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Radiographic Analysis of the Canale View for Displaced Talar Neck Fractures

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ABSTRACT

Fractures of the talar neck comprise almost 50% of fractures of the talus and may result in significant long-term morbidity. It is of paramount importance to ensure anatomic reduction of the fracture not only for fracture healing but also for minimizing future posttraumatic arthritic sequelae. In addition to conventional radiographs and computed tomography scans, the Canale view has proven to be beneficial, especially when evaluating for varus displacement. This study investigated whether the original method of performing the Canale view could be modified for improved evaluation for varus displacement. Simulated talar neck fractures were created in 6 cadaveric specimens. These were placed into varying amounts of varus displacement; the Canale view was performed with progressive degrees of eversion, from 0° to 25°, resulting in 108 total views. Blinded evaluation was performed, and a ranking system was used to determine the most beneficial degree(s) of eversion for evaluating varus malalignment. Multiple statistical analyses were performed. A significant difference was seen between the high and low range of values of eversion. A significantly lower ranking was achieved with 10° of eversion. As opposed to a single view taken at 15° of eversion, a range of angles may be most beneficial in evaluating varus displacement in talar neck fractures.

Although described as early as 1608 by Fabricius, Anderson in 1919 was probably the first to publish a series of talar neck fractures (1,2). The fractures in Anderson's series resulted from aviation accidents which led to the original term for this fracture, "aviator's astragulus." In 1952, Coltart reported on 228 talar fractures, with fractures of the talar neck making up 48% of these (3). In 2000, Elgafy et al reported a similar value for talar fractures seen at 2 level 1 trauma centers; approximately 45% of 60 talar fractures were talar neck fractures (4). Although originally described as an aviation injury, the vast majority of talar neck fractures seen today are a result of motor vehicle collisions or falls from a significant height. The postulated mechanics of injury of talar neck fractures have included forced dorsiflexion of the ankle, impingement between the tibia and calcaneus, and supination-type forces (2,3,5–10). Although at one time considered a "surgical emergency," delayed fixation has been reported with good success (11).

The most common classification system used today for talar neck fractures is the Hawkins classification, which described 3 types in 1970 (7). An additional "type" was later described by Canale and Kelly, which also involved subluxation/dislocation of the talonavicular joint (12) The average incidence of avascular necrosis after talar neck fractures has been reported to be 52% despite the fact that the talus has extensive intraosseous vascular anastamoses (12,13).

Anatomic reduction of talar neck fractures, including any joint displacement, is paramount to minimize the risk of nonunion, malunion, and future posttraumatic osteoarthritic changes. In particular, any varus displacement of the fracture must be carefully evaluated, both pre-reduction and postreduction. Sangeorzan et al have shown in cadaveric studies that displacements as small as 2 mm significantly impact subtalar joint contact characteristics (14). Others have shown that varus malalignment of the talar neck resulted in a significantly decreased range of motion of the subtalar joint as well as hindfoot and forefoot deformities (15).

Diagnostic imaging is not only vital to the diagnosis and classification of talar neck fractures, but also to determine treatment and accuracy of reduction, and monitor for avascular necrosis of the talar body. Standard foot and ankle radiographs and computed tomography (CT) are routinely used. However, although CT may be the most beneficial in imaging talar neck fractures, it may not be readily available in the emergency department or operating room setting. In 1978, Canale and Kelly described what is now most commonly referred to as the "Canale view" (12). This view was particularly pertinent for the evaluation of varus displacement/rotation of the talar head and neck. This view has been described as essential in determining the degree of initial displacement of a talar neck fracture

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(16). Indeed, it has proven to be valuable not only for pre-reduction evaluation of a talar neck fracture but also for evaluation of the accuracy of closed and/or open reduction of the fracture. The view is performed with the foot maximally plantarflexed at the ankle and pronated 15°, with the radiographic beam directed 75° from the horizontal (Fig. 1).

However, in using the Canale view for evaluating talar neck fractures, the senior author (J.L.T.) has encountered difficulty in achieving reproducible outcomes with the original guidelines for this radiographic view. Although achieving maximal plantarflexion of the ankle and calibration of the radiograph beam to 75° from the horizontal has proven to be easy to perform and duplicate, assuring that 15° of "pronation" has been achieved has been significantly more difficult. In addition, what is perceived to be 15° of pronation is often not the most beneficial angle with respect to clear visualization and evaluation of alignment of the talar head and neck in talar neck fractures. Finally, to our knowledge, a significant scientific investigation has not been presented in the literature to establish the best angle of pronation for investigation of this anatomic area.

