on the basis of radiographs.

Healing time was ascertained from the patient's records. In our clinic, outpatient appointments were held at 6, 9 and 12 weeks after injury. If necessary, additional appointments were arranged. In this study a fracture was regarded as clinically healed once unprotected full weight-bearing without external support was possible without pain.

The criteria for an acceptable position of the fracture were varus/valgus malalignment of 5° or less, ante-/recurvatum 10° or less and shortening 10 mm or less. Fractures caused by slipping and stumbling at ground level, falling from a height less than 3 m and bicycle accidents where no motor vehicle was involved were classified as low-energy trauma. Delayed union was defined if no radiological or clinical signs of consolidation were found at 20 weeks after injury. Criteria for acceptable knee and ankle joint range of movement (ROM) restriction were 20% and 25% compared with the contralateral side, respectively. Final results were assessed according to the system introduced by Johner and Wruhs [11], which takes functional, radiological, clinical and subjective outcome into account.

During the study period there were two treatment protocols for tibial shaft fractures being used in our clinic. At the beginning of the study period all low-energy tibial shaft fractures were treated initially with plaster cast. Gradually the treatment policy has been changed so that only non-displaced tibial shaft fractures are now treated conservatively. Regardless of the treatment modality selected, all the patients were mobilized with crutches as soon as their general condition allowed, but during the first 6 weeks they were not allowed to bear more than leg weight. Thereafter, weight-bearing was gradually increased. Whenever possible, the long-leg cast was changed to below-knee cast at 6 weeks after injury.

To describe the data, means (standard deviations) as well as medians (lower and upper quartiles) are reported for continuous variables. For categorized variables, percentages are used. In view of the slightly skewed distribution, comparison of continuous variables was done by Mann-Whitney U-test in non-matched subjects, and in matched subjects by Wilcoxon's test. For categorical variables in non-matched subjects chi square or Fisher's test are used and in matched subjects McNemar's test. Throughout the study, a *P*-value of less than 0.05 was considered significant. Statistical analyses were carried out using the SPSS for Windows program (Version 8.0; SPSS Inc.).

Results

Thirty-three fractures were treated with an IMLN and 54 with a plaster cast. Characteristics of the patients and fractures in the respective groups are presented in Table 1. At follow-up review the IMLN was removed in all cases.

Delayed union occurred significantly more frequently in the plaster cast than in the IMLN group (Table 2). Among the cast-treated patients ankle joint stiffness tended to be more frequent than among those with IMLN (Table 2). The incidence of anterior knee pain was significantly higher in the IMLN than in the plaster cast group (Table 2).

In 23 of 25 matched pairs both patients had an AO type A fracture; in 1 pair an AO type B1 fracture; and in one pair the IM nailed patient had an AO type A and the cast-treated patient had an AO type B1 fracture (*P*=1.000). In 22 pairs both patients' fractures were closed and in 1 pair the cast-treated patient had an open grade I fracture and the nail-treated patient had a closed fracture. In two pairs the IMLN patient had open grade I fracture and the cast-treated a closed fracture. Regarding the wound there was no statistical difference between the study groups (*P*=1.000). In the matched pairs no significant difference was found between IMLN and cast-trea-

Table 1 Characteristics of the patients and their clinical characteristics [mean (SD) or percent]. (*ROM* Range of movement)

	Plaster cast group *n*=54	Intramedullary nailing group *n*=33	*P* value
Age (years)	37.4 (14.5)	44.7 (12.9)	0.027[a]
Male/Female (%)	61/39	49/51	0.273[b]
Type A/type B fracture (%)	91/9	88/12	0.725[b]
Closed/open grade I wound (%)	89/11	91/9	1.000[b]
Follow-up time (months)	47 (17.0)	32 (10.8)	<0.001[a]
In employment (%)	80	91	0.233[b]

[a] Mann-Whitney U-test
[b] Fisher's exact test

Table 2 Occurrence of general and local complications in plaster cast and intramedullary nailing groups

	Plaster cast group (*n*=54) (%)	Intramedullary nail group (*n*=33) (%)	*P* value (Fisher's exact test)
Deep venous thrombosis	4	0	0.524
Pulmonary embolus	2	3	0.999
Peroneal palsy	0	3	0.379
Delayed union	15	0	0.022
Axial deformity	11	0	0.079
Malrotation	2	6	0.554
Shortening	30	18	0.312
Anterior knee pain	4	79	<0.001
Restricted ROM of knee	4	0	0.523
Restricted ROM of ankle	11	0	0.078

Table 3 Healing time, hospitalization time and sick leave in matched pairs of patients in plaster cast and intramedullary nailing groups

