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The comparison of plate-screw and tension band techniques in the osteosynthesis of Danis-Weber Type A and B lateral malleolar fractures

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Objective: The aim of this study was to compare the clinical and radiological results of plate-screw and tension band fixation in isolated Danis-Weber Type A and B lateral malleolar fractures.

Methods: A total of 135 cases of lateral malleolar fractures (82 Danis-Weber Type B and 53 Type A) operated on in 4 different centers and 6 orthopaedic clinics between November 2005 and December 2010 were reviewed retrospectively. Eigthy-one patients (55 Type B and 26 Type A) had lateral 1/3 tubular plate and screw fixation (Group 1), while the remaining 54 patients (27 Type B and 27 Type A) were operated on with tension band technique (Group 2). The clinical and radiological results of the groups were compared. Student t test was used in statistical analysis.

Results: The mean length of surgical incision scar was 4.9 cm (4.5-5.4 cm) for Type A fractures and 6.8 cm (5.6-7.5 cm) for Type B in Group 1 and 4.0 cm (3.5-5.2 cm) for Type A and 5.3 cm (5.0-5.9 cm) for Type B fractures in Group 2. Radiological union was obtained at mean of 10 weeks (7-13 weeks) in Group 1 and 9 weeks (7-12) in Group 2. The implant had to be removed in 12 patients in Group 1 and in one patient in Group 2. The mean AOFAS Score was 90 (72-100) and 92 (70-100) in Groups 1 and 2, respectively.

Conclusion: Both plate-screw and tension band techniques revealed excellent results in isolated Danis-Weber Type A and B fractures. The tension band technique may be an alternative fixation method in the treatment of these fractures.

Key words: Ankle; operative therapy; fracture fixation-internal; fracture fixation-intramedullar; bone screws.

Lateral malleolar fracures are the most common fractures of the ankle. Danis-Weber classification is a widely used, simple classification system for these fractures and isolated Danis-Weber Type B fracture is the most frequent type, which accounts for approximately 40% of all ankle fractures.[1]

When planning treatment for Danis-Weber Type A and B fractures, the patient's age, general health status, level of activity and the risks of the treatment method are taken into consideration. Surgical treatment is recommended when an anatomical reduction can not be achieved by non-operative methods, and in displaced or unstable fratures.[2] The aim is to achieve anatomical reduction and maintain the reduction until the fracture heals. The application of interfragmentary screws together with a lateral neutralisation plate is the

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Table 1. Patient data of both groups.

	Plate-screw (Group 1)	Tension band (Group 2)
Number of patient	81	54
Sex	56 M / 25 F	33 M / 21 F
Mean age	44 (21-74)	41 (19-66)
Fracture type	55 Type B / 26 Type A	27 Type B / 27 Type A
Follow-up period		
Type A	34 months (12-70)	32 months (8-76)
Type B	35 months (13-76)	32 months (11-75)

most commonly used fixation method and has become the gold standard in these fractures. A short antiglide plate fixation from the posterior of the fibula has also been recommended.[3] The tension band technique, which has various advantages over plate application, is most frequently used in medial malleolar fractures,[4,5] and may also be applied in lateral malleolar fractures.

The aim of this study was to compare the clinical and radiological results of the lateral plate-screw and tension band fixation methods in the osteosynthesis of isolated Danis-Weber Type A and B fractures.

Fig. 1. **(a, b)** Preoperative AP and lateral radiographs of a case with surgical fixation with plate-screw. **(c, d)** Postoperative radiographs of the same patient.

Patients and methods

Retrospective evaluation was made of a total of 135 cases from 4 different centres and 6 separate clinics, who had undergone surgery due to a diagnosis of isolated Danis-Weber Type A or B lateral malleolar fracture between November 2005 and December 2010. The patients were 89 males (65.9%) and 46 females (34.1%) with a mean age of 43 (range: 19 to 74) years. The mean follow-up period was 34 (range: 8 to 76) months. The fractures were classified as 82 Type B and 53 Type A according to the Danis-Weber classification. The cause of fracture was determined as distortion in 66 cases, sports injury in 27 cases, a fall in 23 cases and traffic accident in 19 cases. Patients with a previous history of ankle trauma, those with immature bones, open fractures, concomitant fractures and those determined with syndesmosis instability were not included in the study.

Following open reduction, fixation was made by lateral 1/3 tubular plate with screws to the 81 patients in Group 1 (55 Type B, 26 Type A) and by tension band technique to the 54 patients in Group 2 (27 Type B, 27 Type A) (Table 1).

