

**AN ANATOMICAL BASIS FOR THE MANAGEMENT OF
COMPLEX WRIST INJURIES**

JAMES M MCLEAN, MB BS

Clinical Associate Lecturer

Discipline of Orthopaedics and Trauma

University of Adelaide, Australia

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ABSTRACT

The work described in this thesis was carried out by the author to address perceived deficiencies in the knowledge of wrist anatomy, imaging and surgical management principles. The thesis encompasses studies of normal anatomy, imaging of the normal and abnormal wrist, the classification of complex carpal injuries, and the potential for further research.

At the commencement of this work, areas of deficiency were identified and were addressed. These included (i) the morphology of the normal wrist, (ii) imaging techniques of morphological variants, (iii) morphological association with midcarpal osteoarthritis, and (iv) the clinical application of classification systems for the management of complex carpal injuries.

To address these deficiencies, a combined radiographic and MRI study was undertaken to determine the best method for identification of the various morphological variations of the articular surfaces at the midcarpal joint, using non-invasive imaging techniques. In addition, a clear standard for accurate recognition of these variants using different imaging techniques was established. An inter-observer reliability study was undertaken to establish the reproducibility of the techniques, and to compare the results with previously reported data. A correlation analysis of the various carpal morphologies can now be undertaken. If a clear pattern of wrist morphology exists, the differences in carpal kinematics and pathomechanics related to wrist morphology can be more easily investigated. In addition, it is now possible to use non-invasive methods of investigation to examine the relationship(s) between various wrist morphologies and differences in ligament composition and distribution, different carpal kinematics and pathomechanics, and different incidences and predispositions to various carpal pathologies. Further research is needed to address these questions.

In summary, the work described in this thesis increases the knowledge of normal wrist morphology and imaging. It further advances the knowledge of pathomechanics related to wrist morphology and presents a new understanding in regard to the principles of the management of complex carpal injuries.

DEDICATION

This thesis is dedicated to my partner Tara-Louise for her unreserved support and understanding in the pursuit of my professional goals. Her love and devotion have inspired me to become a more rounded human being. I look forward to sharing a life with her into the future.

To my father for inspiring my pursuit of knowledge and instilling in me a sense of compassion and responsibility. To my mother for nurturing empathy and kindness. Together, through their unwavering generosity and support, they have allowed me to grow and follow my dreams. The challenge shall be for Tara-Louise and me to emulate the support and encouragement they have shown and to pass this special quality on to the next generation.

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I was most fortunate to be granted access to cadaveric material at the University of Adelaide. I thank Mr Wesley Fisk and the staff at the Discipline of Anatomical Sciences for preparing and providing the materials. I thank the friends and families of the loved ones whose bodies were donated.

My thanks extends to Dr Luke Mooney and Dr Nimah Rezaian who devoted their time and assistance in the preparation of parts of this project.

STATEMENT OF ORIGINALITY

This thesis contains material that has been published in peer-reviewed medical journals.

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution to Dr James Marcus McLean 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 have been the first author or principal investigator of the publications that form the main body of the thesis. Co-authors of any of the papers have provided support for papers to be included in this thesis. The individual statements of the contributions of jointly authored papers are in the section titled "Statement of authorship and contribution".

I give consent to this copy of my thesis when deposited in the University Library, being made available for loan and photocopying, subject to the provisions of the Copyright Act 1968.

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The author acknowledges that copyright of published works contained within this thesis (as listed below) resides with the copyright holder(s) of those works.

- 3.2 Scaphoid anatomy.** Watts AC, McLean JM, Fogg Q, Bain GI. In: Slutsky DJ, and Slade JF, ed. *The Scaphoid*. 1st ed. New York. Thieme Medical Publishers; 2009: *in press*.
- 4.2 Imaging Recognition of Morphological Variants at the Midcarpal Joint.** McLean JM, Bain GI, Watts AC, Mooney LT, Turner PC, Moss M. *Journal of Hand Surgery (American Volume)*. 2009; Jul:34(6): 1044-55.
- 5.2 An association between lunate morphology and scaphoid-trapezium-trapezoid arthritis.** McLean JM, Turner PC, Bain GI, Rezaian N, Field J, Fogg Q. *Journal of Hand Surgery (European Volume)*. 2009; accepted for publication 26 Jun; *in press*.

6.2 Translunate fracture with associated perilunate injury: 3 case reports with introduction of the translunate arc concept. Bain GI, McLean JM, Turner PC, Sood A, Pourgiezis N. *Journal of Hand Surgery (American Volume)*. 2009; Dec;33(10):1770-6.

James M McLean

1st September 2009

STATEMENT OF AUTHORSHIP AND CONTRIBUTION

This section provides a statement of the contribution of each author for all the peer review publications in the thesis. All co-authors have signed the statement of contribution.

Signed statements follow.

Scaphoid anatomy.