	Plaster cast group (n=25)				Intramedullary nail group (n=25)				P value
	Mean	SD	Median	Q1, Q3[a]	Mean	SD	Median	Q1, Q3[a]	
Healing (weeks)	19	6.65	17	15, 24	12	4.39	11	10, 13	<0.001[b]
Hospitalization (days)	8	4.8	6	5, 12	7	2.7	6	5, 9	0.686[b]
Sick leave (days)	195	81	180	124, 247	106	31	105	90, 131	0.001[b]

[a] Lower (Q1) and upper (Q3) quartiles
[b] Wilcoxon's test

ted groups when treatment outcome was assessed according to the classification of Johner and Wruhs [11] (P=0.146). There were 21 pairs in which both patients were in employment. Of these, in 8 pairs both patients were engaged in heavy work (i.e., work involving much standing or walking) and in 7 pairs both had light work (mainly sedentary or retirement). In 2 pairs the nail-treated patient had heavy work and the cast-treated patient light work; in 4 pairs the nail-treated patient had light and cast-treated patient heavy work. No statistical difference was found between the study groups when work profile was considered (P=0.687). Sick leave calculated on the basis of 21 pairs of patients was significantly shorter in the IMLN group than in the plaster cast group (Table 3). Likewise, the healing time was significantly shorter in the IMLN than in the plaster cast group (Table 3). Regarding hospitalization time no difference was found between the groups (Table 3).

Discussion

One of the most important findings in the present study was that delayed unions occurred more frequently in conjunction with plaster cast than IMLN treatment, a phenomenon noted in many previous studies [2, 3, 4, 6, 14, 18]. The development of axial deformity in cast-treated cases did not differ significantly from those treated with IMLN. However, it must be kept in mind that those patients in whom plaster cast treatment was converted to intramedullary nailing due to loss of acceptable position were excluded from this study.

The stiffness of the ankle joint was attributable to the plaster cast treatment and no patients in the IMLN group complained of such an adverse effect. Following plaster cast treatment residual joint stiffness has been reported in 20% to 30% of patients [5, 10, 18, 22]. The occurrence of anterior knee pain was striking. Among nail-treated patients, almost 80% suffered pain at the insertion site although the nail had been removed. In many patients this complaint offset the otherwise excellent final outcome. Some authors have suggested that by inserting the nail through a para-patellar incision and careful choice of nail length this problem can be minimized [13]. Many surgeons hold that such knee pain is alleviated after extraction of the nail. However, Keating and colleagues [13] found that in 49 out of 61 patients with anterior knee pain the pain was completely relieved 32 months after nail removal in 45%, partially relieved in 35%, and unimproved in 20%.

By using Johner and Wruhs classification [11] no significant difference was found between the study groups. This finding does not directly tally with those in previous studies in which intramedullary nailing proved superior compared with closed non-operative treatment [1, 3, 9, 12]. However, it should be noted that our material consisted purely of low-energy fractures while other studies have also included high-energy trauma cases [1, 3, 9, 12]. A particularly striking finding in the present study was that IM-nailed patients returned to work earlier than conservatively treated patients. Similar results have been described in a number of other investigations focusing on the economic aspects involved in fractures of the tibial shaft [1, 3, 6, 20]. Evidently, the IMLN-treatment provided sufficient stability to start walking without external support earlier than treatment with plaster cast. Secondly, prolonged immobilization of knee and ankle joints is usually essential for adequate healing of tibial shaft fractures under closed management, and the result is frequently joint stiffness [5].

The retrospective nature of this study calls the comparability of the study groups into question. The following exclusions were made to minimize the possibility of bias: patients whose plaster cast treatment proved to be insufficient to retain the fracture in an acceptable position (initial treatment was incorrectly selected in these cases); alcoholic patients and mentally retarded patients because they tend to have difficulties in following treatment protocol; diabetic patients because diabetes itself exposes the patient to infection [15]; rheumatoid arthritis patients because the disease itself and the treatment drugs depressing the immune system tend to lower the healing capacity of wounds (in addition, evaluation of the functional status of rheumatoid patients is difficult because many joints are generally involved). The purpose of identifying matched pairs was also to improve the comparability of the study groups. Parameters that have been shown to be of greater prognostic significance were used. Ferrandez et al. [7] found that age has a significant predictive value. We considered ±15 years a reasonable matching criterion with the provision that the patient is over 20 years of age. Sex was considered an important matching criterion because obviously men and women's work profiles differ from each other; men's work tends to involve more strenuous physical activities than women's. Regardless of matched pairs there might be some differences such as social class, which affect the end results. This concerns particularly the duration of sick leave. Although we did not include work profile in matching criteria, the pairs were reasonably matched. However, the retrospective nature of the study made it impossible to define exactly the physical demands of the patient's work and motivation to resume work; entrepreneurs return to work earlier than employees.

In summary, in displaced, closed or open grade I simple and spiral wedge fractures of the tibial shaft both intramedullary nailing and plaster cast treatment yield similar long-term results. However, significantly shorter healing and sick leave time tips the scale in favor of intramedullary nailing in the treatment of this kind of fracture.

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