Inclusion of a Visual Aid Improves Surgeon and Trainee Accuracy when Evaluating Images for Ankle Syndesmosis Repair

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Introduction/Purpose: Malreduction in ankle syndesmosis repair is associated with post-operative pain, instability, and revision. Although multiple surgical techniques are designed to minimize malreduction, little is understood regarding the multi-factorial sources of error these techniques aim to address. For example, image interpretation errors may be particularly problematic, as previous work indicates identifying subtle fibular displacements from imaging is challenging for experienced orthopaedic trauma surgeons. In this context, this study evaluates whether surgical experience and/or inclusion of a visual aid improves surgeon accuracy during an image interpretation task. The task originates from the center-center technique, which is designed to minimize syndesmosis malreduction by drilling through the aligned centers of the tibia and fibula on an internally-rotated, lateral ankle x-ray.

Methods: Twenty-eight individuals participated in this IRB-approved study (10 orthopaedic surgery attendings, 8 orthopaedic surgery residents, 10 medical students). Each evaluated 90 lateral ankle images arranged in two equal sets. In each set, the fibula was displaced from perfectly centered (-40% posterior to +40% anterior in 10% increments; each increment repeated 5 times). The two sets were identical, except one was augmented with a visual aid (or crosshair) marking the center of the tibia. Image and set order were randomized to control for learning effects. For each image, participants classified the fibula as “centered” or “non-centered” while wearing eye-tracking glasses. The glasses recorded two physiological measures of cognitive burden: image interpretation time and blinks per image. Statistical analyses tested the hypotheses that surgical experience and addition of a visual aid improved interpretation accuracy and decreased cognitive burden. Statistical significance ($p \leq 0.05$) was evaluated using ANOVA followed by paired t-tests.

Results: All participants accurately identified images with large fibular displacements (>20%) and perfectly centered (0%) images; however, interpretation accuracy at small displacements (10%) approximated random chance (Fig. 1A). Inclusion of a visual aid significantly improved image interpretation accuracy for both the full image set ($p=0.015$, Fig. 1B) and images with small displacements ($p=0.025$, Fig. 1A 10% and 20%). Although surgical experience was not a significant predictor of interpretation accuracy, surgical experience did significantly influence physiological measures of cognitive burden. Interestingly, inclusion of a visual aid slightly increased cognitive burden as measured by blinks per image for trainees, but significantly decreased this metric for attendings ($p=0.014$, Fig. 1C). Compared to attendings, time per image was significantly increased for residents ($p=0.007$), but not medical students (Fig. 1D).

Conclusion: This study demonstrates that a visual aid can improve image interpretation accuracy for both experienced surgeons and trainees. Interestingly, the inclusion of the visual aid

decreased the physiologically measured cognitive burden of attendings, but not trainees. This suggests that additional visual information displayed on an x-ray image may be processed and used differently by experienced versus inexperienced surgeons. Thus, this study provides foundational evidence that augmenting images can improve surgical accuracy and motivates future work to characterize how image augmentation influences clinical and educational outcomes.

Figure :

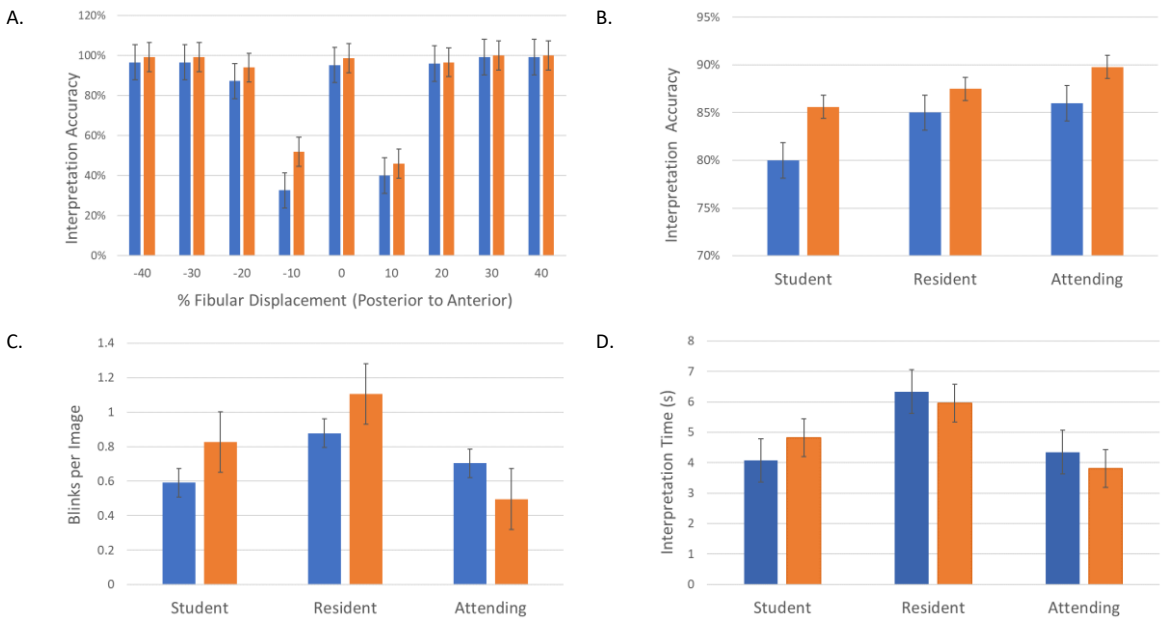

Figure 1. (A-B) Image interpretation accuracy, (C) blinks per image and (D) interpretation time are reported with (orange) and without (blue) a visual aid. In A, image interpretation accuracy averaged across all experience levels highlights differences based on magnitude of fibular displacement. In B, image interpretation accuracy split by experience level highlights differences based on visual aid. In C and D, image blinks per image and interpretation time demonstrated differences based on surgical experience. Error bars represent standard error.