A comparison of two shoulder strapping techniques in patients with stroke.

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DECLARATION

I, Nicolette Comley-White, declare that this dissertation is my own unaided work, except to the extent indicated in the reference list and acknowledgements. It is being submitted in fulfilment of the requirements for the degree of Masters of Science in Physiotherapy at the University of the Witwatersrand. It has not been submitted before for any other degree or examination at this or any other university.

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Nicolette Comley-White

..25.. day of ....May....... 2015

PRESENTATIONS ARISING FROM THIS STUDY

- Podium presentation at World Confederation for Physical Therapy, Africa Region-Zambia 2014
- Poster presentation at World Confederation for Physical Therapy- Singapore 2015

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ABSTRACT

Background

Despite it being used clinically, there is limited, inconclusive literature available on shoulder strapping techniques for patients with stroke. Of the published techniques, circumferential strapping seems to show the most positive results. However, in South Africa, variations of a longitudinal technique are applied most often. This study aimed to establish if longitudinal or circumferential strapping techniques would have an impact on a patient's upper limb tone, subluxation, motor function or pain, post stroke and how they compared to each other.

Participants

This study recruited 56 participants within two weeks of having a stroke, presenting with upper limb involvement (hemiplegia). Participants were excluded if they had receptive aphasia and/or were medically unstable.

Method

The study was a longitudinal randomised controlled trial comprising of three groups: a control, longitudinal strapping and circumferential strapping groups. Patients with stroke who met the inclusion criteria were assessed at baseline, week one, week two and week six post baseline assessments. The participants were assessed for shoulder subluxation (finger width measurement system), shoulder pain (Ritchie Articular Index), upper limb motor function (upper limb subscales six, seven and eight of the Motor Assessment Scale) and muscle tone (Modified Ashworth Scale). The intervention groups were strapped for two weeks. The sample size for the study was originally calculated at 15 participants however we felt that this should be larger and thus using the central limit theorem a minimum of 30 participants per group was calculated. Demographic data were analysed using descriptive statistics and are presented in tables using frequencies and percentages for the following variables: age, gender and side of stroke. The two-sample test of proportions was used to determine differences among the groups over the study period. The overall within group effect was tested using the Cochran's Q test. The generalized estimated equations were was

used to determine the overall effects of the intervention overtime adjusting for groups as well as using population levels.

Ethical approval was granted by the Human Research Ethics Committee at the University of the Witwatersrand and informed consent was obtained from all participants prior to the study.

Results

The total number of participants recruited into the study over three years was 56. The number of participants in the control, circumferential and longitudinal groups was 19, 15 and 22 respectively. Data showed that the study participants were generally young with a mean age of 49.4 (± 13.8) years. There were more females (51.8%) than males and the majority of the study sample (60.7%) had a right cerebrovascular accident.

Longitudinal strapping decreased shoulder subluxation and pain, but not tone, however, across all of the outcome measures the changes did not reach statistical significance.

Circumferential strapping had no significant effect on any of the outcomes compared to the control group, however, it prevented the shoulder pain from worsening, but it had no positive effect on shoulder subluxation post stroke.

Improvement in upper limb motor function was observed for all three groups with only a significant improvement in upper arm function being observed for the circumferential group.

Conclusion and implications

Overall, the study showed positive trends in changes in the shoulder post stroke but no significant differences were found between the groups in any of the outcomes, even when both intervention groups were combined and analysed against the control participants. Looking at the trends, however, the longitudinal technique, with its positive effect on shoulder subluxation and pain, would appear to be the preferred method of the two.

Although the study produced overall results that did not have statistical significance one cannot discredit the use of the strapping. Even if strapping had purely a placebo effect it would still serve a purpose by creating awareness in the patient, caregivers and medical personal and thus ensure more cautious handling of the affected upper limb.

Thus, when rehabilitating the shoulder post stroke, there appears to be enough clinical evidence to suggest that strapping, more precisely longitudinal strapping, of the hemiplegic shoulder may be used.