Adam C. Watts MB ChB, James M. McLean MB BS, Quentin Fogg PhD, Gregory I. Bain PhD

In: Slutsky DJ, and Slade JF, ed. The Scaphoid. 1st ed. New York. Thieme Medical Publishers; 2009: in press

Watts AC:

Editing draft and revised manuscripts. Edited revisions of the paper. Responded to reviewer's comments. Assisted with figure preparation.

McLean JM:

Literature review, wrote initial paper draft, assisted with figure preparation.

Fogg Q:

Performed comprehensive analysis of the scaphoid through PhD analysis under the supervision of Mr Gregory Bain. Editing draft paper. Assisted with figure preparation.

Bain GI:

Senior and corresponding author, edited draft manuscripts and responded to reviewers comments, assisted with figure preparation.

Signature.....
Watts A

Signature
Bain GI

Signature.....
McLean JM

Signature
Fogg Q

Imaging Recognition of Morphological Variants at the Midcarpal Joint.

James M. McLean MB BS, Gregory I. Bain PhD, Adam C. Watts MB ChB, Luke T. Mooney MB BS, Perry C. Turner MB ChB, Mary Moss MB BS.

J Hand Surg Am. 2009 Jun 3. [Epub ahead of print]

McLean J:

Principle author, literature review, study design, first observer for review of images, performed all dissections, assisted with analysis of data, wrote initial paper draft and edited subsequent drafts, figure preparation, presentation of paper at State and National meetings. Responded to reviewers comments.

Bain GI:

Senior and corresponding author, assisted with study design and approved study design, edited draft manuscripts and reviewers comments.

Watts AC:

Assisted with editing draft and revisions of the paper.

Mooney LT:

Second observer for review of images. Second observer for review of dissections.

Turner PC:

Assisted with editing draft, assisted with dissections.

Moss M:

Assisted with the provision of access to imaging equipment, assisted with the review of images.

Signature.....
McLean J

Signature
Turner PC

Signature
Bain GI

Signature
Moss M

Signature.....
Watts AC

Signature.....
Mooney LT

An association between lunate morphology and scaphoid-trapezium-trapezoid arthritis.

James M. McLean MB BS, Perry C. Turner MB ChB, Gregory I. Bain PhD, Nimah Rezaian MB BS, John Field PhD, Quentin Fogg PhD

J Hand Surg (European) 2009; in press.

McLean J:

Principle author, literature review, study design, identified and collected patient groups, first observer for review of radiographs, assisted with analysis of data, wrote initial paper draft and edited subsequent drafts, figure preparation, presentation of paper at State and National meetings. Responded to reviewers comments.

Turner PC:

Assisted with editing draft and revisions of the paper.

Bain GI:

Senior and corresponding author, approved concept design, edited draft manuscripts and reviewers comments.

Rezaian N:

Second observer for review of radiographs.

Field J:

Provided guidance in analytical design, performed statistical analysis of data.

Fogg Q:

Assisted with figure preparation.

Signature.....
McLean J

Signature.....
Field J

Signature
Turner PC

Signature
Fogg Q

Signature
Bain GI

Signature
Rezaian N

Translunate Fracture With Associated Perilunate Injury: Three Case Reports With Introduction of the Translunate Arc Concept

Gregory I. Bain PhD, James M. McLean MB BS, Perry C. Turner MB ChB, Aman Sood MB BS, Nicholas Pourgiezis MB BS.

J Hand Surg 2008;33A:1770–1776.

Bain GI:

Senior and corresponding author, concept design, senior surgeon in all cases, edited draft manuscript and reviewers comments.

McLean J:

Principle author, literature review, collected case reports for paper, wrote initial paper draft, figure preparation, presentation of paper at State and National meetings.

Turner PC:

Assisted with figure preparation, assisted with revisions of the paper. Responded to reviewers comments.

Sood A:

Edited first draft.

Pourgiezis N:

Operative surgeon in one of the cases, edited first draft.

Signature

Bain GI

Signature.....

McLean J

Signature

Turner PC

Signature

Sood A

Signature.....

Pourgiezis N

THESIS ORGANISATION

The thesis is presented in the following sections.

Introduction

The introduction provides background information on the topic of the wrist. This section concludes with the aims, significance of the aims and a list of the objectives of the thesis.

Literature review

The literature review covers those areas relevant to the research performed. It is divided into the three sections: Midcarpal Morphology, Pathological Variance Related to Morphology, and Classification of Complex Carpal Injuries. The deficiencies in knowledge relevant to the research performed are acknowledged. This section concludes with a discussion on the linkages within the thesis and between the research projects.

Research undertaken

The thesis is arranged into chapters under the headings of Anatomy, Classification, Recognition and Pathology. The discussion of each publication commences with the stated aims and objectives. The principles of study methodology and the main findings of the research project are presented. This is not intended to be a detailed restatement of the published paper but does provide the main points of methodological interest.

Conclusion

The conclusion is an overarching discussion on the main features of the thesis. It provides a link between the publications and identifies other possible research objectives. It also includes the significance of the findings, problems encountered and future directions of the work.

Publications

This section includes the six peer reviewed publications that have been included in the thesis.

Videos

An image capture (single frame) of the video is in the written document. The actual videos are available online as referenced.