EXPERIMENTAL STUDY

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Talar neck fractures: anatomic landmarks of suitable position for posterolateral screw insertion

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Objective: The posterolateral window is a suitable position for screw insertion. The aim of this study was to define this position for posterolateral screw insertion.

Methods: Fifteen adult cadaver ankles were used in this study. When the ankle was positioned in a neutral position, the posterolateral window was exposed. Height and width of the window were measured. Vertical distance from the center of the window to the lateral malleolus tip (LMT), horizontal distance from the center of the window to the lateral of the Achilles tendon (LAT), and horizontal distance from the lateral of the Achilles tendon to the sural nerve (SN) were measured. Additionally, the anatomical relationships between the center of the window (the screw insertion point) and surrounding tissues were noted.

Results: The results indicated that the posterolateral window was bounded medially by the lateral tubercle of the posterior process of the talus (LTPT), laterally by the posterior border of lateral malleolar (PBLM), superiorly by the trochlear articular surface (TAS), and inferiorly by the posterior calcaneal facet (PCF). The height and width of the posterolateral window were 1.89±0.04 cm and 0.91±0.01 cm, respectively. LMT was 0.40±0.01 cm, LAT was 0.19±0.02 cm, and SN was 0.62±0.04 cm. The present data showed that posterior screw insertion may be a safer screw insertion technique for talar neck fractures. Performing the operation through the posterolateral window had no negative effect on surrounding tissues such as the flexor hallucis longus and posterior talofibular ligament tissues when the ankle joint was positioned in a neutral position. Additionally, the screw head should be countersunk to reduce intraoperative risk.

Conclusion: The posterolateral window is a safer point for posterolateral screw insertion for talar neck fractures.

Keywords: Anatomical morphology; posterolateral screw insertion; posterolateral window; talar neck fractures.

Talar neck fractures occur infrequently and have been associated with high complication rates.[1] The mechanism of action for these fractures has been frequently described as a combination of axial compression forces and dorsiflexion.[2] Stronger fixation of talar neck fractures is helpful to decrease incidence of malunion, withstand early motion after surgery, and improve ankle and subtalar joint function. However, treatment of talar neck fractures

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is challenging. In recent years, techniques of internal fixation of the talus include placement of Kirschner wires, Steinmann pins, and screws and plates of various types and sizes inserted anteriorly either through the articular surface of the talar head or through the talar neck.[3,4]

Although knowledge and understanding of talar neck fractures, as well as the biomechanics and techniques of treatment have advanced, a significant number of patients with these fractures still experience long-term complications.[5] Treatment has evolved slowly over the years, from closed treatment to open reduction and internal fixation (ORIF). There is a growing tendency toward screw insertion techniques for talar neck fractures, including posteriorly inserted screws and anteriorly inserted screws. Posterior screw insertion facilitates screw placement perpendicular to the fracture line; this is the preferred method for treatment of talar neck fractures. However, this treatment method presents drawbacks. The approach may endanger the cartilage, posterior neurovascular structures, or talar articular.[6] Moreover, the fracture site is routinely exposed from an anterior approach, which facilitates anterior screw fixation, but makes posterior screw fixation technically challenging. Thus, careful assessment of the anatomic landmarks of posterolateral screw insertion is essential prior to any procedure. According to a previous study,[7] there is an approximate trapezoid bone window on the posterior lateral of the talus. This bone window, the posterolateral window (security zone), is not covered by articular cartilage. The position of this zone remains controversial.

The aim of this study was to define the anatomic landmarks associated with the posterolateral window for screw insertion of talar neck fractures. We investigated the anatomical relationships of the posterolateral window to its surrounding structures and set the posterolateral window center as a screw insertion point to measure the anatomical relationships between the screw insertion point and the surrounding tissues in order to provide guidance for clinical surgery.

Materials and methods

To define the anatomic landmarks associated with suitable position for posterolateral screw insertion of talar neck fractures, 15 adult cadaver ankles were used in the present study. Exclusion criteria included congenital malformations, traumatic malformations, and other diseases which affect skeletal morphology. According to Ebraheim et al.,[6] with the ankle in equinus position, a curvilinear posterolateral incision lateral to the Achilles tendon was made, extending to the lateral tubercle of the calcaneus. After dividing the superficial transverse veins, the sural nerve (SN) and short saphenous vein were exposed. The crural fascia was incised lateral to the Achilles tendon, and the adipose tissue was dissected to the deep fascia covering the deep compartment of the posterior leg. The fat pad and subtalar joints were excised. The deep fascia was carefully incised proximal to the posterior aspect of the ankle joint. The flexor hallucis longus muscle tendon was identified as it passed distally from lateral to medial. The lateral tubercle of the posterior process of the talus was then identified. The peroneal artery was confirmed before the lateral calcaneal branch and retracted laterally toward the tendon of the peroneus brevis muscle. The posterolateral window was exposed; in order to identify its size, a vernier caliper with an accuracy of 0.01 cm was used to measure the height and width of the posterolateral window. The anatomical position of the posterolateral window center was determined, including vertical distance from the window center to the lateral malleolus tip (LMT), horizontal distance from the window center to lateral of the Achilles tendon (LAT), and horizontal distance from the lateral of the Achilles tendon to the SN. Additionally, the anatomical relationships between the screw insertion point (the window center) and the surrounding tissues such as the flexor hallucis longus and posterior talofibular ligament tissues were observed.