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LIST OF ABBREVIATIONS

EBSCO	- Elton B. Stephens Co.
ICF	- International Classification of Functioning, Disability and Health
MAS	- Modified Ashworth Scale
RAI	- Ritchie Articular Index
SD	- Standard Deviation
TIA	- Transient Ischaemic Attack
UL-MAS	- Upper Limb Subscale of the Motor Assessment Scale
WHO	- World Health Organisation

CHAPTER 1

1. INTRODUCTION

1.1 Background and need

Following stroke, many patients suffer from upper limb dysfunction. Lawrence et al. (2001) found that 30% of patients with stroke have a sensory deficit of the upper limb, while 77% have a motor deficit. It has been shown that a patient's upper limb degree of motor deficit is positively associated with shoulder pain (Ratnasabapathy et al., 2003). Ratnasabapathy et al.'s (2003) study showed that approximately one in five patients with stroke suffer from shoulder pain, which often increases as time goes on, up to six months post stroke. Post stroke shoulder pain on movement has been found to be a predictor of poor functional outcome and to contribute to an increased length of hospital stay (Barlak et al., 2009; Roy et al., 1995).

In addition to shoulder pain, patients can develop spasticity post stroke, causing a higher dependency for activities of daily living (Lundström et al., 2008). Spasticity post stroke presents across all the three phases of acute, sub-acute and chronic stroke, with up to 42% of patients presenting with spasticity upon admission to rehabilitation (Ryu et al., 2010; Dajpratham et al., 2009).

Another upper limb complication of stroke is shoulder subluxation, with higher incidences of shoulder subluxation occurring in patients with lower levels of function (Suethanapornkul et al., 2008) The link between shoulder pain and subluxation has been widely studied yet remains inconclusive, with some authors showing evidence for it and some against it, as is shown in the literature review by Turner-Stokes and Jackson (2002).

In a study done by Gamble et al. (2002) they found that although 40% of patients with stroke developed a painful shoulder (55% in the first two weeks post stroke), it improved in 80% of the patients over six months with standard treatment. This standard treatment incorporated physiotherapy, simple analgesics, steroid injections and (in some cases) amitriptyline (Gamble et al., 2002). The study did not specify what aspects of physiotherapy were administered but looking at additional studies, one is given a clearer idea with regards to the scope of physiotherapy used in the treatment of the hemiplegic upper limb of patients with stroke.

In Barreca et al.'s (2003) systematic review of 68 articles they determined that sensorimotor training, careful limb handling, electrical stimulation, movement with elevation, strapping and not using overhead pulleys all play a role in treating the hemiplegic upper limb of patients with stroke. Additionally, Bender and McKenna (2001) summarised from literature that positioning of the limb and external supports are also used in the management of hemiplegic shoulder pain in patients with stroke.

There are various types of external supports that are used in patients with stroke (Zorowitz et al., 1995), and as stated above, strapping is utilised by therapists in managing patients with strokes' upper limbs (Barreca et al., 2003; Bender and McKenna, 2001), specifically with regards to shoulder pain and subluxation (Paci et al., 2005; Morley et al., 2002).

In the literature, one can find a variety of different shoulder strapping techniques (Pandian et al., 2013; Appel et al., 2011; Griffin and Bernhardt, 2006; Peters and Lee, 2003; Kneeshaw, 2002; Hanger et al., 2000; Morrissey, 2000; Morin and Bravo, 1997) however two main trends emerge from the descriptions: a longitudinal method (Pandian et al., 2013; Peters and Lee, 2003; Kneeshaw, 2002; Morrissey 2000) and a circumferential method (Griffin and Bernhardt, 2006; Ancliffe, 1992).

The longitudinal method is frequently used in the South African clinical setting. However, only one randomised control trial has been published, with no statistically significant outcomes (Pandian et al., 2013).

The circumferential type of strapping described by Ancliffe (1992) appears to have had positive effects on the shoulder post stroke. Although Ancliffe's (1992) study is a small pilot, the results showed that this circumferential taping technique delayed the onset of shoulder pain in patients with stroke. A larger study was done using the same strapping technique in both a therapeutic strapping group and a placebo strapping group (Griffin and Bernhardt, 2006), where it was found that the therapeutic strapping positively influenced the development of hemiplegic shoulder pain in patients with stroke. Although the placebo strapping also had an effect, therapeutic strapping produced better results. By comparison to the studies done with the other techniques, it would appear that the circumferential technique is a more influential technique to use in patients post stroke.

