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Mobilization after operation of ankle fractures

Good results of early motion and weight bearing

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Fifty-one patients with dislocated lateral malleolar fractures took part in this prospective randomized study. Active ankle movements with weight bearing in an orthosis were compared with active ankle movements without weight bearing using a dorsal splint. By using cerclage, staples, and pins (Cedell 1967), an exact reconstruction of the ankle mortise was achieved in 44/51 ankles. Radiographic and stereophotogrammetric analyses at 3 months showed no redislocation and only small movements in the ankle mortise. Better loaded dorsal flexion capacity at 3 months was found in the orthosis group. This study was designed as the second part of a consecutive study. In the first part, early or late weight bearing without ankle exercises was compared (Ahl et al. 1986). The results from the two consecutive parts indicate that active ankle movements in combination with weight bearing facilitate and improve the rehabilitation following operation for an ankle fracture.

After operation on ankle fractures, immobilization in a plaster cast without weight bearing has often been used (Cedell 1967, Leeds and Ehrlich 1984, de Souza et al. 1985). However, after fracture treatment, joint loading and exercises are considered to have a positive influence on articular cartilage and joint recovery (Burr et al. 1984, Salter et al. 1984).

We have compared early and late weight bearing and active ankle movements after operations of lateral malleolar fractures.

Patients and methods

This prospective randomized study included 51 patients with displaced lateral malleolar fractures. All the ankles had at operation a verified rupture of the anterior tibiofibular ligament. Children, patients with open fractures, those with other injuries interfering with the rehabilitation program, and those unable to cooperate – e.g., alcoholics, drug addicts, and senile persons – were excluded from the study.

The study was approved by the ethics committee at Karolinska Institute, Stockholm.

At the end of the operation the patients were randomly allocated either to active ankle movements and no weight bearing using a dorsal splint (n 25) or active ankle movements and weight bearing using an orthosis (n 26). During the first postoperative week, all the ankles were immobilized in a plaster cast and weight bearing was not allowed. From the second to the seventh postoperative week, the patients were instructed to perform active unloaded plantar/dorsal ankle movements at least five times daily, and those with an orthosis were encouraged to bear weight.

The mean age in the dorsal splint group was 39 (18–74) years and in the orthosis group 47 (18–74) years. There were 25 males and 26 females with equal distribution between the groups. The fractures were classified according to Lauge-Hansen (1942) and Weber (1972; Table 1). The patients were operated on by all the staff surgeons using cerclage wires, staples, and pins (Cedell 1967). A fracture of the posterior tibial margin, in no case exceeding one third of the articular surface, was found in 26 patients, 11 in the dorsal splint group

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Figure 1. The orthosis. The ankle can easily be lifted out for active ankle movements.

Table 1. Fracture classification. Ankles stereophotogrammetrically analyzed are given within brackets

		Splint	Orthosis
Weber	B	15 (6)	19 (7)
	C	10 (3)	7 (4)
Total		25 (9)	26 (11)
Lauge-Hansen			
Supination-eversion	II	12 (4)	10 (3)
	III	3 (2)	5 (1)
	IV	7 (2)	9 (5)
Pronation-abduction	III	1 (0)	0 (0)
Pronation-eversion	III	1 (0)	0 (0)
	IV	1 (1)	2 (2)
Total		25 (9)	26 (11)

Table 2. Comparison of dorsal splint and orthosis after operative treatment of ankle fractures. Mean values (SD) in percentage of uninjured side

	3 months		6 months	
	Splint (n 21)	Orthosis (n 22)	Splint (n 22)	Orthosis (n 21)
Ankle circumference	106 (4)	104 (4)	103 (3)	103 (3)
Calf circumference	96 (2)	96 (2)	98 (2)	99 (2)
Loaded dorsal flexion	73 (17)	81 (10)	84 (10)	87 (11)
Loaded plantar flexion	86 (8)	88 (9)	92 (8)	94 (6)

and 14 in the orthosis group. None of these fractures were operated on.

