Reliability, Surgeon Perioperative Preferences, and Eye-Tracking Assessment of the Stress Examination of the Lisfranc Joint Complex

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Statement of Purpose and Literature Review

In addition to plain film radiographic characteristics and advanced imaging, manual stress examination is a widely accepted and commonly performed diagnostic tool to determine stability of the Lisfranc joint complex following acute injury and to evaluate the need for operative intervention. Despite this, there is scant published data on the performance and interpretation of this test [1-4]. This might introduce the possibility of unwanted subjectivity and variability during the performance of a purportedly objective diagnostic test likely important in surgical and functional outcomes.

The primary objective of this investigation was to determine the level of agreement and reliability of the stress examination of the Lisfranc joint complex. Secondary objectives were to determine surgeon preferences with respect to this testing and to utilize gaze recognition software to perform an eye-tracking assessment during the performance of the test.

Methodology

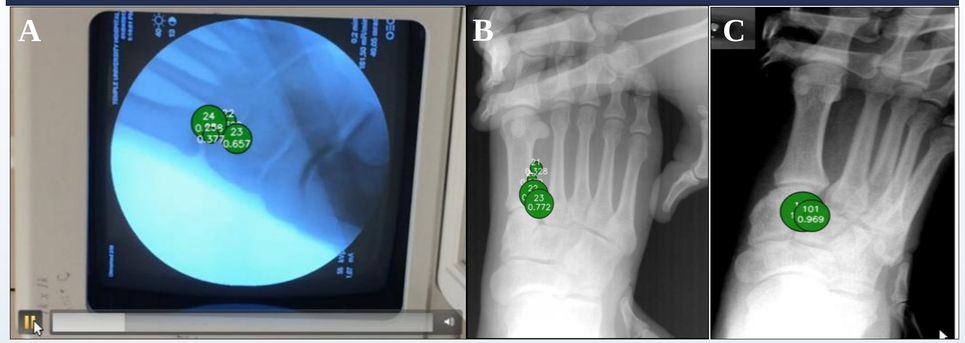
Following approval by our IRB, 12 board-certified foot and ankle surgeons, 12 senior-level podiatric residents, and 12 4th year podiatric medical students were recruited and consented to participate. Participants were shown two still intra-operative C-arm images and one intra-operative C-arm video of an actual Lisfranc joint stress abduction of the forefoot on the rearfoot examination. During this test one examiner hand is held on the lateral rearfoot, while the other hand pushes the forefoot in a lateral direction while looking for diastasis and incongruity across the tarsometatarsal joint complex Participants evaluated each image/video and reported whether they felt the test was "positive" (indicating the Lisfranc joint complex was unstable and they would perform operative stabilization) or "negative" (indicating the Lisfranc joint copmlex was stable and they would not perform operative stabilization). No time limit was enforced on examination of the images, and the video could be rewatched multiple times if requested by participants.

The primary outcome measure was considered the level of agreement with respect to the interpretation of the stress examinations. This was measured with a percent count. However, as there is a 50% likelihood that participants would agree on the interpretation simply as a result of chance within this design, reliability was also measured using the Fleiss' Kappa. This is a measure of agreement between more than two raters when data is categorical, in this case "positive" versus "negative". An established value interpretation of the kappa statistic is as follows: Kappas from 0.01 to 0.20 indicate "slight" agreement, from 0.21 to 0.40 indicate "fair" agreement, from 0.41 to 0.60 indicate "moderate" agreement, from 0.61 to 0.80 indicate "substantial" agreement, and from 0.81 to 1.00 indicate "almost perfect" agreement. Calculated kappa values less than 0.00 were considered 0.00.

The surgeons and residents additionally completed a survey following completion of their evaluations in an attempt to elucidate perioperative testing protocols dealing with Lisfranc injuries. Surgeons were asked for their current clinical practices while residents were asked what they thought their preferences and protocols would be next year in practice. We chose to not have the students complete the survey as it was our opinion that their level of clinical experience would not be to the point of development of perioperative preferences and protocols.

Further, eye-tracking and gaze recognition software (Gazepoint©, Clemson, South Carolina) was utilized to provide a subjective measure of what specific anatomic structures participants were looking at during testing.

Results



Figures A-C: We showed foot and ankle surgeons one video (Figure A) and two still images (B and C) of the stress examination of the Lisfranc joint complex. Eye-tracking software was utilized to evaluate which specific anatomic structures surgeons looked to during performance of this testing. The green circles indicate where the subjects were looking, with larger circles indicating consistent gaze and focus. Generally we noted that surgeons focused on the proximal first interspace (Figure A) with some looking relatively more distally (Figure B) or proximally (Figure C).