1.2 Problem statement

In conclusion, it is apparent that a person faces a variety of upper limb sequelae post stroke that impact on their quality of life. Of the treatment options available, however, there is not a great deal of published literature on shoulder strapping for patients with stroke, despite it being used clinically. It is this lack of consensus on the type of technique and effectiveness of shoulder strapping post stroke that created the need for this study.

1.3 Research question

Which shoulder strapping technique is more effective (between the longitudinal and the circumferential strapping techniques) in the management of the hemiplegic shoulder in patients with stroke?

1.4 Aim

To compare the effects of two shoulder strapping techniques in patients with stroke.

1.4.1 Objectives of the study

The objectives of the study were to:

1. Establish the effects of the longitudinal strapping technique on hemiplegic shoulder pain, tone, subluxation and motor function in patients with stroke.
2. Establish the effects of the circumferential strapping technique on hemiplegic shoulder pain, tone, subluxation and motor function in patients with stroke.
3. Compare the effects of the two different strapping techniques on hemiplegic shoulder pain, tone, subluxation and motor function in patients with stroke.

4. Establish the effect of strapping (in general) on hemiplegic shoulder pain, tone, subluxation and motor function in patients with stroke.

1.5 Hypotheses

1.5.1 H_0

- Longitudinal strapping will have no effect on hemiplegic shoulder pain, tone, subluxation and motor function in patients with stroke.
- Circumferential strapping will have no effect on hemiplegic shoulder pain, tone, subluxation and motor function in patients with stroke.
- There will be no difference between longitudinal and circumferential strapping effects on hemiplegic shoulder pain, tone, subluxation and motor function in patients with stroke.
- There will be no effect from strapping (in general) on hemiplegic shoulder pain, tone, subluxation and motor function in patients with stroke.

1.5.2 H_1

- Longitudinal strapping will have a positive effect on hemiplegic shoulder pain, tone, subluxation and motor function in patients with stroke.
- Circumferential strapping will have a positive effect on hemiplegic shoulder pain, tone, subluxation and motor function in patients with stroke.
- Longitudinal strapping will have different effects to circumferential strapping on hemiplegic shoulder pain, tone, subluxation and motor function in patients with stroke than circumferential strapping.
- Strapping (in general) will have a positive effect on hemiplegic shoulder pain, tone, subluxation and motor function in patients with stroke.

1.6 Significance of the study

Optimal strapping technique and the potential effectiveness on stroke upper limb sequelae has not been satisfactorily addressed in the literature and so this study hoped to establish which of the two techniques (the longitudinal technique or the circumferential technique) was more effective to use when strapping the hemiplegic shoulder of patients with stroke, and what the effects of these two techniques were on the hemiplegic shoulder pain, tone, subluxation and motor function in patients with stroke. Optimising this in the clinical setting can have a large influence on the functional outcome of the shoulder post stroke and thus on a patient's quality of life and reintegration into the community.

CHAPTER 2

2. LITERATURE REVIEW

2.1 Introduction

The intention of this literature review is to address the impact of stroke on a person's daily functioning and participation with regards to their upper limb use; specifically looking at dysfunction in four areas of the upper limb post stroke: namely shoulder subluxation, shoulder pain, motor function and muscle tone. An overview will be given of the prevalence and incidence of stroke on a global, African and South African level, as well as the prevalence of each of the four abovementioned areas of upper limb dysfunction. The unaffected shoulder will be discussed as a background for normal function prior to the definitions, pathophysiology, prevalence and impact on quality of life that will be discussed for each area of upper limb dysfunction.

