CHARACTERISTICS OF CHRONIC ANKLE INSTABILITY AND THE ROLE OF JOINT MOBILISATION

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This is to certify that the thesis entitled **'Characteristics of Chronic Ankle Instability and the Role of Joint Mobilisation'** submitted in fulfilment of the requirements for the degree of Doctor of Philosophy (Physiotherapy) is in a form ready for examination.

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DECLARATION

I hereby certify that the work embodied in the thesis is my own work, conducted under normal supervision. The thesis contains no material which has been accepted, or is being examined, 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. 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 and any approved embargo.

I hereby certify that this thesis is in the form of a series of papers. I have included as part of the thesis a written declaration from each co-author, endorsed in writing by the Faculty Assistant Dean (Research Training), attesting to my contribution to any jointly authored papers.

Ishanka Weerasekara _____ 16 August 2019

Signature Date

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PUBLICATIONS AND PRESENTATIONS

Papers published and submitted for publication in peer-reviewed journals as part of this thesis:

1. Weerasekara, I., Osmotherly, P., Snodgrass, S., Marquez, J., de Zoete, R., & Rivett, D. A. (2018). Clinical benefits of joint mobilisation on ankle sprains: a systematic review and meta-analysis. *Archives of Physical Medicine & Rehabilitation, 99*(7), 1395-1412.e1395. doi:https://doi.org/10.1016/j.apmr.2017.07.019

2. Weerasekara, I., Osmotherly, P. G., Snodgrass, S. J., Tessier, J., & Rivett, D. A. (2019). Effects of mobilisation with movement (MWM) on anatomical and clinical characteristics of chronic ankle instability: a randomised controlled trial protocol. *BMC Musculoskeletal Disorders, 20*(1), 75. doi:10.1186/s12891-019-2447-x

3. Weerasekara, I., Osmotherly, P., Snodgrass, S., Tesseir, J., & Rivett, D. A. (2019). Is the fibula positioned anteriorly in weight-bearing in individuals with chronic ankle instability? (under review).

4. Weerasekara, I., Snodgrass, S., Osmotherly, P., Tessier, J., & Rivett, D. A. (2019). Clinical characteristics of chronic ankle instability: a case-control study (under review).

Published abstracts from peer-reviewed conferences:

1. Weerasekara, I., Osmotherly, P., Snodgrass, S., de Zoete, R., & Rivett, D. (2016, October 12-15). Clinical benefits of passive joint mobilisation on ankle sprains. In *Journal of Science &*

Medicine in Sport. Paper presented at the Sports Medicine Australia Conference, Sydney, Australia. *20*, e49. doi:10.1016/j.jsams.2017.01.133

2. Weerasekara, I., Osmotherly, P., Snodgrass, S., Marquez, J., de Zoete, R., & Rivett, D. (2017, October 19-21). A systematic review and meta-analysis of the clinical benefits of passive joint mobilisation on ankle sprains. Paper presented at the *Australian Physiotherapy Association Conference*, Sydney, Australia.

3. Weerasekara, I., Osmotherly, P., Snodgrass, S., Tessier, J., & Rivett, D. (2019, May 10-13). Fibular position in chronic ankle instability (CAI) and the reliability of weight-bearing radiographic measurements of fibular position. Paper presented at the *World Confederation for Physical Therapy Congress,* Geneva, Switzerland.

4. Weerasekara, I., Osmotherly, P., Snodgrass, S., Tessier, J., & Rivett, D. (2019, October 3-4). Fibular position in chronic ankle instability radiographically measured in weight-bearing (accepted). Paper will be presented at the *8th International Ankle Symposium*, Amsterdam, Netherlands.

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LIST OF ABBREVIATIONS

ADL	activities of daily living
AMI	axial malleolar index
ANZCTR	Australian New Zealand Clinical Trial Registry
AP	antero-posterior
APTA	American Physical Therapy Association
ATFL	anterior talofibular ligament
AUC	area under the curve
BMI	body mass index
CAI	chronic ankle instability
CAIT	Cumberland ankle instability tool
CFL	calcaneofibular ligament
CI	confidence interval
CoP	centre of pressure
CT	computed tomography
df	degrees of freedom
DFROM	dorsiflexion range of motion
FAAM	foot and ankle ability measure
FAOS	foot and ankle outcome score

GRADE	Grading of recommendations, assessment, development and evaluation
HVLA	high velocity low amplitude
IAC	International Ankle Consortium
ICC	intra-class correlation coefficient
ICF	International classification of functioning, disability and health
IMI	intermalleolar index
ITT	intention to treat
IV	inverse variance
LR	likelihood ratio
MCID	minimal clinically important difference
MD	mean difference
MDC	minimal detectable change
ML	medio-lateral
MRI	magnetic resonance imaging
MWM	mobilisation with movement
N/A	not applicable
OR	odds ratio
PL	postero-lateral
PM	postero-medial
POLICE	protection, optimal loading, ice, compression and elevation

