Early mobilization of operated on ankle fractures

Prospective, controlled study of 40 bimalleolar cases

Torbjörn Ahl[1], Nils Dalén[1], Arne Lundberg[2] and Carin Bylund[3]

40 patients with dislocated bimalleolar and trimalleolar ankle fractures took part in this randomized study. All ankles were operated on using cerclage, staples and pins. Active ankle movement with weight bearing in an orthosis was compared with active ankle movement without weight bearing using a dorsal splint. Stereophotogrammetric analysis showed small movements in the ankle mortise in both groups but conventional radiography revealed no fracture redislocation. The clinical results did not differ. This study was designed as the second part of a consecutive project. In the first part, early and late weight bearing in a cast without ankle movements was compared (Ahl et al. 1987b). In comparing the first and the second parts of the study, a small but significant increase in fracture instability was observed in the early motion group. No lasting superior clinical result was achieved by early ankle movement. After operation on dislocated bimalleolar ankle fractures, early postoperative weight bearing in a walking cast is recommended.

Karolinska Institute Departments of [1]Orthopedics and [3]Radiology, Danderyd Hospital, S-182 88 Danderyd, and Department of [2]Orthopedics, Karolinska Hospital, S-104 01 Stockholm, Sweden. Tel +46–8 655 50 00. Fax –8 7551476
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In a previous study, active ankle movements in combination with weight bearing improved the rehabilitation of surgically-treated lateral malleolar fractures (Ahl et al. 1988b).

We have now compared early and late weight bearing and active ankle movements after operations on displaced bimalleolar and trimalleolar ankle fractures.

Patients and methods

40 displaced bimalleolar and trimalleolar ankle fractures were included in a randomized study. Excluded from the study were children, patients with open fractures or other injuries interfering with the rehabilitation program, and those unable to cooperate, e.g., alcoholics and drug addicts. Another 3 patients were excluded after randomization; 1 patient did not want to participate in the study and the other 2 were mistakenly given a walking cast postoperatively. The study was approved by our ethics committee.

At the end of the operation the patients were randomly allocated to the dorsal splint group or the orthosis group, i.e., no weight bearing using a dorsal splint (n 19) or weight bearing using an orthosis (Figure 1) (n 21); all were encouraged to move the ankle actively. To facilitate wound-healing, a plaster cast without weight bearing was used during the first postoperative week. From the second to the seventh postoperative week, all patients were instructed to perform active unloaded plantar/dorsal ankle movements at least 5 times daily. In addition, those using an orthosis were also encouraged to full weight bearing.

The mean age in the dorsal splint group was 55 (22–77) years and in the orthosis group 55 (20–76) years. The ratio male/female was 3/16 and 4/17 in the dorsal splint and orthosis groups, respectively.

The fractures were classified according to Lauge-Hansen (1942) (Table 1). A fracture of the posterior tibial margin was present in 35/40 cases. Postoperative residual displacement was classified according to Cedell (1967) (Table 2).

The operations were performed by all staff surgeons using cerclage wires, staples and pins (Cedell 1967) (Figure 2). In the orthosis group two fractures of the posterior tibial margin included more than one third of the articular surface and one of them was operated on using a screw.

18 patients agreed to undergo roentgen stereophotogrammetric analysis (RSA; Selvik 1974, 1989, Kärrholm 1989). Tantalum markers, diameter 0.8 mm, were inserted into the distal tibia, the lateral and medial malleolus, and when possible the fibula, proximal to the fracture site (Figure 2). One patient could not be analyzed by RSA, due to technical failure when inserting the bone markers.

Radiographic examinations (n 40), including RSA (n 17), were undertaken postoperatively, at 3 months, and at a minimum of 18 months.

Table 1. Fracture classification according to Lauge-Hansen (ankles stereophotogrammetrically analyzed within brackets)

	Motion		No motion[a]	
	Splint No WB	Orthosis Early WB	Cast Early WB	Cast Late WB
Supination eversion IV	13 (8)	15 (6)	13 (7)	14 (6)
Pronation abduction III	3 (0)	3 (2)	6 (5)	6 (5)
Pronation eversion III	0 (0)	0 (0)	1 (0)	1 (1)
Pronation eversion IV	3 (1)	3 (0)	5 (5)	7 (4)
Total	19 (9)	21 (8)	25 (17)	28 (16)

[a] Ahl et al. 1987b.
WB weigth bearing.

