Δ Four-Dimensional CT Analysis Confirms the Importance of Ankle Position When Assessing Syndesmotic Position

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Purpose: The syndesmosis ligament complex stabilizes the distal tibiofibular joint, while still allowing physiologic motion. This syndesmotic motion is important to maintain joint congruity through ankle range of motion (ROM). Syndesmosis injuries occur in 25% of ankle fractures. When injured, malreduction of the syndesmosis is the most important factor contributing to inferior functional outcomes. Syndesmotic reduction is a dynamic measure, which is not adequately captured by conventional CT. Four-dimensional CT (4DCT) can image joints as they move through ROM in real time. Our aim was to employ 4DCT to determine in vivo syndesmotic motion with ankle ROM in uninjured ankles.

Methods: Uninjured ankles were analyzed in patients with contralateral syndesmotic injuries, as well as healthy volunteers with bilateral uninjured ankles. Bilateral ankle 4DCT scans were performed as participants moved their ankles between maximal dorsiflexion and plantar flexion, capturing 10 time points through ankle ROM. Multiple measures of syndesmotic width, including anterior, middle, and posterior syndesmotic distances, tibiofibular clear space, and tibiofibular overlap, as well as sagittal translation, fibular rotation, and syndesmotic area were automatically extracted from 4DCT to determine the change in syndesmotic position with ankle ROM. Linear mixed-effects models determined syndesmotic motion with ankle ROM, while side-to-side variability was assessed with linear regression.

Results: 58 ankles were analyzed from 39 patients (24 males and 15 females). Mean ankle ROM was 46°. As ankles moved from dorsiflexion to plantar flexion, measures of syndesmotic width decreased by 0.7 to 1.1 mm (P<0.001 for each measure). The fibula externally rotated by 1.2° with ankle ROM (P<0.001), but there was no significant motion in the sagittal plane (P = 0.43). Syndesmotic area decreased by 21% (P<0.001). No participants with bilateral uninjured ankles had a side-to-side difference in syndesmotic width of 2 mm or greater.

Conclusion: There is substantial syndesmotic motion during ankle ROM, thereby impacting common measures of reduction. It is important to appreciate and standardize foot position when imaging or reducing the syndesmosis in order to optimize patient outcomes. Syndesmotic position and motion are consistent within subjects; therefore the contralateral ankle may be used to template for anatomic reduction, provided ankle position is standardized. Consideration should also be given to restoring motion, as well as position, after syndesmotic injuries. A syndesmosis rigidly fixed in dorsiflexion may be undercompressed, resulting in abnormal diastasis, and may result in excessive fibular external rotation. Conversely, fixation in plantar flexion may produce overcompression of the syndesmosis and excessive internal rotation of the fibula.

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