Detecting differences in the interpretation of radiographs: Do gaze data vary based on level of expertise?

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Introduction

- Accurate, efficient interpretation of radiographs is critical to the diagnosis and treatment of musculoskeletal injuries. Eye-tracking platforms have been used to characterize individual gaze patterns in various medical subspecialties.
- There is no existing data specifically pertaining to the gaze patterns of orthopaedic surgery staff and residents. This study was designed to determine if a proprietary eye-tracking platform is capable of detecting variations in gaze patterns between orthopaedic surgery staff and residents.

Objective

- This study was designed to determine if a proprietary eye-tracking platform is able to detect differences in gaze patterns when evaluating an ankle radiograph. Particularly, variations in gaze habits between resident and staff groups were sought.

Methods

- An AP radiograph of a Weber C trimalleolar ankle fracture was de-identified and used as the test radiograph (Figure 1).
- This radiograph was uploaded to the eye tracking software and participants observed the AP ankle radiograph. Embedded with the test questions were related to demographic information including experience level (PGY1-5, staff), number of years post-residency and orthopaedic subspecialty. After observation of the radiograph, participants were asked to determine if the fracture was stable or unstable.
- Participants completed the test using the eye tracking equipment; the equipment was calibrated in standard fashion for each participant. 12 staff surgeons and 19 residents from PGY1-5 completed the test. This equipment tracks eye movement through infrared retinal tracking. Data includes fixations, saccades and visits as well the order and time of fixations. Fixations are defined as more prolonged focusing of the retina on a particular area. Visits are defined as the sum of all fixations and other eye movements within an area of interest (AOI). No limit was placed on observation time for each subject.
- The program builds “heat maps” that represent the number and duration of fixations in a given area. Warmer colors (red) represent more and/or longer fixations. The heat map for the staff was generated (Figure 3).
- Based on staff surgeon gaze pattern heat maps, AOIs were qualitatively defined (Figure 4).
- The system’s proprietary software was used to calculate differences between staff and resident groups for gaze fixations and timing of fixation, visits to an AOI, duration of fixation on an AOI and time spent observing the radiograph outside the AOI.

Statistics

- Paired t-tests were used to compare the means of the staff vs. resident groups.
- Significance defined as p<0.05

Results

<table>
<thead>
<tr>
<th>Gaze Metric</th>
<th>Staff</th>
<th>Residents</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation time</td>
<td>7.65s</td>
<td>15.22s</td>
<td>N/A</td>
</tr>
<tr>
<td>Fixation count</td>
<td>313</td>
<td>907</td>
<td>N/A</td>
</tr>
<tr>
<td>Fixations outside AOI</td>
<td>18.42</td>
<td>38.37</td>
<td>0.0051</td>
</tr>
<tr>
<td>Time outside AOI</td>
<td>3.07s</td>
<td>9.17s</td>
<td>0.002</td>
</tr>
</tbody>
</table>

Table 1: Selected mean gaze data of staff and resident groups. Times are in seconds. No other metrics reached significance.

- Staff surgeons demonstrated fewer overall fixations and a shorter observation time (Table 1). Staff surgeons also had fewer fixations outside of the set AOIs and spent less time fixating outside these AOIs.
- Only 4 staff and 5 residents fixated on the syndesmosis A0I. This AOI was not used in analysis as a result.
- There were no differences between the two groups in AOI fixation duration, number of fixations before arriving at an AOI, AOI fixation duration or number of visits to an AOI.
- All participants identified this as an unstable fracture.

Discussion/Conclusion

- Differences in some gaze metrics between staff and residents were identified. Staff surgeons appear to be able to observe and make a diagnosis based on a radiograph in a shorter time and with fewer overall fixations.
- These findings suggest that staff surgeons are more efficient in radiographic evaluation. They appear to have a more global view of this radiograph while maintaining a focus on the fractures. Residents focus intensely on fractures while fixating more and longer on other areas of this radiograph.
- There appears to be differing gaze habits based on experience level when interpreting an AP ankle radiograph. This may imply that staff surgeons are able to make a correct diagnosis quickly but still effectively scan a radiograph for other potential findings.
- It is unknown at this time at what point in training habits change or if they can be modified through specific training curricula.
- This technology may be useful in helping residents become more efficient in examining radiographs and could also be used in the future to determine resident gaze habits when presented with surgical cases. This knowledge may improve faculty teaching efficiency by recognizing what residents observe and how to modify those behaviors if needed.

Limitations

- This is the analysis of one program so some bias may be introduced by our training habits.
- Due to the large amount of data generated by a single participant, further statistical analysis is ongoing. The current findings represent simplifications of the data that are available to all users of this equipment.

References

- Giovine NA, et al. Passing Glance? Differences in Eye Tracking and Gaze Patterns Between Trauma and Emergency Reading Film Film Burnout Radiologists. J Foot Ankle Surg. 2015;54:182-191

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