The review will also cover evidence for the management of the upper limb post stroke, with specific detail given on the different types of strapping for the hemiplegic shoulder and reasons for which it is used. The majority of the articles accessed were from 2004-2014 and were obtained from electronic data bases such as Science Direct, PubMed, EBSCOHost, Elsevier. The library of the University of the Witwatersrand was used to access these data bases and the following keywords were used: stroke; cerebrovascular accident; upper limb; shoulder pain; tone; spasticity; motor dysfunction; weakness; hemiplegia; subluxation; quality of life; strapping; taping; shoulder management; prevalence; incidence; global; Africa; developing country; South Africa.

2.2 Definition of stroke

The World Health Organisation (WHO) defined stroke as "rapidly developed clinical signs of focal or global disturbance of cerebral function, lasting more than 24 hours or until death, with no apparent non-vascular cause" (Tunstall-Pedoe and WHO MONICA Project. investigators, 1988). This is to include intracerebral haemorrhage and subarachnoid haemorrhage as described by Sacco et al. (2013) respectively as "a focal collection of blood within the brain parenchyma or ventricular system that is not caused by trauma" and "bleeding into the subarachnoid space". This differs from a transient ischaemic attack (TIA) which was recently defined as "a transient episode of neurological dysfunction caused by focal brain, spinal cord, or retinal ischemia without acute infarction" (Easton et al., 2009). Patients with TIA's did not meet the inclusion criteria of this study and thus this literature review does not take TIA's under any further consideration.

2.3 Epidemiology

On a global level, stroke, along with ischaemic heart disease is seen as the leading cause of death across countries of all income levels, together resulting in more than one fifth of the world's mortality (Lopez et al., 2006). Using data from 107 member states of the WHO, it is predicted that by 2015 18 million people will have a first incident stroke and 6.5 million people will die from stroke (Strong et al., 2007).

Although Johnston et al. (2009) found that there is a large variability of stroke mortality and burden of disease across countries, they concluded that countries that are the most affected by stroke are those of low national income. This is corroborated by data collected in 2004 for the WHO Africa, showing that the age-standardised death rate from cerebrovascular disease was 142/100 000, compared to the global age-standardised death rate of 101/100 000 (Mathers et al., 2011). One can further compare the African and global statistics to a high income country, such as the United States of America, where the age-adjusted stroke death rate was 45/100 000 (CDC, 2006)

Although there is little selection of information available on stroke prevalence in South Africa, Connor et al. (2004) did an in-depth collection of data in a rural area of South Africa, showing an adjusted stroke prevalence of 300/100 000, thus showing the extent to which stroke affects our population. Stroke is one of the key components of the non-communicable disease pillar that holds up South Africa's quadruple burden of disease (Mayosi et al., 2009). Furthermore, stroke is in the top ten causes of death in South Africa (Bradshaw et al., 2003). A study in India, a developing country as is South Africa, showed a fatality rate of 27% by 28 days post stroke (Sridharan et al., 2009). This is similar to the South African mortality rate found by Mudzi et al. (2012) with 26% and 38% fatality post stroke within three and twelve months post discharge respectively.

Not only is stroke a leading cause of death, but it is also one of the leading causes of disability (Brault et al., 2009), with the global burden of disease from stroke on the increase (Truelsen et al., 2000). It has been shown that the prevalence of disabling stroke in sub-Saharan Africa is comparable to high-income countries (Connor et al., 2007).

In a rural South African setting it was found that up to 66% of people surviving stroke need assistance with one activity of daily living or more (Connor et al., 2004). In a study done in another developing country, India, it was found that of the 394 participants with stroke, 42% had mild disability, 43% had moderate disability and 15% were bedridden (Sridharan et al., 2009). This shows a pattern of persistent disability post stroke.

A component of post stroke disability is potential upper limb involvement, with 77% of patients presenting with weakness (Lawrence et al., 2001), and up to 64% with shoulder pain (Aras et al., 2004). The numerous changes to the upper limb post stroke will be presented later, along with their impact on function. When addressing upper limb function, an integral component is the shoulder.

