WEB.AM: WRIST EXPERIMENTAL AND BIOMECHANICAL ANALYTICAL MODEL

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Introduction

The stability and precision of wrist movement rely on mechanical interactions of the carpal bones [1], and damaged ligament(s) could alter their mechanical behaviour. However, although wrist injuries are common worldwide, there is still lack of 3-dimensional (3D) quantitative clinical tool to analyze these changes due to the wrist complex structure.

This research aims to develop a novel biomechanical wrist model, WEB.AM (**W**rist **E**xperimental & **B**iomechanical **A**nalytical **M**odel) for wrist kinematic analysis. We hypothesized that different wrist positions and conditions would display distinct web-like network patterns, which in turn, could address the complex challenges.

Methods

3D models from 5 cadaveric wrist were reconstructed using Mimics (*Materialise NV, Belgium*) from Computed Tomography (CT) images acquired at 11 different wrist positions: Neutral, 15°, 30° and 40° of Flexion and Extension, 5° and 10° of Radial Deviation, and 10° and 20° of Ulnar Deviation, using a custom-made jig (Figure 1).

Figure 1: Cadaveric wrist at 40º extension

The WEB.AM analysis program was developed using Matlab (*Mathworks Inc, USA*). An illustration of the network model is shown in Figure 2.

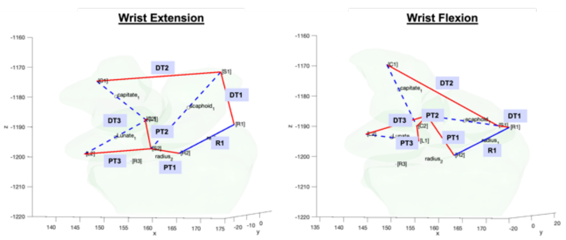

Figure 2: Web-network formed between radius, scaphoid, capitate, and lunate at extension and flexion

The networks were compared and analyzed based on the changes between the network threads (e.g. Radius-Distal Scaphoid thread [DT1] and Distal Scaphoid – Capitate thread [DT2]).

Results

The networks between scaphoid, lunate and capitate at different wrist positions displayed distinct patterns. An example of the correlation between the networks of wrist neutral and flexion, with respect to R1 (length between distal radius and styloid process), has shown the following relations:

With respect to R1

<u>Wrist at Neutral:</u>

$DT1_{neu} = 1.26\ R1$ $\quad PT1_{neu} = 0.48\ R1$

$DT2_{neu} = 1.70\ DT1_{neu}$ $\quad PT2_{neu} = 0.84\ PT1_{neu}$

$DT3_{neu} = 0.4\ DT1_{neu}$ $\quad PT2_{neu} = 0.73\ PT1_{neu}$

With respect to $DT_{1\text{-}neu}$ and $PT_{1\text{-}neu}$

<u>Wrist at 30º Flexion:</u>

$DT1_{flex} = 1.11\ DT1_{neu}$ $\quad PT1_{flex} = 2.18\ PT1_{neu}$

$DT2_{flex} = 1.11\ DT2_{neu}$ $\quad PT2_{flex} = 2.18\ PT2_{neu}$

$DT3_{flex} = 1.31\ DT3_{neu}$ $\quad PT3_{flex} = 1.04\ PT3_{neu}$

Discussion

We have observed that each wrist positions displayed distinct patterns, and this observation appeared consistent across different specimen. By analyzing the correlation of these interconnected networks, we would be able to not only quantify but also classify these networks into different datasets of wrist movements and/or conditions, thus establishing quantitative wrist database that could facilitate in the development of a clinical tool for 3D wrist biomechanics assessment.

References

1. M. J. Rainbow et al, "Functional kinematics of the wrist," *J Hand Surg Eur Vol,* 41(1) : 7-21, 2016.

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