Perioperative Protocols Survey Results

-Total Survey Participants (n=24; 12 board certified foot and ankle surgeons and 12 senior level podiatric surgical residents)

-Intra-operative Stress Testing:

-12 (100.0%) of 12 surgeons and 8 (66.7%) of 12 residents reporting performing the stress abduction test of the forefoot on the rearfoot as part of their protocol during testing for Lisfranc stability. Eight surgeons and 6 residents reported that this was their primary determinant of Lisfranc stability.

-9 (75.0%) of 12 surgeons and 9 (75.0%) of 12 residents reported utilizing the mechanism of injury and pre-operative radiographic characteristics as part of their protocol during testing for Lisfranc stability. Three surgeons and 6 residents reported that this was their primary determinant of Lisfranc stability.

-Intra-operative Testing Interpretation:

-10 (83.3%) of 12 surgeons and 11 (91.7%) of 12 residents reported looking to diastasis between the medial cuneiform and second metatarsal base during testing to assess for Lisfranc stability. Eight surgeons and 11 residents reported that they primarily looked to this area while making the determination of Lisfranc stability.

-5 (41.7%) of 12 surgeons and 1 (8.3%) of 12 residents reported looking to instability and diastasis between the medial and intermediate cuneiforms during testing to assess for Lisfranc stability. One surgeon reported that they primarily looked to this area while making the determination of Lisfranc stability.

-5 (41.7%) of 12 surgeons and 4 (33.3%) of 12 residents reported to additionally performing stability assessment in the frontal and/or sagittal planes.

-2 (16.7%) of 12 surgeons reported looking to incongruity between the 2nd metatarsal and intermediate cuneiform during testing, 1 (8.3%) of 12 residents reported looking to instability and diastasis between the first and second metatarsal bases during testing, and 3 (25.0%) of 12 surgeons further reported that they did not have a primary anatomic area that they looked to while determining Lisfranc stability.

With respect to the first still Lisfranc image, 4 (33.3%) of the 12 surgeons, 1 (8.3%) of the 12 residents, and 3 (25.0%) of the 12 students considered it "positive". With respect to the second still Lisfranc image, 10 (83.3%) of the 12 surgeons, 7 (58.3%) of the 12 residents, and 11 (91.7%) of the 12 students considered it "positive". With respect to the Lisfranc video, 10 (83.3%) of the 12 surgeons, 11 (91.7%) of the 12 residents, and 8 (66.7%) of the 12 students considered it positive. **The overall reliability of the interpretation of the stress examination of the Lisfranc complex was a kappa of 0.281 indicating "fair" agreement (surgeons 0.182; residents 0.423; students 0.256).**

Survey results of perioperative preferences and protocols are displayed in the accompanying table. Examples of eye-tracking results are displayed in the accompanying figures. Generally we noted that surgeons focused on the proximal first interspace (Figure A) with some looking relatively more distally (Figure B) or proximally (Figure C).

Discussion

As with any scientific investigation, critical readers are encouraged to review the study design and results and reach their own conclusions, while the following represents our conclusions based on the specific results. As scientists, we also never consider data to be definitive, but do think that these results are worthy of attention and future investigation:

-First, we conclude the observed levels of agreement were well below what would be expected of a gold standard diagnostic test during stress examination of the Lisfranc joint complex. The observed "fair" levels of agreement (as measured by the kappa coefficient) were not much better than would be expected from agreement by chance. **This indicates that the stress examination of the Lisfranc joint complex might benefit from the creation of an objective definition and standardized interpretation**. The survey results and eye-tracking/gaze recognition patterns observed in this study might be useful as a starting point in defining such an objectification.

-Second, the results of the survey indicate variability in clinical practice and teaching with respect to the performance and interpretation of these tests when dealing with the Lisfranc joint complex. Although it should certainly not be considered epidemiologic data representing contemporary clinical practice in the US, it does at least show a relatively wide variety of perioperative preferences and protocols exist.

In conclusion, the results of this investigation provide evidence of reliability well below what would be expected of a gold standard during stress examination of the Lisfranc joint complex. These results indicate that future research is required in order to standardize the performance and interpretation of this test. It is our hope that the survey questions and eye-tracking results provided herein might be utilized to do so.

References

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