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Chevron osteotomy in patients with scheduled osteotomy of the medial malleolus

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Objective: The aim of the present study was to evaluate intermediate-term outcomes of Chevron osteotomy for treatment of osteochondral lesions of the talus with mosaicplasty and to assess its effect on surgery and whether it reduces complications that might occur intraoperatively.

Methods: The present study included a total of 42 patients (31 men and 11 women) who underwent Chevron osteotomy of the medial malleolus and who had been followed for more than 2 years. Mean age of the patients was 34 years (range: 18–54 years). Preoperatively, size of the lesions was measured in millimeters in the coronal and sagittal planes using magnetic resonance imaging (MRI). The angle between the osteotomy with the long axis of the tibia was measured on the coronal plane, the angle between the arms and the angle for the screws to be directed to the osteotomy line were measured on the sagittal plane on the postoperative images. Nonunion, malunion, and complications from the screws were evaluated from X-ray images taken at the final follow-up.

Results: Mean duration for follow-up was 31.4 years (range: 24–46). On the X-ray images taken at the final follow-up, no distraction, migration of the distal part, or rotation was observed. Only 1 patient experienced radiological non-union. Mean duration to union was 5.8 weeks (range: 4–14 weeks). Screws of 8 patients were removed at an average of 7.4 months (range: 5–11 months). The angle between the osteotomy line and long axis of the tibia was 29.0°±6.5°, the angel between the osteotomy arms on the sagittal plane was 74.7°±8.3°, and the direction angle of the screws on the coronal plane was 85.7°±5.9°.

Conclusion: Chevron osteotomy is an assistive surgical method used for treatment of osteochondral lesions located in the medial talar joint surface (TOL) which provides fast anatomical healing because it allows efficient fixation due to its geometry.

Keywords: Inverted Chevron; malleolus; osteochondral lesions of talus; osteotomy; talus.

Osteotomy of the medial malleolus is an assistive surgical method frequently used to access osteochondral lesion located on the medial talar joint surface (TOL) or for surgery of talus fractures.[1–5] It was first defined in 1947 by Ray and Coughlin[6] as transverse-shaped malleolar osteotomy, and various types of osteotomy have been defined since then.[7–13]

Oblique osteotomy is the currently preferred method for many surgeons, owing to its low learning curve and the successful results that it yields.[13] Chevron osteotomy is another type of malleolar osteotomy and has been suggested to provide a wide visual field for the central and posterior parts of the talus.[14] With Chevron osteotomy, it has been reported that proximal migration

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of the distal part is less due to the geometry of the osteotomy and the distal part has greater stability, which are advantages that positively affect the healing process.[12] Furthermore, it has been claimed that a wider area can be managed during Chevron osteotomy than during oblique osteotomy, and thus, Chevron osteotomy is an easier and more efficient treatment.[14,15] Although advantages and disadvantages have been reported in the literature for each osteotomy type, no consensus has been reached.

The objectives of the present study were to evaluate intermediate-term outcomes of Chevron type malleolar osteotomy used during TOL treatment and to evaluate radiologically its effects on the complications that might occur on the osteotomy line.

Patients and methods

A total of 42 patients (31 men, 11 women) who underwent Chevron osteotomy of the medial malleolus and who had been followed for more than 2 years were included in the present study. Mean duration of follow-up was 34.3 years (range: 18–54). Patients with follow-up of less than 2 years were excluded.

Preoperatively, standard anterior-posterior (AP), lateral, and oblique images were taken. Additionally, preoperative magnetic resonance imaging (MRI) scans were taken to assess location and size of the lesion. The angle between the osteotomy with the long axis of the tibia was measured on the coronal plane, the angle between the arms and the angle for the screws to be directed to the osteotomy line were measured on the sagittal plane on the postoperative images. Maintenance of the trabeculation on either side of the osteotomy line was considered as radiological union. Lack of pain or tenderness on the osteotomy line was considered as clinical union.