2.4 The normal shoulder

To have a good understanding of the effects of stroke on the shoulder, one first needs to have knowledge of the gross anatomy and functioning of an unaffected shoulder.
The bony structures that make up the shoulder are the scapular (which includes the acromion and coracoid process), the clavicle and the humerus (Hermans et al., 2013). These bones of the shoulder articulate with the axial skeleton and between themselves in four areas, namely the sternoclavicular joint, acromioclavicular joint, glenohumeral joint and the scapulothoracic joint (Zuckerman and Koval, 2005). Some authors additionally describe a fifth area of articulation, the subacromial bursa (Turner-Stokes and Jackson, 2002). These areas of articulation are what allow the shoulder a large amount of mobility, however, with this mobility a certain amount of bony stability is forfeited (Zuckerman and Koval, 2005;

Hess, 2000).

Figure 2.1 below shows the bony structures and anatomical components of the shoulder joint.

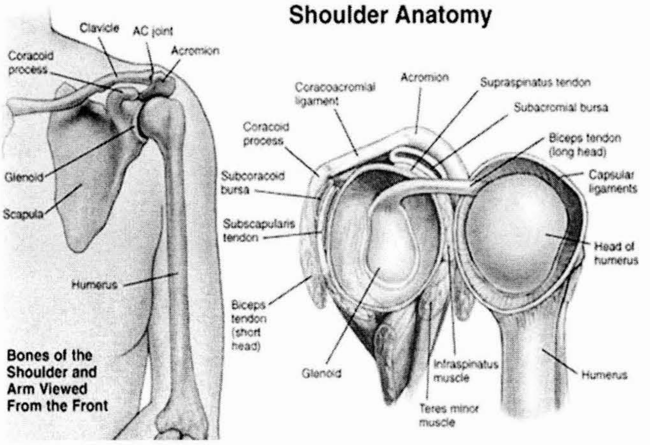

Figure 2.1: Anatomy of the shoulder (taken from http://www.edoctoronline.com, 2015)

The stability of the shoulder can be seen as an interplay of static and dynamic restraints (Lam et al., 2007). The static structures (additional to the articular biomechanics mentioned above) that provide stability to the glenohumeral joint are capsuloligamentous, including the labrum which allows for a deeper cup space of the glenohumeral fossa (Lam et al., 2007; Kibler, 1998). Meanwhile, the dynamic structures of the shoulder provide stability through passive tensioning; dynamic contraction; causing a secondary tightening of the static structures; and by providing a direct barrier (Lam et al., 2007). These dynamic structures are comprised of 17 muscles that cross the joints of the shoulder (van der Helm, 1994).

Of these 17 muscles, it is of particular importance to discuss the four muscles making up the rotator cuff. The rotator cuff plays a key role in the dynamic stability of the shoulder with its principal role being to stabilise the humeral head during movement (Hess, 2000). The rotator cuff is innervated by the brachial plexus which originates from the anterior rami of C5-T1 (Zuckerman and Koval, 2005).

Hess (2000) describes the four muscles of the rotator cuff as follows: subscapularis lies anterior to the glenohumeral joint and internally rotates the upper limb; infraspinatus and teres minor are found posteriorly and work together to externally rotate the upper limb; and supraspinatus lies superiorly and stabilises the humeral head during elevation of the upper limb. Supraspinatus is also involved in abduction of the upper limb (DeFranco and Cole, 2009). These four muscles work together to stabilise the humeral head in the glenoid fossa during movement (Kibler, 1998), with up to 53% of the moment around the humeral head being generated by subscapularis (Keating et al., 1993).

2.5 Post stroke changes and upper limb dysfunction

2.5.1 Shoulder subluxation

Following stroke (and subsequent paralysis) shoulder stability is compromised, allowing gravity to pull the head of the humerus inferiorly, thus stretching the capsule and causing shoulder subluxation (Ada and Foongchomcheay, 2002). Shoulder subluxation has been defined as "changes in the mechanical integrity of the glenohumeral joint causing a palpable gap between the acromion and humeral head" (Suethanapornkul et al., 2008; Teasell et al., 2006). Figures 2.2 and 2.3 below show the bony separation from a shoulder subluxation and the resultant appearance of the shoulder respectively.