PPT	pressure pain threshold
PTFL	posterior talofibular ligament
QOL	quality of life
RCT	randomised controlled trial
RICE	rest, ice, compression and elevation
ROC	receiver operating characteristic
ROM	range of motion
SD	standard deviation
SE	standard error
SEBT	star excursion balance test
SEM	standard error of measurement
SMD	standard mean difference
TCJ	talocrural joint
TFJ	tibiofibular joint
TTS	time to stabilisation
VAS	visual analogue scale
WHO	World Health Organisation

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Abstract

Chronic ankle instability (CAI) is the occurrence of giving way and/or recurrent sprain and/or feelings of instability of a previously injured ankle. Compared to a simple ankle sprain, the additional morbidity and additional costs incurred due to diagnostic imaging related to CAI create significant economic and other societal consequences. Direct costs can include consultations with physicians, physiotherapists and other health professionals, diagnostic imaging and various hospital expenses, while indirect costs may arise from productivity losses, absenteeism (from school, work and sports) and diminished levels of physical activity resulting in economic burden on the healthcare system and for the individual patient. Rehabilitation of CAI commonly involves manual therapy procedures applied to joints in the ankle region, such as non-thrust passive joint mobilisation, high-velocity thrust manipulation and mobilisation with movement (MWM) as described by Brian Mulligan. These techniques largely involve a continuum of skilled passive movements of joints that are applied at different speeds and amplitudes. The overall aims of this thesis were to explore the clinical characteristics of CAI and to determine the effects of joint mobilisation in CAI. This thesis comprises four studies designed to meet these aims, presented as five manuscripts which have either been published in peer-reviewed journals or are in the process of review or submission.

Study 1 is a systematic review and meta-analysis undertaken to evaluate the current evidence for joint mobilisation in the clinical rehabilitation of ankle sprains, using the previously published body of literature. Based upon this investigation, joint mobilisation appears to be beneficial for improving dynamic balance immediately after application and dorsiflexion range of movement in the short-term

in chronic ankle sprains. The results of this study also suggested that the combination of MWM and associated fibular repositioning taping is more likely to exhibit a clinical benefit than other assessed mobilisation techniques, and potentially supporting the hypothesis of Brian Mulligan that the distal fibula is displaced anteriorly in CAI.

Study 2 explored the position of the distal fibula in relation to the position of the distal tibia in CAI using weight-bearing radiographs. The findings of this study indicated that there is a more anteriorly positioned fibula in individuals with CAI compared to individuals with healthy ankles when assessed in a weight-bearing position, consistent with Mulligan's hypothesis. Notably, this study was the first to use weight-bearing radiographs to measure the fibula position in CAI.

Study 3 investigated other clinical characteristics of CAI including ankle dorsiflexion range of motion, balance, self-reported function, pain and pressure pain threshold which have not been consistently reported, or for which little research has been published in the previous literature. It was found that individuals with CAI exhibit a multi-factorial presentation including impaired ankle dorsiflexion range, reduced static and dynamic balance, lower self-reported function and greater pain intensity, compared to individuals with healthy ankles. Despite the persistence of pain often reported in CAI, no evidence was found to suggest maladaptive central nervous system sensitisation (nociplastic pain).

Study 4 involved a randomised controlled trial (RCT) to investigate the effects of MWM of the distal tibio-fibular joint with fibular repositioning taping on fibular position and other clinical characteristics of CAI. The protocol for this study was published, and in contrast to almost all previously published studies of this manual therapy technique, highlighted the long-term nature of the trial with a one year follow-up. The immediate and short-term findings revealed no significant differences in any of the outcomes measured except for improvements in two self-reported function subscales (pain and sports on the foot and ankle outcome score (FAOS) questionnaire) in the placebo (detuned laser) intervention group. The long-term results were still being collected at the time of the submission of this thesis so are not reported or considered in the discussion.

The body of work contained in this thesis extends our current understanding of CAI and its clinical management. The results have implications for the identification of the features of CAI and for improving its treatment using joint mobilisation. Reproduction of the contained research using more homogeneous samples of CAI may permit a greater understanding of this persistent condition and how it responds to manual therapy. In addition, the use of weight-bearing radiographs in future studies to assess fibula position may be a more functional method. Other future directions for research and implications for clinical practice are discussed in detail in relation to the results of each of the studies in this thesis.