Standard anterior curved longitudinal incision was made at the level of the medial malleolus in supine position following spinal anesthesia. For patients scheduled for Chevron osteotomy, Kirschner (K) wire was introduced under scopic guidance from the center of the malleolus to the joint by targeting the most lateral tip of the lesion, and point of entry for the osteotomy to the joint was determined (Figure 1a). Two screw tracts to be used postoperatively were opened first by K-wire and then by cannula drilling from above the wire (Figure 1b). By sparing the posterior tibial tendon, malleolar osteotomy was performed using an oscillatory saw until reaching the subchondral region (Figure 1c). Osteotomy was performed to complete the articular part of the incision. After measuring diameter of the talus lesion, a cylindrical osteochondral graft of appropriate size was taken from the lateral to the ipsilateral lateral femoral condyle using receiver set and inserted on the lesion area (Figure 2). Upon completion of the surgical procedure on the talus, the medial malleolus was reduced, and fixation was achieved using 2 titanium cannulated screws of 4.0 mm vertical to the osteotomy line on the coronal plane and parallel on the sagittal plane through the previously-drilled spaces (Figure 3a). Position of the malleolus was assessed under scopic guidance, and the surgical procedure was completed.

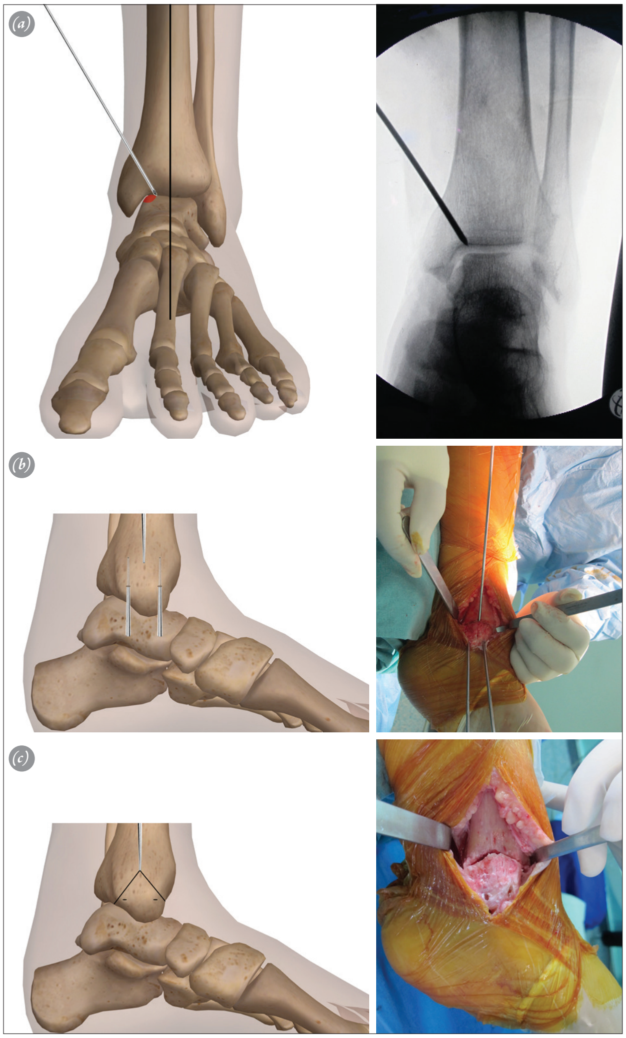

Fig. 1. **(a)** Schematic and scopic view of the osteotomy line and apical point by targeting the most lateral tip of the lesion with Kischner (K) wire under scopic control. **(b)** Schematic and scopic view of the K-wire for determining tract for 2 cannulated screws for malleolar fixation. **(c)** Schematic and scopic view of the osteotomy performed via saw after determining the screw holes and osteotomy incision sites. [Color figures can be viewed in the online issue, which is available at www.aott.org.tr]

A splint was used for tissue healing for 7–10 days following surgery; once removed, the ankle was mobilized. Radiological control images were taken at the 1st, 3rd, and 6th postoperative weeks and then serially with 3-week intervals, and the union was evaluated. Load was initiated from the 3rd week depending on status of union, and mobilization was achieved by giving full load between the 8th and 12th weeks. The athletes were allowed to commence sportive activities after the 12th week.

