

Fracture of the lateral malleolus

Comparison of 2 fixation methods in cadavers

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20 pairs of lateral malleolar fracture were created by an osteotome at autopsy of elderly patients and repaired on one side with staples and cerclage wire and on the other side with plate and screws. The stability of the fixation was then tested in an apparatus creating outward rotational load. The breaking load in

fractures fixated with staples and wire was about 60 percent (18 SD 7.6 Nm) of the plated fibular fractures (32 SD 11 Nm). However, at an outward deflection up to 30 degrees there was no difference in breaking load with the two methods of fixation.

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An isolated lateral fracture is the most common ankle fracture, usually described as supination outward rotation Stage 2 (Lauge Hansen 1942) or Weber type B (1972). In Scandinavia there are 2 common methods for internal fixation of such injuries, namely, staples and cerclage wire according to Wiberg (Cedell 1967, Andersson et al. 1986) or plate and screws (Lindsjö 1981, Olerud and Molander 1986). We have studied the difference in stability between the 2 methods.

mm screws and the other with a one-third tubular dynamic compression plate having 3.5-mm screws. Ticon 4-0 suture (Davis Geck, Danbury, U.S.A.) was

Material and methods

A mechanical testing apparatus was constructed to allow application of the external torque across the ankle joint. This was accomplished by locking the tibia to a frame and a platform by 2 special rods (diam 8 mm) 10 cm apart and the calcaneus and metatarsus by 4 metallic peg screws to a foot disc that could be rotated outwards around the long axis of the tibia by increasing loads (Figure 1). Lateral malleolar fractures were created by a 30 mm osteotome obliquely from the level of the upper talus in a proximal posterior and lateral direction similar to the typical supination-outward rotation fracture. The anterior tibiofibular ligament (ATFL) was cut through to conform to the classical lesion. The same procedure was used on both sides, and 1 side was repaired by 2 staples (Stille, Sweden) and a cerclage wire according to Wiberg (Cedell 1967). The other side was repaired with a plate and 5 screws (Synthes, Switzerland).

2 series of experiments were conducted, 1 with a semitubular dynamic compression plate having 4.5-

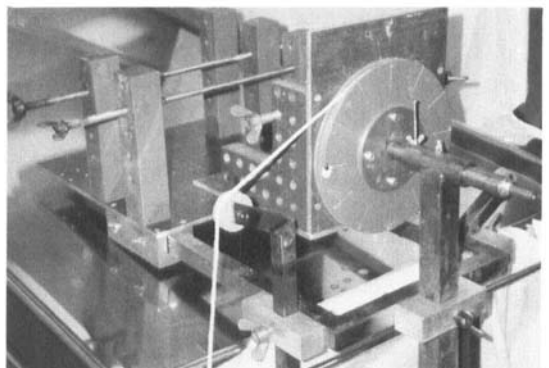
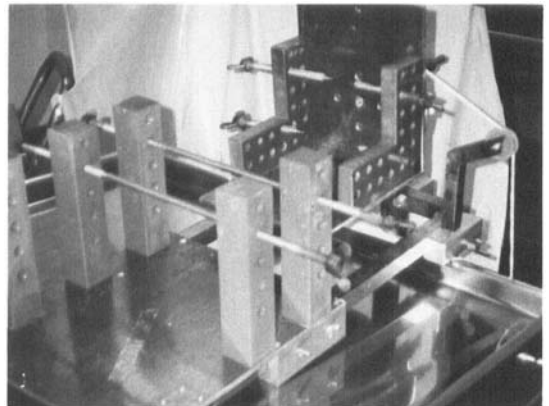


Figure 1. Mechanical fixation and testing apparatus from side and foot-end.

Table 1. Comparison of breaking torque (Nm) and failure angles (degrees) in bilateral lateral malleolar fractures in cadavers, repaired with 2 methods of internal fixation

No.	Sex	Age	Staples and wires		Plate and screws		Staples/plate percentage
			Torque	Failure angle	Torque	Failure angle	
1	F	71	9	30	18	60	53
2	F	57	30	85	24	75	123
3	F	48	34	55	42	85	82
4	M	91	28	45	27	90	103
5	F	86	15	45	33	60	46
6	M	77	19	35	41	65	46
7	F	88	21	75	23	120	92
8	F	72	11	60	23	75	48
9	F	88	7	30	15	80	44
10	F	89	12	35	14	60	87
11	M	78	27	60	48	65	56
12	F	83	21	45	42	50	49
13	M	72	19	60	51	65	36
14	M	76	20	60	36	70	54
15	F	79	13	55	34	105	38
16	M	74	14	25	34	60	41
17	M	68	23	55	44	85	53
18	M	76	14	35	22	50	63
19	M	71	21	50	39	85	52
20	F	63	8	50	27	85	31
Mean <i>SD</i>		75 11	18 7.6	50 15	32 11	75 18	60 25
Range		48-91	7-34	25-85	14-51	50-120	31-123

P-value torque 0.0001
P-value angles 0.0001

used to repair the ATFL in the plated cases, as recommended in the AO-manual (Müller et al. 1979). The first series comprised 10 pairs and the second 10 more pairs of ankles. The experiments were conducted on regular autopsy patients (9 men and 11 women), mean age 75 (48-91) years, who had died from causes unrelated to lower limb injuries or any other known cause of unilateral influence on bone strength. Rotational yield in degrees was plotted against torque to breaking point and the fracture fixation was observed during the procedure. The type of failures and the degree of outward rotation achieved at failures were recorded.

