CLINICAL IDENTIFIERS FOR EARLY STAGE PRIMARY/IDIOPATHIC ADHESIVE CAPSULITIS

Sarah Walmsley

BSc, Grad Dip Phty, MAppSc (Orthopaedic Physiotherapy)

Thesis submitted for the degree of

Doctor of Philosophy

The University of Newcastle, Australia

March 2014
Statement of Originality

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university or other 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 the final version of my thesis being made available worldwide when deposited in the University’s Digital Repository, subject to the provisions of the Copyright Act 1968.

…………………………

Sarah Walmsley

Date:
Acknowledgement of Authorship

I hereby certify that this thesis is in the form of a series of published papers of which I am a joint author. I have included as part of the thesis a written statement from each co-author, endorsed by the Assistant Dean Research Training, Faculty of Health and Medicine attesting to my contribution to the joint publications (Appendix 1).

…………………………

Sarah Walmsley Date:
Acknowledgements

The completion of this thesis has been a long journey but one that has not been travelled alone. Many people in both professional and personal roles have provided assistance and support as well as understanding and friendship. Without them the journey would not have been possible and I would like to express my sincere thanks to them all.

Firstly I would like to thank my supervisors, Professor Darren Rivett and Dr Peter Osmotherly for their academic expertise, guidance and assistance for the studies and the completion of this thesis. I would also like to extend my thanks to Kim Colyvas for his contribution to the statistical analyses and Jane McDonald for her invaluable assistance with the formatting of the thesis. Beyond the University I was fortunate to have the willing assistance of Drs Colin Walker, Mariola Wierna and Michelle Roy, from Hunter Imaging Group, who generously gave their time and expert skill to review the ultrasound images and contribute to the manuscripts in Chapters 4 and 5. Many thanks also to all the staff at Hunter Hand and Upper Limb Surgery/Therapy for identifying potential participants and enabling the collection of data. Of course clinical research is not possible without the participants to whom I am grateful for willingly volunteering their time to contribute to the studies.

I could not have completed this journey without the support of my family and friends who understood the importance of me reaching my destination and were prepared to take a back seat throughout the long trip. A special thanks to John who never expected
me to put my studies second and provided some much needed balance to my life. To my fellow PhD students, and especially Lucy Thomas, who have been travelling their own roads, your camaraderie and support made the hills seem less steep and softened the impact when I have hit the potholes.

Lastly, I would like to express my overwhelming gratitude to both my parents who not only instilled in me the value of education but gave me the opportunity and fortitude to achieve my potential. I am deeply grateful to them for providing me the insight to gain the most from life by undertaking its challenges, and giving me the tenacity to weather the storms that have arisen throughout this long journey. Finally, I would like to dedicate this thesis to my father who never stopped believing in my ability, and battled advancing years and frailty to give me the mental strength and encouragement to see me finally reach my destination.
Publications and presentations

The following publications and presentations were a direct result of the work completed in this thesis:

Published papers


Published abstracts


**Conference and other invited presentations**

The following conference and invited presentations were a direct result of the work completed in this thesis:


13. Walmsley S, Osmotherly PG, Rivett DA (2013). Validation of a set of clinical identifiers for the early stage of primary/idiopathic adhesive capsulitis. 5x5 oral

Melbourne, Australia. October 2013.
# Table of Contents

Statement of Originality ........................................................................................................ ii  
Acknowledgement of Authorship ........................................................................................ iii  
Acknowledgements ................................................................................................................ iv  
Publications and presentations ........................................................................................... vi  
List of Tables .......................................................................................................................... xvi  
List of Figures ....................................................................................................................... xvii  
List of Abbreviations ........................................................................................................... xviii  

Abstract ......................................................................................................................................... 1  

Chapter 1  
Introduction .............................................................................................................................. 3  
1.1 Background and context .................................................................................................. 3  
1.2 Research aims .................................................................................................................... 6  
1.3 Outline of the thesis ......................................................................................................... 6  
1.4 Scope/de-limitations ....................................................................................................... 11  
1.5 Significance ..................................................................................................................... 11  