Results

Mean duration for follow-up was 31.4 years (range: 24–46 years). When early postoperative radiograms were reviewed, all patients were observed to have achieved anatomical fixation of the medial malleolus via 2 parallel cannulated screws. On the control radiograms taken at the final follow-up, no distraction, migration of the distal part, or rotation was observed, and radiological union was achieved in all patients except 1 (Figure 3b).

Forty-one patients (97.6%) had complete radiological union and clinically asymptomatic osteotomy line. Average duration for radiological union was 5.8 weeks (range: 4–14 weeks). There was tenderness on the osteotomy line and pain during load bearing in patients with incomplete radiological union. The osteotomy region was renewed by sparing the present screws, and autograft from the iliac crest was inserted. Radiological union and clinical healing were achieved on Week 6 after the 2nd operation. Screws of 8 patients (19%) with complaints due to the screws were removed after an average 7.4 months (range: 5–11 months). No patient developed infection in the early or late postoperative period.

Mean angle between the osteotomy line and long axis of the tibia was 29.0°±6.5° on the coronal plane. This angle was observed to be ±5% of the mean value (24–34°) in 35 ankles (83.3%). Angle between the 2 osteotomy arms was found to be 74.7°±8.3° on the sagittal plane. Mean width of the talus lesions on the coronal plane was 9.29±1.69 mm, and their mean width on the sagittal plane was found to be 11.67±2.25 mm. Mean directional angle of the screws relative to the osteotomy line on the coronal plane was found to be 85.7°±5.9° (Table 1).

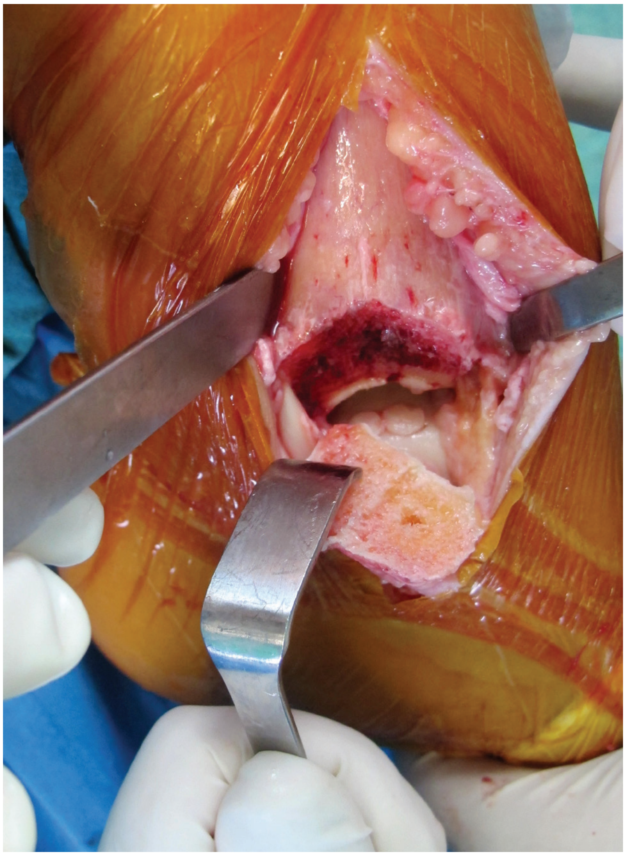

Fig. 2. Visible situation of the joint and location of the grafts after the malleolus has been elevated. [Color figure can be viewed in the online issue, which is available at www.aott.org.tr]