The type of failure in the stapled cases was loosening of both the staples from the fibula, except in Case 8 where 1 staple loosened from the fibula and 1 from the tibia. In the plated cases there were 6 different types of failures: plate loose distal to fracture (5 cases), plate loose proximal to fracture (6 cases), fracture through screw-hole proximal to fracture + tibial fracture at the same level (3 cases), fracture through screw-hole proximal to fracture (4 cases), plate loose distal to fracture + tibial fracture through rod (1 case) and tibial fracture through rod (1 case).

Student's *t*-test was used in the statistical analysis.

Table 2. Torque (Nm) at 3 outward deflection angles of lateral malleolar fractures repaired by 2 methods. Mean *SD*

Method	10°		20°		30°	
Stapling	2.1	1.0	5.3	2.3	7.9	3.0
Plating	2.1	1.3	4.9	2.4	8.3	3.9

Results

The mean ultimate torque for stapling in the first series was 19 (7-34) Nm and for plating 26 (14-42) Nm using the semitubular plate. In the second series with the one third tubular plate the mean ultimate torque for stapling was 18 (8-27) Nm and for plating 38 (22-51) Nm. When both series were combined, the mean breaking torque with staples and wire was 18 ± 7.6 Nm and with plate and screws 32 ± 11 Nm (Table 1).

The mean torque for 10, 20, and 30 degrees of outward deflection showed no difference between the 2 series with staples and wire or between the 2 series with the different plates. The observations for the 2 series combined are shown in Table 2.

Discussion

A search of the literature 1966-1990 yielded only 2 studies on mechanical testing of experimental ankle fractures. Michelson et al. (1990) found a lateral translation of the talus of 2 mm during axial loading. Displacing the distal fibula laterally did not increase this translation. Capsular structures therefore are of importance for stability. Solari et al. (1990) created Weber Type C fractures in cadavers and measured the external rotational stability. They found a maximal external rotation of 7.7 degrees in the intact ankle and 32 degrees with the fracture at the same load. When repaired both laterally with a plate and medially, the rotational stability improved by 73 percent and they then found no need for a syndesmotic screw.

Many patients with ankle fractures have bone fragility and lack muscular strength for ambulation using crutches without weight bearing. During walking with a below-knee plaster cast, supination is prevented but not outward rotation. Irrespective of the method used for internal fixation, a plaster is normally used for about 6 weeks. Groups in favor of plate fixation claim that the method with staples and wire does not create enough stability for a secure fixation of the fracture.

The tendency to a better result with a weaker plate is explained by the fact that the weaker plate in our series could more easily be bent to follow the contour of the lateral malleolus. The failure angles of outward rotational displacement with each method were far above what would be possible in a walking cast. Furthermore, our study also showed that the 2 methods are equal in strength for the first 30 degrees of outward rotational displacement of the foot. This may be because the staples bind the lateral malleolus directly to the tibia. Our study supports an earlier report (Ahl 1988) that early weight bearing in a walking cast is acceptable when using staples and wire for fixation of the lateral malleolus fracture.

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References

- Ahl T. Ankle fractures: with special reference to early postoperative weight bearing. Thesis, Karolinska Institute, Stockholm, Sweden 1988.
- Andersson C, Cedell C A, Svendler C Å. Joint congruence and stability in ankle fractures operated on with cerclage, pins and syndesmosis staples. Abstract Swedish Orthop Ass 1986.
- Cedell C A. Supination outward rotation injuries of the ankle. A clinical and roentgenological study with special reference to the operative treatment. Acta Orthop Scand (Suppl 110) 1967.
- Lauge-Hansen N, Ankelbrud I. Genetisk diagnose og reposition. Thesis, Munksgaard, Copenhagen 1942.
- Lindsjö U. Operative treatment of ankle fractures. Acta Orthop Scand (Suppl 189) 1981.
- Michelson J D, Clarke H J, Jinnah R H. The effect of loading on tibiotalar alignment in cadaver ankles. Foot Ankle 1990; 10 (5): 280-4.
- Müller M E, Allgöwer M, Schneider R, Willenegger H. Manual of internal fixation. Springer Verlag, Berlin, 2nd ed. 1979.
- Olerud C, Molander H. Bi- and trimalleolar ankle fractures operated with nonrigid internal fixation. Clin Orthop 1986; 206: 253-60.
- Solari J, Benjamin J, Wilson J, Russel L. Ankle mortice stability in Weber C ankle fractures. Indications for transmalleolar fixation. Abstract, SICOT, Montreal 1990.
- Weber B G. Die Verletzungen des oberen Sprunggelenkes. Akt Probl Chir, Verlag Hans Huber, Bern, 2 Aufl. 1972; 3.