Statistical analysis was performed using SPSS 19.0 software (SPSS Inc., Chicago, IL, USA). Values are reported as mean ± standard deviation.

Results

When the ankle joint was positioned in a neutral position (0° of dorsiflexion), the posterolateral window was completely exposed. The posterolateral window was bounded medially by the lateral tubercle of the posterior process of the talus (LTPT), laterally by the posterior border of the lateral malleolar (PBLM), superiorly by the trochlear articular surface (TAS), and inferiorly by the posterior calcaneal facet (PCF) (Figure 1). Average height and width of the posterolateral window center were 1.89±0.04 cm and 0.91±0.01 cm, respectively (Figure 2). Vertical distance from the center to the LMT was 0.40±0.01 cm and horizontal distance from the center to the LAT was 0.19±0.02 cm (Figure 2). Horizontal distance from the LAT to the SN was 0.62±0.04 cm.

Although the flexor hallucis longus is located at the proximal end of the posterolateral window, performing the operation through the posterolateral window had no effect on this muscular issue when the ankle joint was positioned in a neutral position. In addition, introducing the screw through the posterolateral window did not significantly affect neighboring tissues such as the pos-

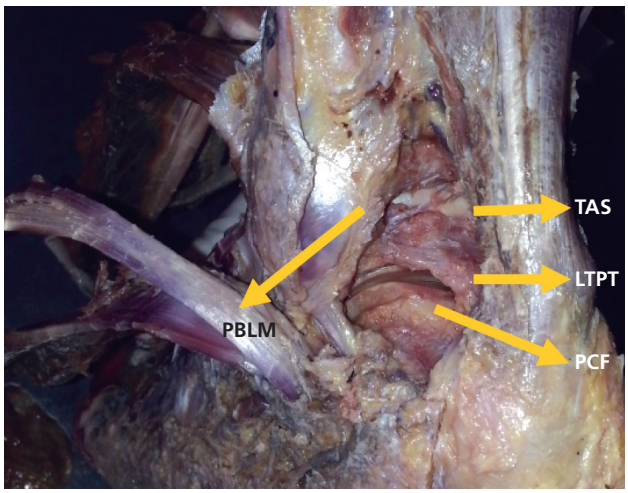

Fig. 1. The anatomical position of the posterolateral window. The posterolateral window was bounded medially by the lateral tubercle of the posterior process of the talus (LTPT), laterally by the posterior border of lateral malleolar (PBLM), superiorly by the trochlear articular surface (TAS), and inferiorly by the posterior calcaneal facet (PCF). [Color figure can be viewed in the online issue, which is available at www.aott.org.tr]

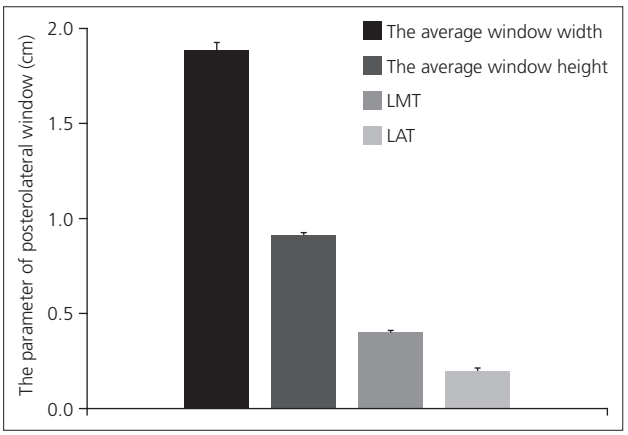

Fig. 2. The parameter of posterolateral window. Values are reported as mean ± standard deviation. LMT, the vertical distance from the center to the lateral malleolus tip; LAT, the horizontal distance from the center to lateral of the achilles tendon.

terior talofibular ligament as a result of it covering the inferior surface of this security zone (Figure 3a, b). Consequently, the most suitable position for posterolateral screw insertion is the posterolateral window (Figure 4a, b), and the screw head should be countersunk to avoid violating the posterior talofibular ligament.

