Scaphoid Variation and an Anatomical Basis for Variable Carpal Mechanics

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# Table of Contents

Abstract

Declaration

Acknowledgements

Publications resulting from this thesis

<table>
<thead>
<tr>
<th>Preface</th>
<th>Thesis Intent and Structure</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chapter 1</td>
<td>Scaphoid Morphology and Carpal Nomenclature</td>
<td>4</td>
</tr>
<tr>
<td>1.1</td>
<td>Introduction</td>
<td>5</td>
</tr>
<tr>
<td>1.2</td>
<td>Materials</td>
<td>39</td>
</tr>
<tr>
<td>1.3</td>
<td>Methods</td>
<td>40</td>
</tr>
<tr>
<td>1.4</td>
<td>Results</td>
<td>43</td>
</tr>
<tr>
<td>1.5</td>
<td>Discussion</td>
<td>63</td>
</tr>
<tr>
<td>1.6</td>
<td>Conclusions</td>
<td>80</td>
</tr>
<tr>
<td>1.7</td>
<td>References</td>
<td>81</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter Two</th>
<th>Tissue Differentiation</th>
<th>89</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Introduction</td>
<td>90</td>
</tr>
<tr>
<td>2.2</td>
<td>Materials</td>
<td>116</td>
</tr>
<tr>
<td>2.3</td>
<td>Methods</td>
<td>117</td>
</tr>
<tr>
<td>2.4</td>
<td>Results</td>
<td>120</td>
</tr>
<tr>
<td>2.5</td>
<td>Discussion</td>
<td>131</td>
</tr>
<tr>
<td>2.6</td>
<td>Conclusions</td>
<td>146</td>
</tr>
<tr>
<td>2.7</td>
<td>References</td>
<td>147</td>
</tr>
</tbody>
</table>
Appendices

I  The embalming process of the Ray Last Anatomy Laboratory  257
II  Processing of histological specimens  259
III  Sliding microtome sections  263
IV  Modified Masson’s trichrome staining  267
V  Digital photography  270
VI  Digital measurements with Image J  272
VII  Digital survey of wrist anatomy  274
VIII  Ligament measurements  275
Abstract

The morphology and function of the wrist is poorly understood. Improved understanding of carpal anatomy may facilitate improved understanding of carpal mechanics and may enhance the clinical management of wrist dysfunction. Many detailed investigations of wrist structure have been reported, many of which have focussed on the scaphoid and its ligamentous supports. The results of these studies are not readily collated to provide an accurate description of the scaphoid and its supports.

This study attempted to provide a detailed description of the anatomy of the scaphoid and its supporting structures. A detailed nomenclature was proposed to facilitate accurate description of the scaphoid and related structures. Gross observation enabled separation of the sample population of scaphoids into two groups. Morphometric analyses were used to determine any significant differences between the groups (type one and type two). The histological sections were then used to facilitate accurate gross identification of ligaments and computed tomographs were used to investigate the \textit{in situ} variation of scaphoid orientation.

The investigations suggest that two distinct populations of scaphoid existed within the sample population. The scaphoids varied in bone morphology, arrangement and degree of ligamentous support and position relative to the capitate. Articular facet shape and size differed between scaphoid types. The orientation and number of ligaments supporting the scaphoid were suggestive of variable scaphoid motion. The variation in ligamentous patterns was supported by histological investigation. Computed tomographs through the
longitudinal axis of the scaphoid suggested a variable position of the scaphoid relative to the capitate.

The variation of these structures was discussed in relation to the kinematic findings of others. A theoretical model of variable scaphoid function was proposed based on the anatomical findings. The data presented and the reviewed kinematic data may be extrapolated to suggest two models of scaphoid motion. The scaphoids may be divided into rotating/translating scaphoids and flexing/extending scaphoids. This must be confirmed by a combined anatomical and mechanical study. The clinical implications of different scaphoid structure and function may be profound. The ability to identify such differences in situ may facilitate varied clinical management for the various types of wrist suggested.


Declaration

This work contains no material that has been accepted for the award of any other degree or diploma in any university or tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

I give consent to this copy of my thesis, when deposited in the University Library, being made available for loan and for photocopying.

Quentin A Fogg 12/03/04
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Publications Resulting from this Thesis


Preface

Thesis Intent and Structure
The wrist is poorly understood. Detailed analyses of structure and function have been performed but a consensus on either is yet to be reached. This thesis is a collection of studies conducted with the general aim of clarifying the structure of the scaphoid, discussing the structural detail in a functional context, and determining whether the structural understanding can be applied in a clinical environment. These aims are addressed in four chapters.

The first chapter aims to improve understanding of scaphoid structure and variation. To facilitate this a detailed nomenclature for the scaphoid and related structures is proposed. Morphometric variations in the scaphoid were used to separate the sample population into two groups or types. Differences between the groups were discussed and the functional significance of the variations was hypothesised.

The second chapter addresses a common issue in joint research. Can ligament and joint capsule be accurately differentiated? A histological investigation was conducted in an attempt to answer this question. Various tissues were identified and the bone to which each tissue was attached was measured. This gave an indication of the degree of force transmitted through each tissue to the bone, and hence acted as a quantitative test of the differentiating power.

The third chapter utilised the observations of chapter two in conjunction with a gross investigation of ligamentous support of the scaphoid. The combination of histological and gross data was used to improve the accuracy and limit the subjectivity of the investigation. Patterns of ligaments were used to separate the wrists into groups and the
differences between the groups were discussed. The functional significance of the differences was hypothesised.

The fourth chapter aims to identify scaphoid variation applicable to the clinical environment. Computed tomographs were used to assess scaphoid morphology and orientation in situ. The differences in morphology and orientation are discussed, and their functional significance hypothesised.

The fifth chapter summarises all of the investigations and collates the results into an overall theory of scaphoid function. It is hoped that with improved understanding of scaphoid structure and its supporting structures that understanding of scaphoid function may be improved. The results within this thesis may provide a new perspective on the investigation of wrist structure and function. It is anticipated that the functional hypotheses within this thesis will be tested in future investigations.