The patients of both groups were operated on in a supine position and under tourniquet control. Prophylactic antibiotic treatment was started prior to tourniquet application and continued for 48 hours postoperatively. For the application of the lateral plate, a longitudinal incision was made on the fibula. The plate was placed with attention paid to the neurovascular structures, and generally fixed with 3.5 sized cortical screws; 3 screws to the proximal of the fracture and 2-3 to the distal (Fig. 1).

For the tension band technique, a short longitudinal incison was made over the fibula, extending from the fracture line to the tip of the fibula. Being careful of the neurovascular structures, the fracture was reduced and temporarily fixed with a single clamp. In all patients, 2 K-wires and cerclage wire were used as fixation materials. The 2 parallel K-wires were driven intramedullarly

from the fibular tip, and from the level of the fracture, the wires were advanced at least double the length of the fracture line from the fibular tip. Generally, K-wires of 1.8 mm or 2 mm thickness were used to approximately fill the proximal intramedullary canal. Immediately proximal to the fracture, a hole was opened in the fibula with a 3.2 sized drill from anterior to posterior, protecting the posterior anatomic structures. From this hole, the cerclage wire was passed medially to the K-wires in patients with poor bone quality, and in patients with good bone quality, it was passed lateral to the K-wires. In the distal, it was passed medial to the K-wires, the reduction clamp was removed and the cerclage wire was tied in a figure-of-eight. Then, by bending the ends of both K-wires, the ends were laid over the fibular tip, turned towards the talofibular joint, so as not to create any irritation (Fig. 2). To check whether syndesmosis was stable or not, evaluation was made both visually and by fluoroscopy, and the external rotation test was applied in both groups. Postoperatively, a splint was applied to the patients for 1 week to control edema and after 1 week, active joint movements were introduced. Full weight-bearing was allowed after 6 weeks. The patients were followed-up regularly during the first 12 weeks and then the follow-up schedule was made based on the radiological and clinical findings.

The groups were compared based on the length of the surgical incision, complications, joint range of motion, patient satisfaction, time to union, AOFAS score and radiological results. Student t test was used in statistical analysis and p values below 0.5 was considered significant.

Results

The mean length of the incision scar of the Group 1 patients was 4.9 (range: 4.5 to 5.4) cm for Type A and 6.8 (range: 5.6 to 7.59 cm for Type B fractures. The mean incision length of the Group 2 patients was 4.0 (range: 3.5 to 5.2) cm for Type A and 5.3 (range: 5 to 5.9) cm for Type B fractures (Fig. 3 and 4). In both groups the mean incision length was smaller for Type A fractures ($p<0.01$). The mean incision length of the Group 2 was significantly smaller than the mean of the Group 1 ($p<0.05$). The implants were removed in 12

Fig. 2. **(a, b)** Preoperative AP and lateral radiographs of Danis-Weber Type A lateral malleolar fracture. **(c, d)** Postoperative AP and lateral radiographs of the same case after surgical fixation with the tension band technique.

Fig. 3. Surgical incision length in the plate and screw technique. [Color figure can be viewed in the online issue, which is available at www.aott.org.tr]

Fig. 4. Surgical incision length in the tension band technique. [Color figure can be viewed in the online issue, which is available at www.aott.org.tr]

patients (14%) in Group 1 during the follow-up period due to mechanical irritation of the skin, long screws causing irritation on the tibia and implant loosening. In Group 2, it was necessary to remove the implant in 1 patient (1.8%) due to breakage of the cerclage wire and migration of the K-wire (Table 2).

In the early postoperative period, no reduction loss or malreduction (more than 2 mm displacement) was seen in either group. In 2 cases in Group 1, there was loss of sensation on the lateral aspect of the ankle. There was a superficial infection which was cleared with antibiotic treatment in four patients in Group 1 and two patients in Group 2. In Group 1, 18 patients had a mean of 6º of dorsiflexion loss. Thirteen of these 18 patients had also plantar flexion loss of a mean of 7º. In Group 2, 9 patients had mean of 7º of dorsiflexion loss and 7 patients, including 2 of those 9, had mean of 5º of plantar flexion loss.

A minimal reduction in postoperative joint range of motion, not exceeding 15º, was observed in 18 patients (22.2%) in Group 1 and in 14 patients (25.9%) in Group 2. Reflex sympathetic dystrophy was seen in one patient from each group, which responded to medical treatment and physiotherapy. The joint range of motion of the other patients was measured as the same as the healthy side. The results of ankle function, stability and postoperative pain were similar. The mean radiological union time was 10 (range: 7 to 13) weeks in Group 1 and 9 (range: 7 to 12) weeks in Group 2. There was no significant difference between the mean union time of both groups ($p>0.05$). The mean AOFAS score was mean 90 (range: 72 to 100) in Group 1 and 92 (range: 70 to 100) in Group 2 with no statistically significant difference. All the patients were very satisfied or satisfied with the treatment received.