Table 2. Reduction after operative treatment of ankle fractures. Cedell classification (1967)

	Motion		No motion[a]	
	Splint No WB	Orthosis Early WB	Cast Early WB	Cast Late WB
Lateral malleolus				
anatomic	15	19	23	26
good	3	2	0	1
poor	1	0	2	1
Medial malleolus				
anatomic	16	19	22	23
good	2	2	2	4
poor	1	0	1	1

[a] Ahl et al. 1987b.
WB weigth bearing.

Subjective and objective evaluations of ankle function were performed 3, 6, and 18 months postoperatively (Table 4). We recorded the range of loaded dorsal/plantar flexion, expressed as a percentage of the uninjured ankle (Lindsjö 1981). A linear analogue scale and a scoring system (Olerud and Molander 1984) were also used.

Both ankles were examined radiographically after 18 months to evaluate the presence of arthrosis: Grade I – reduction of the joint space of less than 50 percent, Grade II – reduction of the joint space of 50 percent or more, Grade III – bone-to-bone contact between the tibia and the talus.

This study was designed as the second part of a larger consecutive study of bimalleolar and trimalleolar fractures (n 93). The first part of the study (n 53) was performed comparing early (n 25) and late (n 28) weight bearing, referred to in the text as the early weight bearing cast group and the late weight bearing cast group. No ankle motion was undertaken and a below-the-knee cast was used in both groups for a period of 7 weeks (Ahl et al. 1987b). The two parts of our study were consecutive and comparable regarding type of fracture, age and sex distribution.

For statistical analysis the Student's *t*-test and the Mann-Whitney U-test were used. $P < 0.05$ was considered significant.

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

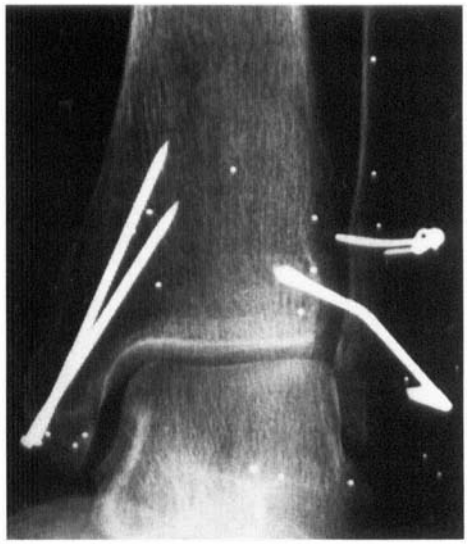

Figure 2. Osteosynthesis devices and tantalum bone markers.

Table 3. Roentgen stereophotogrammetric analysis after fracture healing compared with the postoperative analysis. Mean values in mm or degrees (SD).

	Motion		No motion[a]	
	Splint No WB (n 9)	Orthosis Early WB (n 8)	Cast Early WB (n 17)	Cast Late WB (n 16)
Movements of the lateral malleolus in relation to the tibia				
Widening of the ankle mortise (mm)	1.1 (0.8)	1.2 (0.9)	0.2 (0.3)[b]	0.3 (0.5)[b]
Proximal translation (mm)	0.4 (1.0)	0.3 (1.0)	–0.4 (0.4)[b]	0.1 (0.9)
Dorsal translation (mm)	0.6 (1.2)	1.2 (0.9)	0.5 (0.7)[b]	0.8 (0.8)
Varus angulation (degrees)	–0.6 (2.0)	1.0 (2.0)	0.3 (1.7)	0.5 (1.3)
Dorsal angulation (degrees)	1.2 (1.7)	2.3 (1.7)	0.3 (1.6)[b]	0.8 (1.4)[b]
Outward rotation (degrees)	3.9 (3.3)	1.8 (3.4)	0.9 (2.5)	2.1 (1.9)
Movements of the medial malleolus in relation to the tibia				
Medial translation (mm)	–0.2 (0.6)	–0.1 (0.4)	0.1 (0.1)	0.0 (0.3)
Proximal translation (mm)	–0.1 (0.4)	–0.4 (0.7)	0.0 (0.3)	–0.1 (0.3)
Ventral translation (mm)	0.2 (0.3)	–0.7 (1.6)	0.1 (0.2)	–0.1 (0.3)
Movements of the lateral malleolus in relation to the proximal fibula				
Compression of the lateral malleolar fracture (mm)	0.9 (0.8)	0.5 (0.4)	0.1 (0.3)[b]	0.2 (0.4)

