UNIVERSITI PUTRA MALAYSIA

EFFECTIVENESS OF SEATED COMBINED EXTENSION-COMPRESSION AND TRANSVERSE LOAD TRACTION IN INCREASING CERVICAL LORDOSIS

TAMARA GIEN POOKE

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By

TAMARA GIEN POOKE

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

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DEDICATION

This dissertation is dedicated to my husband, Hayden, for his constant support throughout this process, and for his patience and understanding for the duration of this undertaking. It is also dedicated to my parents for instilling in me the value of education, and to all those who participated in this process, without whom this would not have been possible.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Doctor in Philosophy

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June 2017

Chairman: Prof. Rozi Binti Mahmud, PhD
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Changes in sagittal spinal alignment are gaining more importance in terms of treatment outcomes, as abnormal spinal postures result in altered biomechanics that ultimately result in dysfunctions and pathologies. As such, new methods for improving sagittal alignment are being sought. The goal of this study was to assess the effectiveness of seated combined extension-compression and transverse load traction (ECTL) traction as one such method, to determine if it is effective in increasing a reduced lordosis of less than 30 degrees in a Malaysian population between the ages of 18 and 60 years. Secondary objectives such as changes in clinical outcomes of pain and disability were also assessed, along with degenerative findings and possible changes in disc height. These changes were also assessed for any possible differences between gender, age and race. The theory of how this type of ECTL traction can improve a reduced cervical lordosis is based on creep, as well as on the three-point bending mechanism. By creating tension in the anterior cervical structures, this should result in permanent elongation of these structures, and thereby allow improvement of a reduced cervical curve. This was a single center, randomized, blinded controlled clinical trial with parallel groups, used to test the superiority of the seated combined ECTL traction together with physiotherapy exercises as compared with the same physiotherapy exercises used as a control. Fifty randomly allocated subjects who completed the forty treatments over the fourteen weeks were analyzed using non-parametric tests for changes in cervical lordosis and clinical outcomes. The treatment group was subjected to seated combined ECTL traction in combination with physiotherapy exercises, and the control group was subjected to the same physiotherapy exercises only. There were no significant changes seen, with both of the intervention groups showing a non-significant decrease in cervical lordosis rather than the hypothesized increase. Clinical outcomes of pain and disability were assessed and were the only outcomes in this study to show

significant improvement, however, there were no significant differences seen between the two groups in terms of any of the other measured outcomes. It was determined that neither intervention used in this study was effective in increasing a reduced cervical lordosis. There were however significant changes seen in the clinical outcomes of pain and disability, in contrast to the curve findings, which further adds to the evidence that suggests that cervical alignment and pain and disability are not related. The findings of a greater overall increase in posterior disc height compared with anterior disc height changes, and greater height changes occurring in the control group, are also in contrast to the proposed underlying theoretical framework for this type of ECTL traction.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

KEBERKESANAN PENGGABUNGAN PEMANJANGAN KEDUDUKAN – KEMAMPATAN DAN BEBAN CENGKAMAN MELINTANG DALAM PENINGKATAN LORDOSIS SERVIKAL (LEHER)

Oleh

TAMARA GIEN POOKE

Jun 2017

Pengurusi: Prof.Rozi Binti Mahmud, PhD
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Perubahan dalam penjajaran tulang belakang sagittal menjadi semakin penting dalam rawatan seperti postur tulang belakang yang tidak normal dengan perubahan biomekanik yang akhirnya mengakibatkan disfungsi and pathologi. Sebagai contoh, kaedah baru dalam meningkatkan penjajaran sagittal masih lagi dalam kajian. Matlamat kajian ini adalah untuk menilai keberkesanan *ECTL* sebagai salah satu kaedah untuk menentukan adakah ia berkesan untuk meningkatkan pengurangan *lordosis* sebanyak 30 darjah dalam kalangan populasi rakyat Malaysia yang berumur antara 18 dan 60 tahun. Matlamat kedua adalah seperti perubahan dalam hasil klinikal dalam menilai kesakitan dan ketidakupayaan beserta penemuan degeneratif dan kebarangkalian perubahan dalam *disc height.* Perubahan-perubahan ini juga akan dinilai sekiranya terdapat kebarangkalian dalam perbezaan antara gender, umur dan bangsa. Teori tentang bagaimana jenis cengkaman ECTL bole meningkatkan pengurangan lordosis serviks (leher) berdasarkan kepada *creep* dan juga mekanisma lenturan tiga titik. Dengan mewujudkan ketegangan dalam struktur serviks anterior (leher), seharusnya dapat menghasilkan pemanjangan kekal struktur ini. Dengan itu, ia membolehkan penambahbaikan lengkuk serviks (leher) dapat dikurangkan. Ini merupakan pusat tunggal, secara rawak dan percubaan pengawalan klinikal blinded dengan kumpulan yang selari, digunakan untuk menguji keunggulan cengkaman *seated combined ECTL* bersama dengan latihan fisioterapi dan latihan-latihan fisioterapi yang sama sebagai kawalan. 50 subjek secara rawak telah diperuntukkan yang telah selesai menjalani 40 rawatan dalam masa 14 minggu telah dianalisa tanpa menggunakan ujian parametrik untuk melihat perubahan lordosis servik (leher) dan hasil klinikal. Kumpulan rawatan telah menerima cengkaman *seated combined ECTL* bersama dengan latihan fisioterapi dan kumpulan kawalan telah menerima latihan-latihan