The hypothesis for this study was that, although the Canale view is accepted as being beneficial in evaluating for varus displacement in fractures of the talar neck, 15° of pronation is not consistently the most effective angle for evaluation of varus rotation. It follows then that alternative angles, either > and/or <15°, may allow improved evaluation of varus displacement at the fracture site. In addition, it is felt that "eversion" rather than pronation may be a better descriptive term for positioning the foot after it has been placed in its maximally plantarflexed position.

Materials and Methods

Six transtibial cadaveric specimens were used in this study. The age range of the specimens was 59 to 80 years old, with the average being 72 years old. There were 5 male specimens and 1 female specimen; 3 were right feet and 3 were left feet. Deformity, fracture, and tumor or other osseous or soft tissue pathologies were found to be absent in the specimens through clinical examination and radiographic imaging. In each specimen, a talar neck fracture was simulated via osteotomy with a sagittal power saw and oscillating blade (Stryker Corp, Kalamazoo, MI). Pivoting was minimized/avoided by using 2 points of fixation after the osteotomy. The osteotomies were performed by the coauthor (B.M.B.) who was not involved in the final evaluation process of the radiographic images. The osteotomy site was performed at the anatomical neck of the talus distal to the body and its articular surface, yet proximal to the head of the talus. The direction of the osteotomy was as perpendicular to the neck as possible. Because every specimen was anatomically unique, multiplanar obliquity could not be 100% avoided, but this would actually mimic a true talar neck fracture as some degree of multiplanar obliquity almost always exists. Rotational displacement of the osteotomy was achieved and then fixed with 2, 0.062 Kirschner wires (Smith & Nephew, Memphis, TN) (Fig. 2). True varus rotation of the head and neck was performed and wedging was not used. Varus rotation was produced by rotating the talar head and neck into varus after the osteotomy was produced. Gradients of rotation were performed, measured from the dorsal lateral cortex of the talar neck with a 2-mm, 4-mm, and 6-mm step-off produced. Some adduction and relative shortening medially of the talar neck was produced with this varus rotation. A custom jig was used to secure the proximal tibia and the ankle was placed in maximal plantarflexion. With solid Styrofoam blocks customized to angles of 5°, 10°, 15°, 20°, and 25°, radiographs were taken at 0°, 5°, 10°, 15°, 20°, and 25° of eversion of the foot (Fig. 3). The central beam target was the talar neck. The same protocol was used after achieving 4 mm and 6 mm of varus rotation, respectively. A total of 108 radiographic views were obtained. Figs. 4, 5, and 6 show examples of radiographs.

Blinded evaluation of all 108 views was performed by 3 fellowship-trained orthopaedic trauma surgeons and 1 foot and ankle surgeon. Each set of radiographs at its respective degree of varus displacement and its 6 different degrees of eversion was then ranked on a numeric scale from 1 to 6 by each evaluator. A ranking of 1 was felt to be the most beneficial for visualization and evaluation of varus displacement of the talar head and neck, and a ranking of 6 was the least beneficial. Results were collected and tabulated, and statistical analysis was performed by an independent party. Statistical analysis included Cronbach's alpha and Wilcoxon signed-rank (matched pairs).

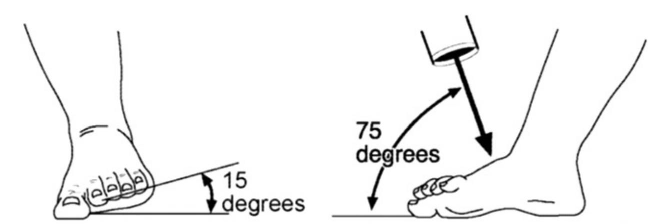

Fig. 1. Canale view.

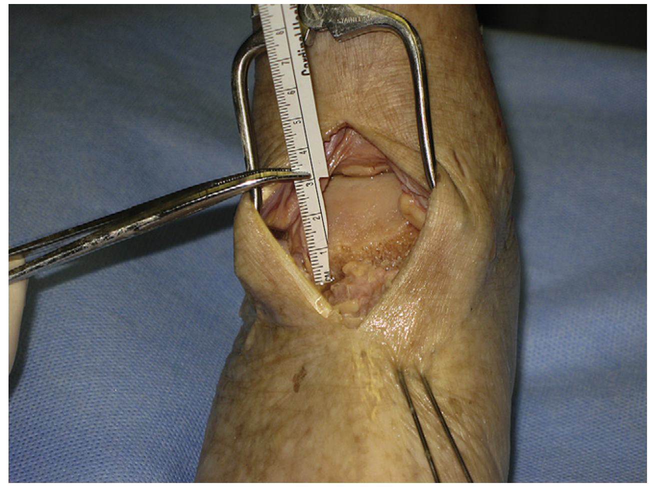

Fig. 2. Cadaveric specimen after talar neck osteotomy and measurement of varus displacement.

Fig. 3. Example of custom block in place allowing for more accurate eversion positioning of the foot.