Displacement of Sequential Syndesmotic Ankle Injuries Assessed by a 3D Weightbearing CT

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Introduction/Purpose: Syndesmotic ankle injuries are challenging to diagnose, since current 2D imaging techniques try to quantify a 3D displacement. Therefore, our aim was two-fold: to determine displacement of sequential syndesmotic ankle injuries under various amounts of load using a 3D weightbearing CT (WBCT) and to assess the relation with current 2D imaging.

Methods: Seven paired male cadaver specimens were included (tibia plateau to toe-tip) and mounted into a custom-built frame. WBCT scans were obtained after different patterns of load (0kg or 85kg) were combined with torque (0Nm or 10Nm external rotation). These conditions were repeated after each ligament condition: intact ligaments, sequential sectioning of the anterior inferior tibiofibular ligament (AITFL), deltoid ligament (DL), and interosseous membrane (IOM). CT images were segmented to obtain 3D models. These allowed quantification of displacement based on the position of computed anatomical landmarks in reference to the intact position of the fibula. A correlation analysis was performed between the 2D and 3D measurements.

Results: The effect of torque caused significant displacements in all directions (P<0.05), except for shortening of the fibula (P>0.05). Weight caused a significant lateral (mean=-1.4mm, SD=1.5) and posterior translation (mean=-0.6mm, SD=1.8). The highest displacement consisted of external rotation (mean=-9.4°, SD=6.5) and posterior translation (mean=6.1mm, SD=2.3) after IOM sectioning combined with torque (Fig. 1). Pearson correlation coefficients were moderate (range 0.31-0.51, P<0.05).

Conclusion: Torque demonstrated superiority over weight in detecting syndesmotic ankle instability after 3D analysis. The clinical relevance of these findings can improve diagnosis by incorporating rotatory platforms during imaging and treatment strategies by providing appropriate stabilization against rotation.
Fig. 1 External rotation of the fibula after torque (10N) and sequential syndesmotic ligament injuries A. The native (grey) fibula was used as a reference to computed angular displacement based on the different position of the axis connecting the anterior (ATF) and posterior tubercle of the fibula (PTF) B. A significant external rotation of the fibula was detected when torque was applied (**; \( P<0.05 \)), but was not significant when loading without torque was applied (\( P>0.05 \)).