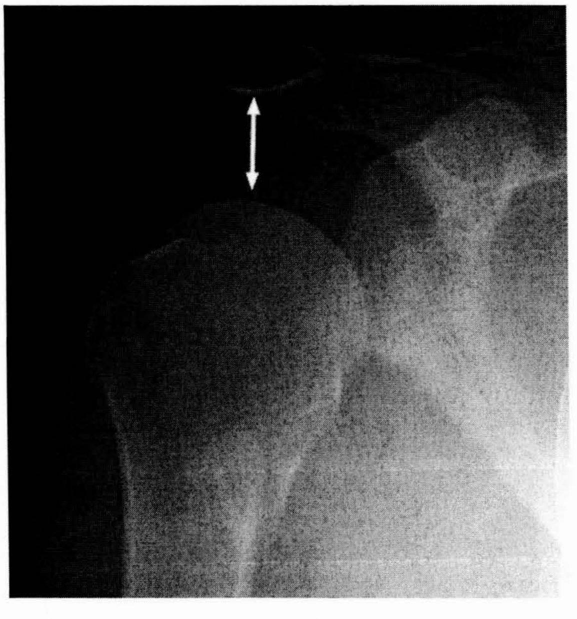

Figure 2.2: X-ray of a subluxed shoulder joint (taken from http://www.gentili.net, 2015)

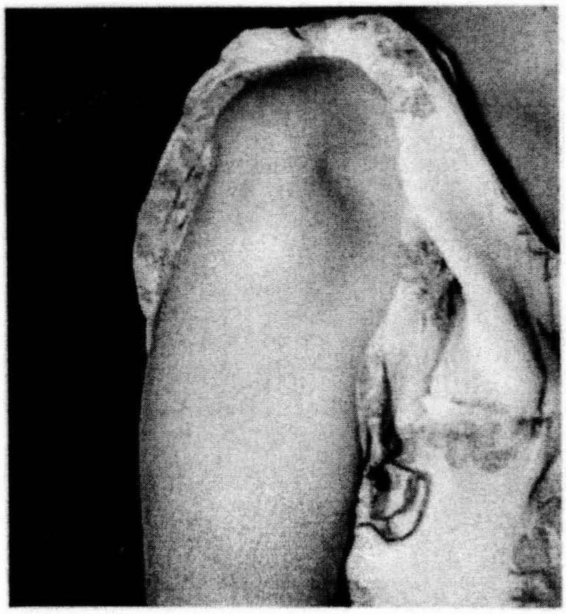

Figure 2.3: Subluxed shoulder (taken from http://www.oandplibrary.org, 2015)

Different incidence studies for shoulder subluxation use varying definitions of shoulder subluxation, patient recruitment criteria, assessment techniques and measurement time frames (Kumar and Swinkels, 2009). The wide discrepancy in the reported incidence of shoulder subluxation could be attributed to these variations. The incidence of shoulder subluxation in patients post stroke ranges from 7% to 81% (Ada and Foongchomcheay, 2002). However, more recently Seuthanapornkul et al. (2008) assessed 327 patients with stroke and found that 37% presented with shoulder subluxation.

Furthermore, it has been shown that the incidence of shoulder subluxation varies according to the level of motor function of the hemiparetic upper limb, with lower levels of function correlating with higher incidence of subluxation (Suethanapornkul et al., 2008). A small study by Zorowitz (2001) of 10 subjects (included after screening 219 potentially suitable patients) showed that spontaneous reduction of shoulder subluxation can occur in patients who have significantly improved motor function of the limb.

Clinically, one would assume that shoulder subluxation is the cause of shoulder pain in patients with stroke and, although some studies have found shoulder pain to be more common in patients with shoulder subluxation (Suethanapornkul et al., 2008), most literature has found that there is inconclusive evidence linking shoulder pain to shoulder subluxation (Ada et al., 2009; Kumar and Swinkels, 2009; Teasell et al., 2006; Foongchomcheay et al., 2005; Zorowitz, 2001).

From the above evidence, one can conclude that shoulder subluxation is an area of stroke rehabilitation that needs to be addressed, however its exact impact on the patient has not been determined. Post stroke shoulder pain, on the other hand, has definitive literature that one can use to influence clinical practise. A review of the literature on this is presented below.

