
http://strathprints.strath.ac.uk/20175/

This is an author produced version of a paper presented at 17th Congress of the European Society of Biomechanics, 5-8 July 2010, Edinburgh, UK. This version has been peer-reviewed but does not include the final publisher proof corrections, published layout or pagination.

Strathprints is designed to allow users to access the research output of the University of Strathclyde. Copyright © and Moral Rights for the papers on this site are retained by the individual authors and/or other copyright owners. You may not engage in further distribution of the material for any profitmaking activities or any commercial gain. You may freely distribute both the url (http://strathprints.strath.ac.uk) and the content of this paper for research or study, educational, or not-for-profit purposes without prior permission or charge. You may freely distribute the url (http://strathprints.strath.ac.uk) of the Strathprints website.

Any correspondence concerning this service should be sent to The Strathprints Administrator: eprints@cis.strath.ac.uk
Effects of Partial Wrist Arthrodesis on Loading at the Radiocarpal Joints

Gislason, M.K. 1*, Stansfield, B.2*, Nash, D.H 3

1 University of Strathclyde, Glasgow, UK, magnus.gislason@strath.ac.uk
2 Glasgow Caledonian University, Glasgow, UK, ben.stansfield@gcal.ac.uk
3 University of Strathclyde, Glasgow, UK, d.nash@strath.ac.uk

Introduction

The radiocarpal joint plays an important role in the stabilization of the wrist joint. Degenerative diseases such as rheumatoid arthritis can destabilize the joint and compromise the kinematics of the carpal bones. Partial wrist arthrodesis in the rheumatoid wrist has been popular since its introduction in 1983 [1]. The procedure prevents ulnar drift of the carpus and prevents progression to a subluxed state as well as providing pain relief for the patient. The biomechanical consequences of arthrodesis at the radiocarpal joint have not been extensively explored. This study looks at the biomechanical changes on the load transfer through the radiocarpal joint after partial wrist fusion.

Materials and methods

A finite element model was created of the wrist using 3T MRI scans from the distal end of the radius and ulna to the proximal third of the metacarpals. The scans were imported into Mimics (v.12.1 Materialise) where edge detection and 3D object creation of the carpal bones were carried out. Meshes of triangular surface elements were imported into Abaqus (v.6.9 Simulia) and converted into 3D tetrahedral elements. Ligaments and tendons were modelled using nonlinear spring elements. Contact areas between each bone articulation were identified manually and the mesh extruded at those locations, creating wedge elements representing the articular cartilage. It was assumed that no force was transmitted through the joint until clearance between the surfaces was 0. Physiological loading, derived using a biomechanical analysis of gripping, was applied as compressive force acting along the long axis of each metacarpal. The analysis was carried out using the explicit solver where the magnitude and angle of the reaction forces acting on the radio-scaphoid and radio-lunate joints. Magnitude and direction of the joint reaction forces are illustrated with red arrows.

<table>
<thead>
<tr>
<th>Condition</th>
<th>RS [N]</th>
<th>RL [N]</th>
<th>α [°]</th>
<th>β [°]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>537.1</td>
<td>529.6</td>
<td>15.3</td>
<td>6.8</td>
</tr>
<tr>
<td>2</td>
<td>403.8</td>
<td>418.7</td>
<td>18.3</td>
<td>-37.7</td>
</tr>
<tr>
<td>3</td>
<td>547.0</td>
<td>439.2</td>
<td>-29.7</td>
<td>2.9</td>
</tr>
<tr>
<td>4</td>
<td>569.0</td>
<td>358.1</td>
<td>-29.4</td>
<td>-19.2</td>
</tr>
</tbody>
</table>

Table 1: The magnitude and angle of the reaction forces acting on the radiocarpal joints for the four conditions.

Fusing the radiolunate joint, decreased the forces on that joint as well as for the radioscapoid joint, whereas fusing the radioscapoid joint increased the loading on that joint, but decreased loading on the radiolunate joint. The direction changes of the resultant forces travelling through the joints suggested that the fusion of the joints helped absorb the shear forces acting ulnarily on the carpus, thus unloading most of the ligamentous mechanism constraining the radiocarpal joint. The load ratio between the radioscapoid and the radiolunate articulation was higher than previously reported [2].

Conclusion

The results suggest that large changes occur in the load transfer characteristics of the wrist during a partial wrist fusion.

Acknowledgements

This work was supported by the Furlong Research Charitable Foundation.

References