Effect of wrist and finger loading and thumb position on scaphoid fracture displacement: a biomechanical study

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Scaphoid

- Scaphoid is the most commonly fractured carpal bone and accounts for ~60-70% of all fractures in the carpus.

- No consensus on how to treat an acute non-displaced scaphoid waist fracture:
  - Cast / surgery
  - Flexion / extension of wrist
  - Above / below elbow
  - Include / exclude thumb
  - Position of the thumb
Specific Aims

- Determine if thumb position has an effect on scaphoid waist fracture displacement
- Determine if wrist and/or finger loading has an effect on scaphoid waist fracture displacement
Methods
Testing Conditions

- 6 cadaveric specimens
- Dissection proximal to the wrist
  - Finger/wrist tendons dissected and Krachow sutures placed into tendons
- Potted in PVC pipe with forearm in neutral rotation
- Placed tracking posts into:
  - Radius
  - Scaphoid proximal pole (dorsal)
  - Scaphoid distal pole (volar)
Carpal Kinematic System

- Attached tendons to load cell on custom carpal kinematic system
- Bars placed across MCPs and screwed into 3rd metacarpal head
- Conditions
  - Wrist tendons loaded + 5 positions
  - Wrist tendons and fingers loaded + 5 positions
  - Record position of posts in each condition
Thumb Positions
Specimen Preparation, Post Placement, Mounting into Jig

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Intact, Wrist Loaded, Position 1, 2, 3, 4, 5

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Intact, Wrist and Fingers Loaded, Position 1, 2, 3, 4, 5

Fracture

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Fractured, Wrist Loaded, Position 1, 2, 3, 4, 5

↓

Fractured, Wrist and Fingers Loaded, Position 1, 2, 3, 4, 5
Fracture

- Mid-waist fracture with oscillating saw
  - Approach through snuffbox with care not to disrupt volar and dorsal ligaments
- Repeated loading and positioning conditions
Analysis

- Distance between proximal scaphoid centroid and distal scaphoid centroid
- Angulation of the posts
  - Flexion / extension
  - Radial / ulnar deviation
  - Pronation / supination
Results
The Effect of Thumb Position on Centroid Distance

- No significant differences between the thumb positions in all loading conditions
- Generally caused extension of distal fragment.
- No significant differences between the thumb positions in all loading conditions.
No statistically significant difference in the degrees of deviation between the various thumb positions
**Pronation / Supination**

- Generally caused pronation of distal fragment.
- No statistically significant difference in the degrees of pronation among the thumb positions.
Tendon Loading Results
**Centroid Distance**

- Grouped all 5 thumb positions together to look only at load effect.
  - Wrist loading is not statistically significantly different from intact
    - Our fracture achieved the objective of being less than 1mm
    - Meets the requirement for non-displaced scaphoid fracture
  - Wrist/Finger loading is statistically different from having only the wrist loaded
    - Loading the fingers does cause increased displacement

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![Graph](https://via.placeholder.com/150)

- **Effect of Loading on Centroid Distance**

<table>
<thead>
<tr>
<th></th>
<th>Change in centroid distance (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intact</td>
<td>-0.00</td>
</tr>
<tr>
<td>Wrist</td>
<td>-0.20</td>
</tr>
<tr>
<td>Wrist &amp; Fingers</td>
<td>1.40</td>
</tr>
</tbody>
</table>

* p < 0.05 vs. intact, + p < 0.05 vs. wrist
Flexion / Extension

- Statistically significant extension after fracture
- No statistically significant difference between loading conditions
Radial / Ulnar Deviation

- No statistically significant difference from intact or between the two loading conditions.
Pronation / Supination

- Statistically significant pronation with wrist loaded vs. intact.
- However, once wrist/fingers loaded there was no significant difference.
Summary

- None of the five thumb positions showed statistical significance for displacement/rotation under any loading condition.
- Interfragmentary displacement significantly increased when combined wrist/finger tendons were loaded when compared to just the wrist being loaded.
Summary

- Wrist and combined wrist/finger loading resulted in extension of the distal fragment.
- Wrist loading caused pronation of the distal fragment.
- Our fracture achieved the objective of being less than 1mm (under wrist loaded condition)
Discussion

- The literature has no absolute consensus as to how to cast patients for non-operative management of non-displaced scaphoid waist fractures.
- Some studies show thumb spica cast might not be necessary.
However, by placing the thumb in a spica cast, this could minimize interaction of the thumb with the fingers in a grasping motion.

- Theoretically, large tendon loads on the fingers would be reduced because patients would not be able to have finger/thumb interaction
- Simple, low load, range of motion of the fingers would be maintained.
Questions / Comments