Scaphoid Variation and an Anatomical Basis for Variable Carpal Mechanics

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A thesis submitted for the degree of Doctor of Philosophy, at the University of Adelaide

March, 2004

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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 *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

Acknowledgements

I would like to thank the following people for their help in all its shapes and forms.

Dr Ray Tedman for being a great supervisor and for all the extra time and effort put into helping me develop into a walking, talking anatomist.

Dr Greg Bain for being a great co-supervisor and always saying the right things. Your enthusiasm for this project has been of immeasurable help.

Mr Wesley Fisk for all the technical and social support a PhD student could ever need. Thanks for everything and let's hope there's plenty more to come.

Mr Stelios Michas (it's about time you got your own line!) for your help and friendship. Whenever something didn't look like working you found a way to make it happen.

Dr Rob Moore and his technicians at the Institute of Medical and Veterinary Science, Greg and Beverly, for x-raying of decalcified specimens.

Mr Nick Zabanias at the Women's and Children's Hospital for doing all the x-rays and CTs.

Dr Aman Sood for performing the four corner fusions and for plenty of good advice.

Dr Nicola Fazzalari at the Institute of Medical and Veterinary Science for all the advice and for the use of your big freezer!

Mr Tavik Morgenstern for being a good mate and the occasional lend of your artistic eye. I promise not to mess up your scanner too much more!

Professor Maciej Henneberg and all the staff of the Department of Anatomical Sciences, the University of Adelaide, for motivating me (intended or not) to be the best anatomist possible and for making going to work feel a lot less like work.

Professor Ian Gibbins for seeing something that the others didn't and giving me a job, and for asking "the dreaded question" once in a while.

Don for being a great best mate and always being around despite the craziness that writing a thing like this develops.

Mum and **Dad** for all the support and advice from day one.

Last but in no way least, to **Kara** for being everything important and cherished.
This is for you.

Publications Resulting from this Thesis

Fogg QA, Bain GI, and Tedman RA (2003) Functional carpal anatomy and its clinical implications. *Clinical Anatomy* **16 (6)**: 555 (Abstract).

Fogg QA, Bain GI, and Tedman RA (2004) Functional scaphoid anatomy and its clinical implications. *Clinical Anatomy* (in review).

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.