Chapter 2  
Literature review ..................................................................................................................... 12  
2.1 General description of adhesive capsulitis ................................................................ 12  
2.2 Epidemiology ................................................................................................................... 13  
2.3 Classification of adhesive capsulitis ............................................................................ 15  
2.3.1 Stages of adhesive capsulitis ................................................................................... 16  
2.3.2 Natural history .......................................................................................................... 18  
2.4 Anatomy and pathophysiology of adhesive capsulitis .............................................. 19  
2.5 Risk factors ..................................................................................................................... 25  
2.5.1 Diabetes ...................................................................................................................... 25  
2.5.2 Dupytren’s disease .................................................................................................... 26  
2.5.3 Thyroid dysfunction ................................................................................................. 27  
2.5.4 Female gender ........................................................................................................... 28  
2.5.5 Genetic factors ........................................................................................................... 28  
2.6 Clinical evaluation of adhesive capsulitis .................................................................. 29  
2.6.1 Patient reported findings ......................................................................................... 29  
2.6.2 Physical examination findings ............................................................................... 31  
2.7 Treatment of adhesive capsulitis ............................................................................... 32  
2.7.1 Early treatment ......................................................................................................... 34  
2.8 Diagnosis of shoulder disorders .................................................................................. 35
Chapter 8  Discussion and conclusions .................................................................160
8.1  Summary of study findings ..............................................................................160
8.2  Limitations of the studies ..............................................................................164
8.3  Generalisability of the findings ......................................................................168
8.4  Conclusions .....................................................................................................169
8.5  Implications of the body of research ...............................................................170
  8.5.1  Clinical .......................................................................................................170
  8.5.2  Future research ..........................................................................................170
8.6  Summary of the thesis .....................................................................................172

References ............................................................................................................173

Appendices ............................................................................................................191
Appendix 1 Statements of collaboration from authors ..........................................192
Appendix 2 Ethics approval and supporting documents for Study 1 ......................199
Appendix 3 Ethics approval and supporting documents for Studies 2, 3 and 4 ....235
Appendix 4 Journal publications ...........................................................................252
List of Tables

Table 2.1 Stages of adhesive capsulitis.................................................................16
Table 3.1 Composition and response rate of participants in Delphi study..........57
Table 3.2 Items generated following round one......................................................59
Table 3.3 Diagnostic criteria achieving consensus ...............................................61
Table 3.4 Factor loadings following principal components factor analysis of clinical criteria.................................................................63
Table 4.1 Summary of MRI studies on adhesive capsulitis.................................82
Table 4.2 Summary of MRA studies on adhesive capsulitis...............................83
Table 5.1 Demographic and clinical characteristics of participants ....................104
Table 5.2 Comparison of reported descriptors of pain in the positive PDUS and negative PDUS groups .................................................................105
Table 5.3 Comparison of passive range of movement (degrees) and pain (visual analogue scale) at the end of ranges of passive movement (mean ± SD) in the positive and negative PDUS groups .............................................................106
Table 6.1 Demographic characteristics of the participants (n = 52) .....................125
Table 6.2 Mean (SD) shoulder ranges of active and passive movement (unaffected and affected), percentage loss of active ranges of movement and pain scores at the end of range of each movement .................................................................125
Table 6.3 Factor loadings for the factor models for percentage loss of active and passive ranges of movement .................................................................127
Table 6.4 Factor loadings for two factor models for pain at the end of active and passive ranges of movement ...........................................................................128
Table 6.5 Reason for limitation of movement .......................................................131
Table 7.1 Clinical identifiers achieving consensus (Walmsley, Rivett et al. 2009) ....142
Table 7.2 Characteristics of the study participants (N=64) ..................................151
Table 7.3 Prevalence of the eight clinical identifiers (N = 64) .............................151
Table 7.4 Relationship between participant characteristics and the eight clinical identifiers and PAR (N = 64) .................................................................152
List of Figures

