The Association between Bony Structure and the Distribution of Forces between the Radius and Ulna in Normal Wrists

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PURPOSE

In the musculoskeletal system, structure dictates function and the development of pathology. Interpreting wrist structure is complicated not only by the existence of multiple joints and ligamentous structures but also by variability in bone shapes and anatomical patterns. A previous study evaluated normal plain radiographs for lunate and capitate shape in the midcarpal joint. This study identified intracarpal measurements related to lunate and wrist type. Assuming that these disparate patterns will transfer forces differently, our purpose was to correlate the forces transferred to the distal radius and ulna with the morphological measurements in cadaver arms.

Hypothesis: we will find significant correlations between force transfer and two distinct anatomical patterns.

METHODS

Radiographs from a database of 40 cadaver wrists previously tested for force transfer between the radius and ulna were examined. The percentage of the compressive force through the distal ulna and radius was determined by mounting load cells to the distal radius and ulna while 22.2 N tensile forces were individually applied to the extensor carpi ulnaris, the extensor carpi radialis and brevis, the flexor carpi radialis and the flexor carpi ulnaris. Each wrist was tested in neutral flexion-extension and radioulnar deviation.

RESULTS

There were 35 wrists type 1 with a mean ulnar force of 27.6% and 11 wrists type 2 with a mean ulnar force of 10.4% (3 unclassified). There was a significant correlation between wrist type and percent of force transfer through the ulna. Percent force transferred to the ulna was weakly correlated with some intracarpal measurements such as capitate circumference, and the capitate–lunate contact. Table 1

![Figure 1: Plain posteranterior views of a wrist type 1 (left) and 2 (right)](image)

Table 1: Some significant correlations between measured radiographic intracarpal parameters and percent transfer of force through the ulna

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean (standard deviation)</th>
<th>t^2</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>% circumference capitate–lunate</td>
<td>0.25 (0.14)</td>
<td>0.12</td>
<td>0.051</td>
</tr>
<tr>
<td>% circumference capitate–lunate</td>
<td>0.0 (0.0)</td>
<td>0.0</td>
<td>1.000</td>
</tr>
<tr>
<td>Ulnar variance mm</td>
<td>0.3 (0.57)</td>
<td>0.18</td>
<td>0.002</td>
</tr>
<tr>
<td>Radius variance mm</td>
<td>0.12 (0.31)</td>
<td>0.03</td>
<td>0.890</td>
</tr>
</tbody>
</table>

CONCLUSIONS

- Percent transfer of force through the ulna was associated with wrist type and other intracarpal measurements. This may support a different transfer of force between morphological wrist types.
- This study does not account for other factors that may affect the transfer of forces such as ligament mechanical properties and dynamic (muscle-tendon) forces that act upon the bony structure.
- More study is needed to evaluate soft tissue differences between the two wrist types and to investigate force transfer through the 2 different types of midcarpal joints.

References