Twenty-two patients accepted to undergo roentgen stereophotogrammetric examinations (Selvik 1974). They had tantalum markers, diameter 0.8 mm, inserted into the lateral malleolus, the distal tibia, and the fibula proximal to the fracture. Two of these patients were not possible to analyze roentgen stereophotogrammetrically, 1 due to technical failures when inserting the tantalum markers, and the other had moved to another part of Sweden. Roentgen examinations (n 51), including stereophotogrammetric analyses (n 20), were performed postoperatively and after a minimum of 3 months. The roentgen stereophotogrammetric technique and calculations have previously been described in detail (Selvik 1983, Kärrholm et al. 1984).

Residual displacement was analyzed using the classification proposed by Cedell (1967).

Objective and subjective evaluations of ankle function were performed 3 and 6 months postoperatively. We recorded the ankle and calf circumferences and the range of loaded dorsal/plantar flexion, expressed as a percentage of the uninjured ankle (Lindsjö 1981; Table 2). The precision of dorsal/plantar ankle flexion (1 SD) has previously been estimated at 5 and 6 percent, respectively. The patients filled in a questionnaire about pain during rest and during weight bearing, stiffness, swelling, stair climbing, walking and running capacity, and the use of supports. Working capacity and capacity for sports and activities during leisure time were evaluated. A linear analogue scale and a scoring system were also used (Olerud and Molander 1984). Of 51 patients included in this study, 1 was lost to follow-up because he had moved to another part of Sweden.

This study was designed as the second part of a larger consecutive study of lateral malleolar

fractures (n 97). The first part of the study (n 46) was designed to compare early weight bearing, i.e., from the first postoperative day (n 24), and late weight bearing, i.e., from the fourth postoperative week (n 22). No ankle exercise was performed, and a below-the-knee cast was used in both of these groups for a period of 7 weeks (Ahl et al. 1986).

The first and second part of this study were comparable regarding type of fractures, age and sex distribution.

For statistical analyses the Student's *t*-test, Mann-Whitney *U*-test, chi-square test, and analysis of variance by regression (Wonnacott and Wonnacott 1985) were used. $P < 0.05$ was considered significant.

Results

All the fractures healed properly. No infection occurred and no reoperation was performed. Postoperative residual displacement of the lateral malleolus was found in 7/51 ankles (Table 3). No case of redislocation was found on standard x-ray examination.

Roentgen stereophotogrammetric analyses revealed only small movements in the ankle mortise during rehabilitation (Table 4). However, the widening of the ankle mortise and the dorsal angulation of the lateral malleolus were more pronounced in the orthosis group compared with the dorsal splint group ($P = 0.03$).

At follow-up 3 months postoperatively, the loaded dorsal flexion capacity and the linear analogue scale result were better after weight bearing in an orthosis ($P = 0.03$ and $P = 0.04$, respectively). All the patients had a capacity of dorsal and plantar flexion exceeding 15 and 25 degrees (mean 30 and 35 degrees), respectively. Only 2 patients expressed a feeling of severe ankle stiffness.

All the patients from both the first and the second part of the study (n 97) were included to compare active ankle movements using an orthosis or a dorsal splint (n 51), with no ankle exercises, using a below-the-knee cast (n 46). When ankle movements were allowed, better results were found regarding loaded dorsal flexion after 3 months ($P = 0.02$) and loaded plantar flexion after 3 and 6 months ($P < 0.001$ and $P = 0.03$, respectively). Evaluation of subjective parameters revealed no differences.

Table 3. Postoperative residual displacement. Cedell classification

	Splint (n 25)	Orthosis (n 26)
Lateral malleolus		
anatomic	23	21
good	2	4
poor	0	1
Posterior tibial fragment		
anatomic	2	8
good	5	4
poor	4	2

Table 4. Roentgen stereophotogrammetric analysis at 3 months compared with the postoperative analysis. Mean values (SD)

	Splint (n 9)	Orthosis (n 11)
Lateral malleolus – distal tibia		
Widening of the ankle mortise (mm)	0.3 (0.4)	0.7 (0.3)
Proximal translation of the lateral malleolus (mm) (shortening of the fibula)	−0.5 (0.4)	−0.1 (1.0)
Ventral translation of the lateral malleolus (mm)	0.0 (1.0)	−0.4 (0.6)
Varus angulation of the lateral malleolus (degrees)	0.6 (1.0)	0.1 (1.0)
Dorsal angulation of the lateral malleolus (degrees)	0.5 (0.9)	1.4 (1.1)
Outward rotation of the lateral malleolus (degrees)	2.3 (1.7)	1.5 (1.8)
Lateral malleolus – proximal fibula		
Compression of the lateral malleolar fracture (mm)	0.4 (0.5)	0.6 (0.6)