[a]Ahl et al. 1987b
[b]Significantly ($p < 0.05$) better fracture stability compared with the orthosis group.
WB weight bearing.

Results

Ankle motion with weight bearing versus ankle motion without weight bearing

All fractures in the dorsal splint and orthosis groups healed properly. No deep infection occurred and no reoperation was performed. 3 superficial wound infections, 1 local wound necrosis, and 1 skin irritation, caused by the orthosis, occurred. These complications all healed uneventfully on local treatment. Postoperative residual displacement of the lateral (6/40) or medial (5/40) malleolus was found in 8/40 ankles (Table 2). No case of redisplacement occurred. RSA (Table 3) revealed a small widening of the ankle mortise and a small compression of the fibula fracture without differences between the orthosis and the dorsal splint groups. Neither did the clinical parameters differ between the groups (Table 4).

At 18 months, all patients, except one, had a capacity of dorsal flexion exceeding 10 (mean 30) degrees and of plantar flexion exceeding 20 (mean 39) degrees. Radiographic examinations 18 months after injury revealed arthrosis in 6 ankles, 3 in each group, 5 of which were Grade I and 1 Grade II (Table 4).

Ankle movements versus no ankle movements

When comparing the orthosis and the dorsal splint groups with the early and late weight bearing cast groups, only at the three-month-control were better results observed, regarding loaded dorsal and plantar flexion, and ankle score, when ankle movements were allowed. RSA revealed increased fracture mobility in the ankle motion groups, regarding widening of the ankle mortise, proximal translation and dorsal angulation of the lateral malleolus, lateral translation of the medial malleolus and compression of the lateral malleolar fracture.

Early weight bearing versus late weight bearing

The orthosis and early weight bearing cast groups were compared with the dorsal splint and late weight bearing cast groups. Better scores were found at 3 months with early weight bearing. RSA did not differ.

Early weight bearing with ankle motion versus late weight bearing without ankle motion

When comparing the orthosis group with the late weight bearing cast group, the patients using the orthosis had better scores at 3 and 6 months reflecting better dorsal flexion (Table 4). RSA showed a more pronounced widening of the ankle mortise and dorsal angulation of the lateral malleolus in the orthosis group (Table 3).

Early weight bearing with ankle motion versus early weight bearing without ankle motion

Compared to the early weight bearing cast group, the orthosis group had better plantar flexion only at 3

Table 4. Patient data and clinical results 3, 6, and 18 months after surgery. Mean values

	Motion		No motion[a]	
	Splint No WB	Orthosis Early WB	Cast Early WB	Cast Late WB
Age, years	55	55	57	57
Male/female	3/16	4/17	10/15	6/22
Score (max 100)				
3	53	66	54	47[b]
6	76	82	70	73[b]
18 months	86	90	84	81
Linear analogue scale (0–150 mm)				
3	56	43	57	60
6	30	23	29	37
18 months	29	15	20	18
Loaded dorsal flexion (percent)				
3	63	67	59	52[b]
6	78	78	77	69[b]
18 months	84	80	82	82
Loaded plantar flexion (percent)				
3	80	83	73[b]	76[b]
6	93	87	85	87
18 months	94	93	93	90
Arthrosis	3	3	4	6

[a] Ahl et al. 1987b
[b]Significantly ($P < 0.05$) inferior results compared with the orthosis group.
WB weigth bearing

months (Table 4). RSA, however, revealed increased fracture mobility in the orthosis group, with widening of the ankle mortise, proximal and dorsal translation and dorsal angulation of the lateral malleolus, as well as compression of the fibula fracture (Table 3).