2.5.2 Shoulder pain

Shoulder pain, in general, has been defined as "pain located in a restricted area in or around the shoulder complex" (Pope et al., 1997). Shoulder pain following stroke is discussed under a variety of different terms, most commonly "hemiplegic shoulder pain" (Barlak et al., 2009; Pong et al., 2009; Suethanapornkul et al., 2008; Rajaratnam et al., 2007; Klotz et al., 2006; Teasell et al., 2006; Ratnasabapathy et al., 2003; Turner-Stokes and Jackson, 2002) and "post stroke shoulder pain" (Chae et al., 2007; Vuagnat and Chantraine, 2003; Gamble et al., 2002).

Post stroke shoulder pain has been researched in many studies, showing a range from 17-64% (Barlak et al., 2009; Suethanapornkul et al., 2008; Lindgren et al., 2007; Aras et al., 2004; Ratnasabapathy et al., 2003; Gamble et al., 2002). Of these studies, the largest sample size was 1761 patients of which 17% of the patients reported shoulder pain at one week post stroke, 20% at one month post stroke and 23% at six months post stroke (Ratnasabapathy et al., 2003). This trend of an increase in shoulder pain over time is supported by similar findings in other studies (Suethanapornkul et al., 2008; Lindgren et al., 2007; Gamble et al., 2002), however, Gamble et al. (2002) found that of the 55-87% of patients who presented with shoulder pain, 80% improved by six months and similarly Suethanapornkul et al. (2008) had 40% patients' shoulder pain resolve by discharge.

Post stroke shoulder pain is a complex phenomenon with multifactorial aetiology (Barlak et al., 2009; Klotz et al., 2006; Aras et al., 2004; Lo et al., 2003; Vuagnat & Chantraine, 2003).

Some of the features that have been found with post stroke shoulder pain include reflex shoulder dystrophy (Barlak et al., 2009; Teasell et al., 2006; Aras et al., 2004; Lo et al., 2003; Vuagnat and Chantraine, 2003), decreased range or motor and sensory dysfunction of the upper limb (Lindgren et al., 2007; Teasell et al., 2006; Aras et al., 2004; Ratnasabapathy et al., 2003; Gamble et al., 2002) shoulder subluxation (Barlak et al., 2009; Suethanapornkul et al., 2008; Teasell et al., 2006; Aras et al., 2004; Lo et al., 2003; Vuagnat and Chantraine, 2003), adhesive capsulitis (Barlak et al., 2009; Lo et al., 2003), spasticity (Barlak et al., 2009; Teasell et al., 2006; Vuagnat and Chantraine, 2003) and tears to the rotator cuff muscles (Teasell et al., 2006; Lo et al., 2003; Vuagnat and Chantraine, 2003). Aras et al. (2004) also found age to be a contributing factor to post stroke shoulder pain, however, they found no link between post stroke shoulder pain to gender, time since onset, side of lesion, pathogenesis, spasticity, hemineglect and thalamic pain.

Pong et al. (2009) investigated soft tissue injuries to the shoulder following stroke and found that over a two week period the poorer the upper limb function (using Brunnstrom stages), the higher the risk of soft tissue injury to the shoulder. These soft tissue injuries can be a further potential cause of pain in the shoulder post stroke.

Post stroke shoulder pain has been shown to be a contributor to an increase in length of hospital stay and to have a negative effect on the functional outcomes of patients on discharge (Barlak et al., 2009; Roy et al., 1995). These functional outcomes can be affected beyond the level of hospital stay to activities of daily living at home, with 51% of patients complaining of shoulder pain restricting dressing and 29% of patients having restrictions in ambulation due to shoulder pain (Lindgren et al., 2007). Chae et al. (2007) found that post stroke shoulder pain is related to a reduced quality of life, while the onset of shoulder pain has been associated with an increase in depression scores in patients with stroke (Gamble et al., 2002).

In conclusion, it can be said that shoulder pain is a common complication of stroke. This arises from potentially many different causes, resulting in a negative impact on function and quality of life.