Discussion

Talar neck fractures account for 50% of major talar injuries.[8] Although uncommon, talar neck fractures are associated with high rates of complication, including nonunion, malunion, arthritis of the ankle and subtalar joints, degenerative arthritis, and avascular necrosis.[9,10] For these reasons, treatment of talar neck fractures is useful in reestablishing circulation to the soft tissue, restoring union of the bone and revascularization, improving congruity of the ankle and subtalar joint, and allowing early motion (which prevents edema, stiffness of the joint, and atrophy of the soft tissue).[11] The appropriate diagnosis and treatment of these fractures plays an important role in the patient's outcome. However, therapeutic tools have evolved slowly in recent years, from

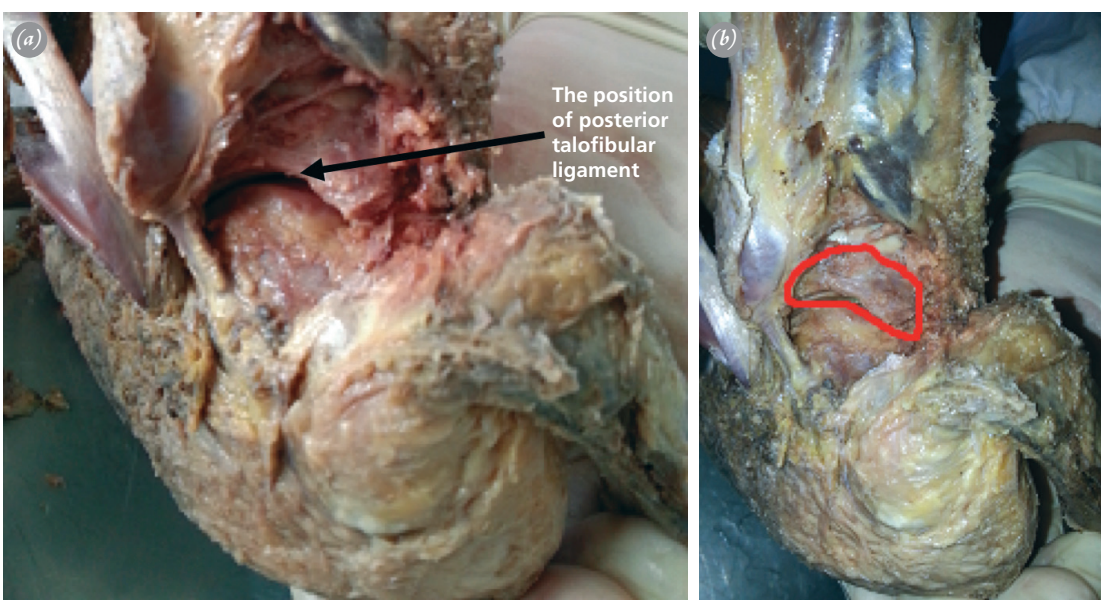

Fig. 3. **(a)** The position of posterior talofibular ligament. **(b)** The area of posterolateral window. [Color figures can be viewed in the online issue, which is available at www.aott.org.tr]