Discussion

Many factors influence the choice of surgical fixation technique such as the type of fibular fracture, the configuration, concomitant injuries or diseases, age and expectations of the patient and the condition of the skin in the incision area.

Lateral plating is the most frequently applied surgical treatment technique for lateral malleolar fractures, although complications have been reported associated with this technique such as infection and skin necrosis.[6] In the application of a lateral plate, the distal screws have to hold the medial cortex of the fibula but must certainly not penetrate the talofibular joint.[7] Particularly in elderly and osteoporotic patients lateral plate fixation may not ensure adequate stability and also wound healing problems are common.[8] However, there are studies which report that in osteoporotic fractures, supportive methods combined with locked lateral plate can increase the quality of the fixation.[9]

Due to problems seen in the application of lateral plate, such as the risk of screws penetrating the talofibular joint, the need for a long incision when using a long plate, and skin irritation, Brunner and Weber recommended short antiglide plate fixation to use a shorter incision and cause less implant irritation, in short oblique fractures of the fibula.[3] In this technique, the plate is placed from the posterior to avoid loss of rotation to the proximal of the distal fragment, the posterior surface of the fibula allows for the use of a strong, thick plate, the distal screws going from posterior to anterior hold both cortices and there is no risk of penetrating the joint. However, even in posterior plating, peroneal tendon irritation may be seen with a thick plate and screws.[10] In mechanical terms, no difference has been shown between antiglide and lateral plating.[11] There are studies reporting the superiority of lateral plating even in osteoporotic fractures.[8,12]

Tension band wiring with 2 K-wires and cerclage wire requires a shorter incision and cause less soft tissue damage as in posterior plating, without irritating the peroneal tendons. This effective fixation method which

Table 2. Comparison of both groups regarding some results.

		Plate-screw (Group 1)	Tension band (Group 2)
Incision scar	Type A	4.9 cm (4.5-5.4)	4 cm (3.5-5.2)
	Type B	6.8 cm (5.6-7.5)	5.3 cm (5-5.9)
Radiologic union time		10 weeks (7-13)	9 weeks (7-12)
	Type A	9 weeks (7-12)	9 weeks (7-11)
	Type B	10 weeks (8-13)	10 weeks (7-12)
Need for removal of the implant		12 patients (%14)	1 patient (%1.8)
	Type A	4 patients (%15)	1 patient (%3)
	Type B	8 patients (%14)	-
AOFAS	Type A	92 (75-100)	92 (78-100)
	Type B	90 (72-100)	91 (70-100)

is mostly used for medial malleolar fractures may also be alternative for lateral malleolar fractures.[4,5]

During lateral malleolar fracture surgery, the peroneal nerve which penetrates the crural fascia at a mean of 5 cm proximal to the level of the ankle joint and its branch intermediate dorsal cutaneous nerve may be damaged.[13,14] Wide variations are seen at the emergence site of the lateral compartment of the superficial peroneal nerve from the crural fascia. In a study by Mirza et al., this nerve was found to be mean 11.6 cm from the tip of the lateral malleolus.[15] Thus, a long incision increases the possibility of nerve injury. As a matter of fact the loss of sensation seen in 2 patients of Group 1 in our study may be due to a long incision. In this context, tension band technique which uses a shorter incision, may be more advantageous than lateral plating.

When the results of the current study were examined in respect of the incision scar, the length of the incision was seen to increase proportional to the fracture type in both groups. However, in terms of incision length, there was a highly statistically significant difference between the groups, which may be due to the rate of Type B fractures in Group 2 being lower. The mean union time which was found 1 week shorter in Group 2 may be due to the impairment of periostal circulation with plate fixation. However the higher rate of type B fractures in Group 1 probably extended the union time.

The AOFAS scores were found to be excellent in both groups. Besides the good results of both treatment methods, this finding can be considered to be influenced by the exclusion of the cases with syndesmosis instability and other concomitant injuries which may have reduced the score.

As both treatment methods appear to be evenly effective, tension band technique which can be applied cheaply with universally available may have a significant advantage over plate and screw technique.

In conclusion, both surgical techniques used in the treatment of Danis-Weber Type A and B fractures give excellent results. The tension band technique in the treatment of lateral malleolar fractures is a cheap and clinically acceptable treatment alternative. For reasons such as less impairment of periosteal circulation, less mechanical irritation where there are skin problems in the surgical area, the need for a shorter incision, no problems such as screw loosening and no need to remove an implant, the tension band technique has conspicuous superiority. Plate and screw should be the choice in comminuted fractures, oblique fractures or osteoporotic fractures, where they provide better control of the fibular length and a more rigid fixation.

Conflicts of Interest: No conflicts declared.

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