Assessment of Radiographic Parameters for Adequate Reduction Following Syndesmotic Injury Causing Fibular Malrotation

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INTRODUCTION
Rotational ankle injuries are one of the most common musculoskeletal problems treated by orthopaedic surgeons. The distal tibio-fibular syndesmosis may be disrupted during injury resulting in ankle instability. The goal of surgery is to restore anatomic relation of tibia, fibula, and talus. Any malreduction including that of the syndesmosis may result in poor clinical outcomes. While currently accepted radiographic criteria can adequately detect tibio-fibular diasthesis or translation malreductions, it is not yet clear if the currently available criteria are equally suited for detection of rotational malreductions of the tibio-fibular syndesmosis. The goal of this study is to quantify the sensitivity of fluoroscopic measurements of tibio-fibular overlap (TFO) and tibio-fibular clear space (TCS) to rotational malreductions of the syndesmosis. Standard x-ray imaging will be compared with a 3D fluoroscan which will simulate post-operative CT.

METHODS
Ten unilateral cadaveric ankles (61-87 y.o., 3 female) were mounted onto a custom-made jig incorporating a rotational dial and an intramedullary peg within the fibula. A large Weber clamp was used to reduce the fibula within the incisura at each of 7 rotational positions: 0°, 10°, 20°, and 30° of external rotation. Free rotation of the fibula within the incisura was achieved by transection of the syndesmotic and talofibular ligaments. A transverse osteotomy was performed on the fibula 13cm above the joint line to simulate a Weber C type fracture. The foot was held in a neutral plantigrade position by two threaded pins through the calcaneus and the talar head. 2D Fluoroscan images were analyzed 1cm above the joint line for four radiographic indices: tibio-fibular overlap in the AP plane (TFO-AP) and mortise (TFO-M), and tibio-fibular clear space in AP (TCS-AP) and mortise planes (TCS-M). In addition the distance from the posterior cortex of the fibula to the posterior cortex of the tibia on the lateral image was measured (TFD-L). The CT reconstruction was used to verify the location of the fibula within the tibial incisura and to independently measure the tibio-fibular angle (TFA).

RESULTS
The rotational dial used to position the fibula showed good correlation (R²=0.99) with measured CT TFA. TFA measurements from the CT images were able to show malrotation at all positions (Figure 3). However, all 2D radiographic indices in both AP and mortise views did not constantly show malrotation during external rotation (Figure 4). This was true for both the absolute value and relative change from the intact ankle. The TCS-AP measurement showed no significant change from the intact neutral position up to 30° external rotation but was significantly different from neutral at 30° internal rotation (8.2±1.7mm, p<0.0001). TCS and TFO calculated from the AP view had a higher sensitivity than those calculated in the mortise view for both internal and external rotation.

DISCUSSION
Based on the results, it appears that the current radiographic indices for fibular malrotation are able to detect internal rotation but do not detect external rotation up to 30° in the case of an ankle fracture with syndesmotic disruption. However, the new method of using a CT reconstruction and measuring TFA was sensitive to all rotational positions and had higher repeatability. The question of applicability and cost-effectiveness of intra-operative CT for syndesmotic malrotation should be addressed in future clinical studies.

REFERENCES