fisioterapi yang sama sahaja. Tiada perubahan ketara dapat dilihat dengan kedua-dua kumpulan dilihat menunjukkan penurunan tidak ketara dalam lordosis serviks (leher) dan berbanding dengan peningkatan hipotesis. Hasil klinikal mengenai kesakitan dan ketidakupayaan dinilai dan hasilnya hanya ditunjukkan dalam kajian ini di mana perubahan ketara tidak dapat dilihat diantara dua kumpulan berdasarkan hasil pengukuran tersebut. Ia menentukan sama ada penglibatan yang berkesan dalam meningkatkan pengurangan lordosis serviks (leher) dalam kajian ini walaubagaimanapun, perbezaan dapat dilihat menerusi hasil klinikal yang melibatkan kesakitan dan ketidakupayaan berbanding dengan pemerhatian lengkuk leher dimana penambahan kepada bukti yang dicadangkan bahawa penjajaran serviks (leher) dan kesakitan serta ketidakupayaan adalah tidak berkaitan antara satu sama lain. Kajian secara menyeluruh meningkatkan *posterior disc height* jika dibandingkan dengan perubahan *anterior disc height* dan perubahan ketara berlaku dalam kumpulan kawalan turut berbeza kepada rangka teoritikal yang dicadangkan untuk jenis cengkaman *ECTL* ini.

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I certify that a Thesis Examination Committee has met on 19 June 2017 to conduct the final examination of Tamara Gien Pooke on her thesis entitled "Effectiveness of Seated Combined Extension-Compression and Transverse Load Traction in Increasing Cervical Lordosis" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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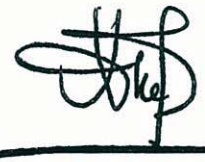

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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This is to confirm that:

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LIST OF ABBREVIATIONS

ECTL	Extension-compression and transverse load
MRI	Magnetic Resonance Imaging
NDI	Neck Disability Index
VAS	Visual Analogue Pain Scale

CHAPTER 1

INTRODUCTION

1.1 Background

There is a recent increase in research on spinal curves and postures, and how these relate to degenerative changes as well as clinical outcomes. Several studies have shown a correlation between abnormal spinal curves and an increase in degeneration, (Alahamadi & Zadeh, 2011; Christensen & Hartvigsen, 2008; Faldini, Pagkrati, Leonettti, Miscione and Giannini, 2011; Miyakoshi, Hongo, Kusakawa, Ishikawa and Shimada, 2011; Miyazakiet al., 2008; Okada et al., 2009; Park et al., 2014; Roussouly & Nnandi, 2010; Silber, Lipetz, Hayes and Lonner, 2004), as well as a possible link to pain and function, (Gore, 2001; Harrison et al., 2003; Harrison, Calliet, Harrison, Janik and Holland, 2002; Harrison, Cailliet, Harrison, Troyanovich and Harrison, 1999 and Keifer, Shirasi-Adl and Parnianpour 1998).

Abnormal spinal postures alter biomechanics. Asymmetrical loading of tissues and increased stresses and strains on the tissues ultimately result in dysfunctions and pathologies (Harrison et al., 2001) and (Harrison et al., 1999). These may in turn have an effect on clinical outcomes such as pain (McAviney, Schulz, Bock, Harrison and Holland, 2005). Due to this, new methods for improving a decreased cervical lordosis are being sought.

1.2 Problem Statement

This research investigates a new device from the United States, that utilizes a new method of seated, combined extension- compression and transverse load (ECTL) traction. Currently there are no available randomized controlled trials available on either the device itself, or on this new method of traction. There is also no research available in these areas on populations other than Caucasians. With recent evidence showing Asian and Caucasian spinal structures to be significantly different, a study such as this, in an entirely different sample population, will further validate results shown in previous studies utilizing this type of traction, as well as highlight any differences that may occur within the different populations.

This study aims to investigate the effectiveness of ECTL traction as a new method for increasing a reduced cervical lordosis, by comparing this form of

structural rehabilitation to the more conventional functional physiotherapy exercises. It also aims to assess if there is any correlation between structural findings and clinical outcomes such as pain and disability. This new device from the United States has never been used in a Malaysian clinical setting, and there are currently no randomized controlled trials for this device or for this new proposed method of traction.

1.3 Research Questions

The main research question for this study was to determine if this type of ECTL traction is more effective in increasing a reduced cervical lordosis than functional physiotherapy exercises, in a Malaysian population between the ages of 18 and 60 years, with a reduced cervical lordosis of less than 30 degrees. Additional research questions focus on any relationships and changes between a reduced cervical lordosis and clinical outcomes such as pain and disability, as well as possible correlation to degenerative findings in the cervical spine as seen on both radiograph and MRI.