No correlation was found between ankle score or loaded dorsal/plantar flexion and fracture stability, measured stereophotogrammetrically.

Discussion

Due to the risk of fracture redisplacement, a plaster cast and late or no weight bearing are still widely used (Cedell 1967, Leeds and Ehrlich 1984, Bauer et al. 1985, de Souza et al. 1985). After operations on ankle fractures performed according to the AO principles, a few days of active ankle movements, before immobilisation in a plaster cast, has been recommended (Burwell and Charnley 1965, Lindsjö 1985). Others have recommended active ankle movements without weight bearing during the entire period of rehabilitation (Weber 1972, Brodie and Denham 1974, Lund-Kristensen et al. 1981). This regime makes the patients completely dependent on crutches and, especially for older patients, requires extended medical care. In a randomized study, Söndenaa et al. (1986) compared active ankle movements with no ankle movements. Weight bearing was not allowed. Only at 6 weeks did the exercise group show better ankle mobility.

With conventional radiography it is difficult to detect small redisplacements that might be of clinical importance (Willenegger 1961, Ramsey and Hamilton 1976, Olerud and Molander 1986). RSA makes it possible to detect such small movements between fracture fragments.

Bimalleolar and trimalleolar ankle fractures are associated with skeletal fragility affecting an older age group with women particularly at risk (Bengnér et al. 1986, Ahl et al. 1988a). Nevertheless, using cerclage wires, staples and pins, an anatomic reconstruction of the ankle mortise was achieved in 32/40 ankles. In 6/8 displaced ankles, the residual displacement was minimal, never exceeding 1 mm. No redislocation during fracture healing was seen on conventional radiography.

It has been estimated that during normal walking, a capacity of dorsal and plantar flexion of at least 10 and 15 degrees, respectively, is needed (Wright and Desai 1964, Stauffer et al. 1977). All ankles in this study, except one, reached a capacity exceeding these values. The present study was the second part of a larger consecutive study of surgically treated bimalleolar and trimalleolar fractures. The first part included patients randomized to early or late weight bearing in a below-the-knee cast (Ahl et al. 1987b). The two studies included similar fractures and surgical treatment, and were comparable regarding age and sex. In this regard, we have permitted ourselves to compare the 4 different regimes in spite of the fact that the 2 studies were consecutive.

When comparing early and late weight bearing in a plaster cast, at 3 and 6 months' follow-up, a tendency to better clinical results was seen in the early weight bearing group. When adding active ankle movements to early weight bearing, using an orthosis, a further tendency to improved clinical results was noticed, and these results were better than those in the late weight bearing cast group. Similar results were found when lateral malleolar fractures were studied (Ahl et al. 1988b). On the other hand, in a randomized study Finsen et al. (1989) did not find any differences between the groups when comparing no plaster cast or weight bearing but active ankle exercises, with a non-weight-bearing plaster cast or a walking plaster cast for the first 6 postoperative weeks.

RSA revealed increased fracture mobility when postoperative ankle motion was performed. However, these movements between the fracture fragments were

small; movements in the ankle mortise were of the same magnitude as found in healthy volunteers during ankle motion (Grath 1960, Kärrholm et al. 1985, Ahl et al. 1987a). It has been suggested that even small fracture displacements might jeopardize the clinical outcome and eventually cause early arthrosis (Ramsey and Hamilton 1976, Olerud and Molander 1986). This is not in agreement with our study, which revealed similar or even better clinical results in the orthosis group, where small fracture movements were observed. Neither did we find any correlation between fracture movements and the development of arthrosis.

When comparing the 4 postoperative regimes, only small differences between the groups were found. As early postoperative weight bearing considerably facilitates rehabilitation it is to be recommended. Early active ankle movements did not reveal any lasting clinical advantages.

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