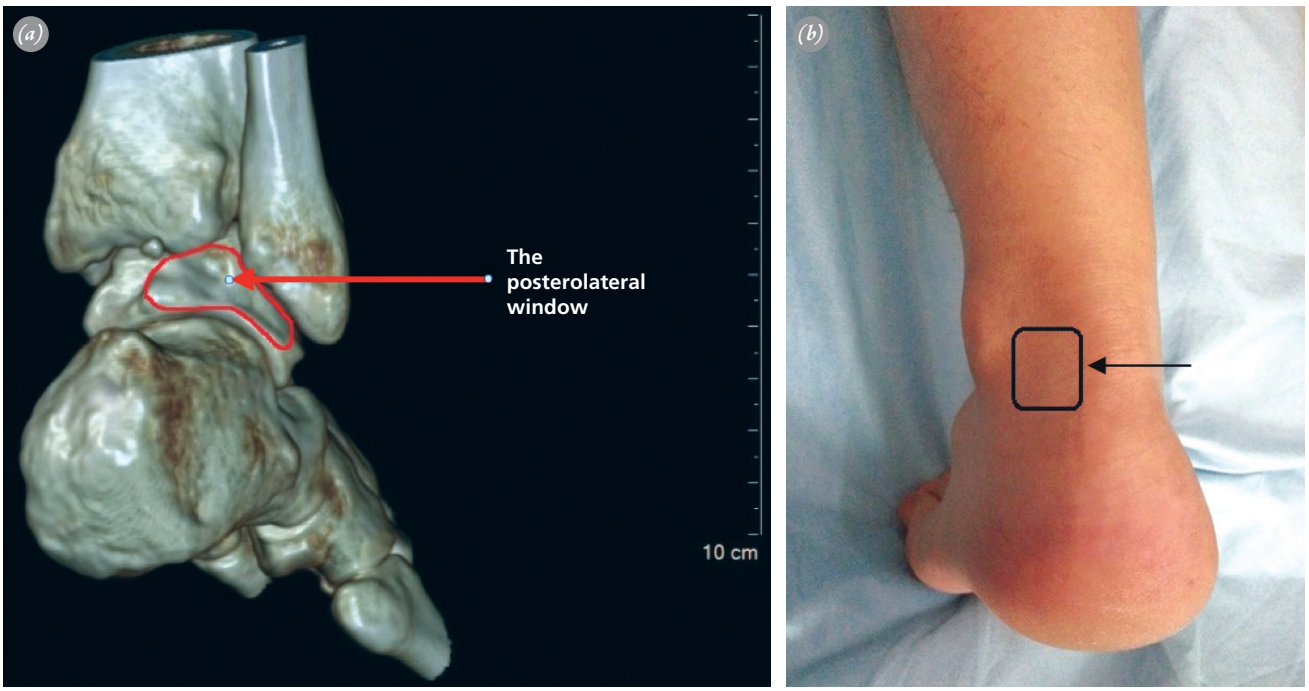

Fig. 4. **(a)** CT scan picture of posterolateral window. **(b)** The outside view of posterolateral window. [Color figures can be viewed in the online issue, which is available at www.aott.org.tr]

closed treatment to open reduction and internal fixation. The incidence of poor results following talar neck fractures remains high despite the advancement in the understanding and knowledge of these fractures.

In a study by Swanson et al.,[12] the results suggested that fixation with screws is biomechanically superior to that with Kirschner wires. Moreover, posterior-to-anterior fixation with screws has a better mechanical advantage than that obtained with screws placed in an anterior-to-posterior direction. Because the posteriorly inserted screws are more likely to cross the central portion of the talar neck in a perpendicular orientation, they theoretically provide a better mechanical advantage compared to anteriorly inserted screws.[13] Nonetheless, posterior screw fixation comes with its own disadvantages; for example, the approach may damage the talar articular cartilage and posterior neurovascular structures.[14,15] On the contrary, in most cases, the anterior approach presents the advantages of direct visualization of the reduction and internal fixation, as well as avoidance of minor blood vessels entering posteriorly. Therefore, posterior screw fixation is still a technically-challenging procedure. The posterolateral window is a safer choice for posterolateral screw insertion for talar neck fractures in reducing intraoperative risk. However, little is presently known regarding the anatomical structure of the posterolateral window and the relationship between the posterolateral window and surrounding tissues, which limits the clinical use of posterior screw fixation.

In the current study, we detected some heretofore unknown parameters which provided information about the anatomical structure of the posterolateral window. The results indicated that the posterolateral window was bounded medially by the LTPT, laterally by the PBLM, superiorly by the TAS, and inferiorly by the PCF. Moreover, the parameter of the posterolateral window showed that average window height and width of the posterolateral window center was 1.89±0.04 cm and 0.91±0.01 cm, respectively. This zone is a suitable position for posterolateral screw insertion, for there are no vital nerves, blood vessels, or tendons. In the anatomical structure, however, the saphenous vein and the SN were found to be in close proximity to the Achilles tendon; this point calls for continued attention.[16] We measured the vertical distance from the posterolateral window center to the lateral Achilles tendon, and the results showed that it was approximately 0.19±0.02 cm. The lateral malleolus is prominent on the outer side of the ankle, and it has been used as a marker in foot operations.[6] Our results indicated that the vertical distance from posterolateral window center to the lateral malleolus tip was approximately 0.40±0.01 cm. Moreover, we detected the horizontal distance from the lateral of the Achilles tendon to SN (0.62±0.04 cm), and this result suggested the posterolateral window is not in close proximity to the SN. The anatomical relationships between screw insertion point and

the surrounding tissues such as the flexor hallucis longus and posterior talofibular ligament were also considered. According to the measurements and bordering anatomical landmarks, the surrounding tissues were not easily affected. Nevertheless, the authors also suggest that the screw head should be countersunk to avoid violating the posterior talofibular ligament. However, the limitation of the present study is the absence of screw insertion photos, which we will address in future studies. In conclusion, the present study demonstrated that the posterolateral window is a safer posterolateral screw insertion point for talar neck fractures. Our results will aid in improving the success rate of screw insertion techniques of talar neck fractures and decrease risk during clinical operation.

Conflics of Interest: No conflicts declared.

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