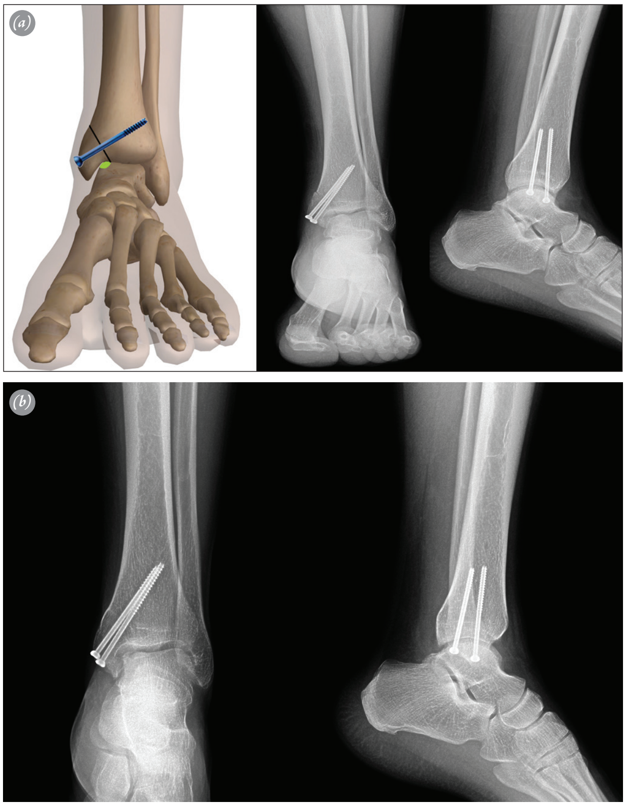

Fig. 3. **(a)** Schematic and scopic view of fixation of the medial malleolus by screws after completing the surgical procedure on the talus. **(b)** AP and lateral ankle radiograms of the patient 2 years later. [Color figure can be viewed in the online issue, which is available at www.aott.org.tr]

Table 1. Clinical and radiographic measurements of the patients.

	Average	Range
Age (year)	34.3	18–54
Follow-up time (month)	31.4	24–46
Time to union (week)	5.8	4–14
Diameter of lesion on coronal plane (mm)	9.29±1.69	6.5–13
Diameter of lesion on sagital plane (mm)	11.67±2.25	7.5–13
Angle on coronal plane with tibia (°)	29.0±6.5	18–45
Angle of between osteotomy lines on sagital plane (°)	74.7±8.3	62–88

Discussion

Medial malleolar osteotomy for treatment of osteochondral lesions located on TOL is an assistive surgical method which produces a wide field of sight and increased ease of working.[1] After transverse-shaped osteotomy was first defined by Ray and Coughlin,[6] oblique, step-cut, inverted U, crescentic, and Chevron-shaped osteotomies have been defined, and superior aspects of each method have been described.[7–13] In the literature, however, it has been reported that problems such as tenderness and pain on the osteotomy line, increased duration of immobilization, malunion, and nonunion can be seen independent of osteotomy type.[10,16] In the present study, the contribution of malleolar Chevron osteotomy in patients with scheduled mosaicplasty for treatment of TOL and its effects on complications that might occur on the osteotomy line were radiologically evaluated retrospectively.

Transverse osteotomy is the 1st defined medial malleolar osteotomy.[6] It is a simple osteotomy extending from the most medial cortex of the medial malleolus at the articular level to the medial corner of the distal tibial articular surface in order to visualize the medial dome of the talus. Although it is considered an easily performed osteotomy, the field of sight is not always sufficient as a result of the contoured structure of the tibial distal joint, which may cause difficulty in performing the procedure. Using a single screw for fixation, however, may cause rotation in the distal part[17–19] The use of transverse osteotomy has decreased because it does not allow a comfortable working area for mosaicplasty and has been observed to increase complications occurring on the osteotomy line.

Inverted U (∏) malleolar osteotomy is another defined osteotomy that remains in use. In this technique, drilling is performed prior to the osteotomy, and 3 incisions are made so that an inverted U shape is created on the medial malleolus. Although it provides an adequate working area for small and central lesions, it has several limitations such as its inability to provide an adequate field of sight and its inability to be used in the patients with limited foot movement and narrow ankle joints.[11] Furthermore, creating 3 incisions poses risk of iatrogenic injuries and nonunion. Compared to inverted U osteotomy, Chevron osteotomy has advantages such as its ability to provide a wide field of sight as well as its ability to be effective in all lesions independent of size. Nonetheless, Chevron osteotomy can increase risk of nonunion or malunion because of less opportunity for proximal migration of the distal part and fewer incisions.