Early weight bearing in an orthosis or a walking cast (n 50) was also compared with late weight bearing in a cast from the fourth postoperative week or no weight bearing for 7 weeks, using a dorsal splint (n 47). The dorsal flexion capacity after 3 months ($P = 0.02$) and the linear analogue scale results after 3 and 6 months ($P = 0.02$ and $P = 0.03$, respectively) were better when early weight bearing was allowed.

Early weight bearing and daily active ankle movements in an orthosis (n 26) compared with early weight bearing in a walking cast (n 24) showed a better plantar flexion capacity after 3 and 6 months ($P = 0.001$ and $P = 0.01$, respectively) and a tendency to better dorsal flexion capacity after 3 months ($P = 0.05$). The subjective parameters did not differ.

Men when compared with women showed better results. Differences were found after 3 and 6 months concerning the loaded dorsal flexion capacity ($P = 0.01$, respectively), the scoring results ($P < 0.001$ and $P = 0.002$, respectively), and the linear analogue scale results ($P = 0.01$ and $P = 0.004$, respectively).

Discussion

Unloaded ankle exercises followed by immobilization in a plaster cast have been recommended after operations on ankle fractures (Burwell and Charnley 1965, Lindsjö 1985). No plaster immobilization and active ankle exercises without weight bearing during the entire period of rehabilitation (Weber 1972, Brodie and Denham 1974, Söndenaa et al. 1986) require extensive medical care resources and supervision.

Combined weight bearing and ankle exercises in an orthosis (Segal et al. 1985) would considerably facilitate the rehabilitation, but have usually not been used because of the risk of fracture redisplacement. However, roentgen stereophotogrammetric analyses of 20 ankles postoperatively and after 3 months showed only small movements in the ankle mortise (Table 4). Although greater widening of the ankle mortise and dorsal angulation of the lateral malleolus were found in the orthosis group, these values were low and for all the patients well within the normal range of ankle motion during dorsal/plantar flexion (Grath 1960, Kärrholm et al. 1985, Ahl et al. 1987).

The range of ankle motion during normal walking has been estimated at approximately 10° of dorsal and 15° of plantar flexion (Stauffer et al. 1977, Wright and Desai 1964). At 3 months' follow-up, all the ankles in our study had a capacity exceeding these values. The loaded dorsal flexion capacity is considered to be the clinical parameter that correlates best with the end results (Lindsjö 1981, Zenker and Nerlich 1982). There was a tendency to better ankle motion capacity in the orthosis group, but this difference was significant only for loaded dorsal flexion after 3 months.

With the operative technique used here, an anatomic reconstruction of the ankle mortise was achieved in 44/51 ankles, and in 6/7 displaced ankles the residual displacement was minimal (Table 3). These results are comparable to the results presented by Lindsjö (1981), where operations had been performed according to the AO principles. Although the Cedell operative technique used by us has been described as "nonrigid" (Olerud et al. 1986), no case of redislocation was found when ankle exercises and weight bearing were performed. Better results among males compared with females have also been described by Lindsjö (1981).

The present study was the second part of a larger consecutive study of operated on lateral malleolar fractures. The first part of the study, including patients randomized to early or late weight bearing in a walking cast, has previously been described in detail (Ahl et al. 1986). The study was, for practical reasons, divided into two consecutive parts. Because the two parts included similar fractures and were comparable regarding age and sex distributions, we have permitted ourselves to compare the four different regimes in spite of the fact that the two parts were consecutive.

When comparing the four different postoperative regimes, we found the best results in the orthosis group where active ankle movements and early weight bearing were practiced. The least favorable results were found among the patients treated with immobilization in a plaster cast without ankle movements for 7 weeks and with no weight bearing during the first 4 weeks.

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