Figure 2.1 Continuum of stages in adhesive capsulitis .......................................................17
Figure 2.2 The rotator interval area of the shoulder ............................................................20
Figure 2.3 A. Fibrous synovial inflammatory reaction. B. Histologic findings of early stage adhesive capsulitis ..........................................................................................................23
Figure 3.1 Flow of participants through the study...............................................................58
Figure 3.2 Percentage of respondents scoring a criterion as ‘strongly agree’ (N = 70)...60
Figure 3.3 Scree plot of final components selected............................................................62
Figure 3.4 Component plot of diagnostic criteria following factor analysis .................63
Figure 4.1 The rotator interval area of the shoulder ............................................................76
Figure 4.2 Magnetic resonance image of a 61 year old woman with clinical evidence of right adhesive capsulitis and a contra lateral healthy shoulder. Sagittal fat-suppressed T1-weighted spin-echo sequence after IV Gd-chelate enhancement (TR/TE=600 ms/15ms). ...................................................................................................................................85
Figure 4.3 Sagittal oblique T1-weighted (700/12) image shows thickened CHL (arrows) in a 57-year-old patient with adhesive capsulitis.................................................................86
Figure 4.4 Power Doppler ultrasound of 54 year old female with a 6 month history of adhesive capsulitis demonstrating increased vascularity at the rotator cuff interval. ...90
Figure 5.1 The position of the participant for the examination, with the hand of the affected shoulder held in supination beside the patient’s thigh and transducer over the anterior shoulder.....................................................................................................................100
Figure 5.2 The rotator interval area of the glenohumeral joint capsule..........................101
Figure 5.3 Power Doppler ultrasound image of the right shoulder of a 60 year old female demonstrating the presence of increased signal in the rotator interval area .....107
Figure 6.1. Device to isolate glenohumeral joint movement..........................................122
Figure 6.2 Factor loading plots following Varimax rotation.............................................130
Figure 7.1 Device to stabilise the scapula for measurement of glenohumeral joint movement.................................................................................................................................146
Figure 7.2 Design and flow of participants through the study ........................................150
### List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>Adhesive capsulitis</td>
</tr>
<tr>
<td>ADL</td>
<td>Activities of daily living</td>
</tr>
<tr>
<td>AR</td>
<td>Axillary recess</td>
</tr>
<tr>
<td>BT</td>
<td>Biceps tendon</td>
</tr>
<tr>
<td>CAL</td>
<td>Coracoacromial ligament</td>
</tr>
<tr>
<td>CDUS</td>
<td>Colour Doppler ultrasound</td>
</tr>
<tr>
<td>CHL</td>
<td>Coracohumeral ligament</td>
</tr>
<tr>
<td>CI</td>
<td>Confidence interval</td>
</tr>
<tr>
<td>CP</td>
<td>Coracoid process</td>
</tr>
<tr>
<td>CRP</td>
<td>C-reactive protein</td>
</tr>
<tr>
<td>ER</td>
<td>External rotation</td>
</tr>
<tr>
<td>ERA</td>
<td>External rotation in abduction</td>
</tr>
<tr>
<td>ERN</td>
<td>External rotation in neutral</td>
</tr>
<tr>
<td>FE</td>
<td>Forward elevation</td>
</tr>
<tr>
<td>GHA</td>
<td>Glenohumeral abduction</td>
</tr>
<tr>
<td>GHF</td>
<td>Glenohumeral flexion</td>
</tr>
<tr>
<td>GHJ</td>
<td>Glenohumeral joint</td>
</tr>
<tr>
<td>IRA</td>
<td>Internal rotation in abduction</td>
</tr>
<tr>
<td>HBB</td>
<td>Hand behind back</td>
</tr>
<tr>
<td>IR</td>
<td>Internal rotation</td>
</tr>
<tr>
<td>IS</td>
<td>Impingement syndrome</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Full Form</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------</td>
</tr>
<tr>
<td>MCS</td>
<td>Mental component summary</td>
</tr>
<tr>
<td>MHz</td>
<td>Mega hertz</td>
</tr>
<tr>
<td>mm</td>
<td>Millimetres</td>
</tr>
<tr>
<td>mths</td>
<td>Months</td>
</tr>
<tr>
<td>MRA</td>
<td>Magnetic resonance arthrography</td>
</tr>
<tr>
<td>MRI</td>
<td>Magnetic resonance imaging</td>
</tr>
<tr>
<td>NSAIDs</td>
<td>Non steroidal anti-inflammatory drugs</td>
</tr>
<tr>
<td>OR</td>
<td>Odds ratio</td>
</tr>
<tr>
<td>PAR</td>
<td>Positive anaesthetic response</td>
</tr>
<tr>
<td>PCS</td>
<td>Physical component summary</td>
</tr>
<tr>
<td>PDGF</td>
<td>Platelet derived growth factor</td>
</tr>
<tr>
<td>PDUS</td>
<td>Power Doppler ultrasound</td>
</tr>
<tr>
<td>PROM</td>
<td>Passive range of movement</td>
</tr>
<tr>
<td>RC</td>
<td>Rotator cuff</td>
</tr>
<tr>
<td>RCT</td>
<td>Rotator cuff tear</td>
</tr>
<tr>
<td>RI</td>
<td>Rotator interval</td>
</tr>
<tr>
<td>ROM</td>
<td>Range of movement</td>
</tr>
<tr>
<td>Rx</td>
<td>Treatment</td>
</tr>
<tr>
<td>SCP</td>
<td>Subscapularis muscle</td>
</tr>
<tr>
<td>SD</td>
<td>Standard deviation</td>
</tr>
<tr>
<td>SF</td>
<td>Short form</td>
</tr>
<tr>
<td>SPADI</td>
<td>Shoulder pain and disability index</td>
</tr>
<tr>
<td>SSP</td>
<td>Supraspinatus muscle</td>
</tr>
<tr>
<td>TGF</td>
<td>Transforming growth factor</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>TSA</td>
<td>Total shoulder abduction</td>
</tr>
<tr>
<td>TSF</td>
<td>Total shoulder flexion</td>
</tr>
<tr>
<td>US</td>
<td>Ultrasound</td>
</tr>
<tr>
<td>VAS</td>
<td>Visual analogue scale</td>
</tr>
<tr>
<td>yrs</td>
<td>Years</td>
</tr>
</tbody>
</table>
Abstract