Crescentic osteotomy is a type of osteotomy requiring a special crescentic saw or osteotomy performed by targeting the contour of the talus dome.[9] Although visualization of the talus is optimal in this osteotomy, it increases risk of nonunion because use of a crescentic saw results in greater heat necrosis. Additionally, wide-contoured osteotomy may increase such complications as malunion or rotation. Chevron osteotomy offers a significant advantage in that it does not require a featured saw and presents less risk of nonunion due to the smaller amount of exposed heat. However, risk of proximal migration is higher in crescentic osteotomy compared to Chevron osteotomy because of the geometry of crescentic osteotomy,[9,15] which may be considered as another superiority of Chevron osteotomy. When radiological results of the present study were evaluated, union rate of 97% and lack of malunion in patients supports findings in the literature.

Step-cut osteotomy is a double-planned osteotomy first defined by Alexander and Watson[10] and then modified by Lee.[20] This type of osteotomy consists of 1 sagittal incision and 1 coronal incision complementing it. It has been suggested that step-cut osteotomy gives a wide field of sight and prevents proximal migration due to the geometry of its incision.[15] However, it requires greater soft tissue dissection compared to other types of osteotomy because of the width of its incision. Moreover, introducing the screw vertical to the osteotomy line is difficult, though it is possible to introduce the screw vertical to the vertical osteotomy line, making stability unreliable.[15] In Chevron osteotomy, both screws are introduced vertically to the osteotomy line in the coronal plane, and wide lesions are easily reached using only the osteotomy angles without requiring wide soft tissue dissection. This contributes to decreased risk of infection or surgical site necrosis due to excessive soft tissue dissection.

Oblique osteotomy is currently the usually preferred method because of its low learning curve.[6,13,21,22] This osteotomy is performed based on only the width of the coronal plane without considering the width of the lesion on the talus on the sagittal plane. Even though it is considered to be an advantageous osteotomy in term of ease of implementation, when it is evaluated in the coronal plane, the angle of osteotomy is decreased compared to the long axis of the tibia, and thus its location between the fixation screws and osteotomy line impairs the recommended right angle. Proximal migration of the distal part is a common complication due to the oblique nature of the osteotomy, and risk of this complication increases as the angle becomes impaired. Maintaining the angle between the osteotomy line and long axis of the tibia on the coronal plane at 30° during oblique osteotomy has been demonstrated to reduce the rate of proximal migration as well as nonunion by using computerized tomography (CT).[12] Reducing this angle to less than 30° in the wider lesions close to the center may decrease possibility of introducing the screws vertical to the fracture line. In conclusion, articular misalignment and proximal migration are common complications of oblique osteotomy.[12,21] In the present study, our angle between the long axis of the tibia and osteotomy in the coronal plane was 29°, and the intersectional angle of the screws introduced with the osteotomy line was 85.7°, which were in the recommended optimal range. We consider that these values might explain the low complication rate observed.

Limitations of the current study were that it was retrospective, lacked a comparative group, measured values based on only radiological data, and reported intermediate-term outcomes. Strengths of the present study were that the study group was homogenous in terms of surgical indication, the implant, and the technique used, and that the study provided results of a type of osteotomy rarely reported in the literature.

Chevron osteotomy is one of the medial malleolar osteotomies frequently preferred in patients with scheduled mosaicplasty for treatment of TOL. This osteotomy has been advocated as a stable osteotomy because of the possibility of reaching wide lesions due to movable incisional angle in the sagittal plane and because of its dentated triangular geometry makes it a stable osteotomy. When we evaluated the radiological data, we saw that keeping the osteotomy angle in the coronal plane at the optimal level and fixing 2 screws vertical to the osteotomy line in the coronal plane decreased such complications as nonunion and malunion. Although we believe that the satisfactory results we obtained further support Chevron osteotomy as the preferred osteotomy type, we consider that these data should be supported by future prospective controlled studies.

Conflics of Interest: No conflicts declared.

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