Previous studies by Harrison et al. (2003), Harrison et al. (2002), and Harrison et al. (2002), as conducted in a Caucasian sample have shown an increase in lordosis with a similar type of seated extension traction, so similar results are expected. It is postulated that the treatment group subjected to ECTL traction combined with physiotherapy exercises, is more likely to have greater improvement in lordosis, as well as a greater increase in anterior disc height, than the control group undergoing the same exercises alone. It is also assumed that there is a relationship between a reduction in cervical lordosis and pain and disability, as well as a relationship between degenerative findings and a potential change in pain and disability outcomes.

The primary outcome variable is that of cervical curve measurement. Several methods of measurement have been employed to determine any changes in cervical lordosis. These include several Cobb method measurements, as well as a change in cervical depth and atlas plane angle. Other radiographic variables include degenerative findings on both x-ray and MRI, as well as changes in cervical disc height on MRI. Clinical outcomes including pain, in the form of VAS score, and function as measured by the Neck Disability Index (NDI) were also analyzed.

1.4 Hypotheses and Research Objectives

The main objective of this study was to conduct a randomized controlled trial to test the effectiveness of this device in increasing a reduced lordosis. This further adds to the body of knowledge on this new method of traction. It also determines how a Malaysian sample respond to this intervention, when compared to a control of physiotherapy exercises. This study is a comparison of two groups, a treatment group that is subjected to a combination of ECTL traction as well as conventional physiotherapy exercises for posture, and a control group that received the same physiotherapy exercises only.

Additional specific objectives were to determine whether:

1. There is a change in cervical lordosis post interventions, and if there is any difference between ECTL traction combined with physiotherapy exercises when compared with the same physiotherapy exercises alone, in subjects with a reduced cervical lordosis.

2. There is a change in pain and disability scores post interventions and if there is any difference between the two intervention groups.

3. There are any differences seen in the outcomes above for age, gender or race.

Secondary additional research objectives of this study were to:

1. See if there was any correlation between baseline cervical curve measurements and degenerative findings with both x-ray and MRI findings.

2. See if there was any correlation between cervical curve measurements and pain and disability scores, at baseline.

3. See if there was any correlation between x-ray and MRI degenerative findings and the change cervical lordosis.

4. See if there is any correlation between degenerative findings and a change in pain and disability scores.

5. See if there is any correlation between changes in cervical curve measurements and changes in pain and disability.

6. See if there is a change in disc height with either intervention, and if there were differences seen with age, gender or race.

The hypothesis, is that this device will be effective in increasing a reduced cervical lordosis, and that between the two groups, the treatment group will show a superior outcome to the control group.

1.5 Theoretical Framework

The theory of how this type of traction can improve a reduced cervical lordosis is based on the principle of creep (Oliver & Twomey, 1995), as well as on a three-point bending mechanism. By creating tension in the anterior cervical structures (anterior longitudinal ligament, anterior disc and anterior neck muscles) whilst administering traction, this should result in permanent elongation of these structures. Thereby allowing improvement of a reduced cervical lordosis. Strengthening the cervical muscles through the use of physiotherapy exercises should also have an effect on cervical posture. Previous studies in a Caucasian sample using a similar traction device showed an improved cervical lordosis over a ten-week period (Harrison et al., 2003).

It is postulated that this treatment group, receiving ECTL traction together with the physiotherapy exercises, are more likely to have greater improvement in their reduced cervical lordosis than those in the control group receiving the exercises only.

1.6 Definition of Terms

Reduced cervical lordosis- any Cobb angle measurement of less than 30 degrees on lateral cervical radiograph/ x-ray.

Cervical Lordosis- this is the normal inward or anterior curvature of the cervical spine in the sagittal plane.

Cervical Kyphosis- this is the abnormal reversal of the inward or anterior curvature of the cervical spine into an outward or posterior direction in the sagittal plane.

Degeneration- describes the process by which tissue deteriorates and loses functional ability due to traumatic injury, aging and wear and tear.

Cervical Traction- a common nonsurgical treatment for a herniated disc in the neck that relieves pain by opening up the cervical foramen to reduce pressure on compressed nerve roots exiting the spinal canal. Traction can either be applied manually or by spinal traction devices.

Extension-compression and transverse load traction- traction whereby the head is distracted, retracted and extended, while the neck is arched into a lordosis, by means of a head harness which is posteriorly fixed. The vectors of pull force and angle can be adjusted.

Cobb Angle- two intersecting lines as drawn through the endplates of the cervical vertebrae, one superior and one inferior, with intersecting perpendicular lines, resulting in an acute angle. A positive measurement indicates a level of lordosis, and a negative measure indicates a level of kyphosis.

Depth of Curve- the measurement of anterior head translation, as measured by a line drawn from the posterior superior portion of the odontoid peg to the posterior inferior corner of the C4 vertebral body. A positive measurement indicates a level of lordosis, and a negative measure indicates a level of kyphosis.

Atlas Plane Angle- the angle between the line drawn through the anterior and posterior tubercles of the atlas, with the true horizontal line.

Disc Height- measured in mm, using a standard rule measurement. This was measured on the mid-sagittal slice of MRI using Dabbs method, which is the mean of the anterior and posterior disc heights.

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