Adhesive capsulitis is a shoulder disorder commonly encountered in musculoskeletal practice. It is recognised as consisting of three stages, and is characterized initially by pain followed by a gradual loss of active and passive ranges of movement. In its early stage, confusion with other shoulder disorders with the potential to cause pain and limited range of movement is common and may result in inappropriate or untimely treatment. Musculoskeletal medicine relies on clinical findings together with medical imaging to inform the diagnosis of many disorders. These findings may be useful in contributing to a diagnosis as well excluding other potential diagnoses. The overall aim of this thesis was to identify and investigate the clinical identifiers or diagnostic criteria that may facilitate recognition of the early stage of adhesive capsulitis. Four research studies and one literature review were undertaken to meet this aim.

A correspondence-based Delphi study was initially undertaken to investigate whether consensus could be achieved among a group of experts on the diagnostic criteria/clinical identifiers that are associated with the early stage of adhesive capsulitis. This study established eight identifiers that clustered into two discrete domains of pain and movement. Secondly, a review of the diagnostic imaging literature was undertaken to determine the current and future contribution that this modality may make to the clinical diagnosis of adhesive capsulitis. As Doppler ultrasonography was identified as having potential to contribute to the early diagnosis of adhesive capsulitis, it was explored in a second study. This study demonstrated that it may be possible to visualise an area of increased vascularity in the rotator interval.
area of the shoulder in patients clinically diagnosed with early stage adhesive
capsulitis. A third study aimed to evaluate patients diagnosed with early stage
adhesive capsulitis to determine the existence of any pattern of movement loss and
associated pain that may facilitate early recognition. The limiting factor to movement
was also analysed. Although pain is reportedly a characteristic in the early stage, the
results of this study suggested it may be less useful than percentage loss of active range
of movement in identifying patients with primary/idiopathic adhesive capsulitis.
Interestingly overall, external rotation in abduction emerged as the most painful active
and passive movement and the movement most frequently limited by pain rather than
resistance, which may provide valuable information to both the clinician and
researcher. The aim of final study was to validate the clinical identifiers established in
the earlier Delphi study. This study, unexpectedly suggested the identifiers from the
earlier study may not be true predictors of early stage adhesive capsulitis.

The study findings presented in this thesis provide a number of features that may
facilitate identification of early stage adhesive capsulitis, as well as enable future
researchers to determine more homogeneous samples. Importantly, the overall results
of the studies challenge the commonly recognised clinical identifiers or diagnostic
criteria for adhesive capsulitis and suggest they may not be able to adequately
diagnose this disorder in its early stage. The findings also highlight the difficulty of
rigorously investigating this stage of the disorder. Future directions for research and
implications for clinical practice are discussed in relation to the findings of the studies
in this thesis.