2.5.3 Motor function

Shepherd and Carr (1998) describe the upper limb's foremost role to be that of reaching for and manipulating objects, allowing a person to interact with the environment. Hemiplegia is one of the main consequences of stroke, with up to 81% of patients presenting with hemiplegia following an acute stroke, leaving a residual 67% with hemiplegia up to 3 months post stroke (Sommerfeld et al., 2004). When looking specifically at upper limb hemiplegia, a multi-ethnic study of 1259 participants showed 77% of patients with stroke have upper limb weakness (Lawrence et al., 2001). The recovery from upper limb hemiplegia is poor, with up to 62% of patients not gaining any upper limb dexterity by 6 months post stroke (Kwakkel et al., 2003), and others reporting that 70% of patients make less than a 50% recovery of the upper limb (Barker et al., 2007). Kwakkel et al. (2003) showed that an absence of arm synergies by the fourth week post stroke was associated with poor outcome of upper limb recovery by six months post stroke. In addition to upper limb synergies, other strong predictors of upper limb motor recovery are the severity of motor dysfunction at baseline assessment and right hemisphere lesions (resulting in poorer recovery) (Coupar et al., 2012; Chen and Winstein, 2009).

A study looking at changes in regional cerebral blood flow in response to task-specific activities showed that the supplementary cortex, cingulate, insula and ipsilateral primary sensorimotor cortex are involved in upper limb function and recovery. These sites shifted over a period of six months, suggesting that adaptation occurs within the motor networks to allow for simple movement (Carey et al., 2005).

Harris and Eng (2007) propose that the results of upper limb weakness are impaired stabilisation of proximal arm segments; limited reach and hand use; and affected control and coordination of the upper limb. Due to the important role the upper limb plays in activities of daily living any impairments of the upper limb result in a decrease of the patient's participation (Harris and Eng, 2007). This speaks to the WHO's International Classification of Functioning, Disability and Health (ICF)'s definition of hand and arm use in activity and participation, that is, to execute coordinated actions so as to move and manipulate objects using the upper limb (ICF, 2001). The impairment with the strongest relationship to activities of daily living is loss of upper limb strength (Harris and Eng, 2007) thus a decrease in upper limb motor function post stroke impacts on a patient's activity and thus participation which ultimately affects their health related quality of life. It has been shown consistently that disability is a determinant of health related quality of life, especially with regards to upper limb function (Carod-Artal and Egido, 2009; Nichols-Larsen et al., 2005).

A qualitative study of the personal experiences of patients with upper limb hemiplegia found that the participants felt that upper limb recovery is an imperative issue that is often neglected and that people do not understand their loss sufficiently. These participants also emphasised the importance of support from others for their recovery and that exercise of the upper limb was a vital part of their recovery (Barker and Brauer, 2005); while a lack of sufficient movement to use in task-related practice is seen as the greatest barrier to recovery (Barker et al., 2007). Studenski et al. (2005) found that patients in the sub-acute phase of stroke showed strong gains in both function and quality of life when they were given a structured exercise programme.

Thus it can be seen that the functional use of the upper limb plays a vital role in a patient's life following a stroke and therefore adequate assessment, treatment and support for the patient is a priority.

2.5.4 Tone

Increased tone is one of the positive features that arise from a stroke due to damage to the pyramidal and/or parapyramidal tracts (Ivanhoe and Reistetter, 2004; Sheean 2002). Spasticity has been defined as "a motor disorder characterised by a velocity-dependant increase in tonic stretch reflexes (muscle tone) with exaggerated tendon jerks, resulting from hyper excitability of the stretch reflex" (Lance, 1980). More recently, Pandyan et al. (2005) discussed the merits of using a more comprehensive definition to describe spasticity, such as "a disordered sensori-motor control, resulting from an upper motor neuron lesion, presenting as intermittent or sustained involuntary activation of muscles". Depending on the site and extent of the lesion, patients post stroke can present with a range of symptoms and varying degrees of spasticity (Ward, 2012).

There are varying reports on the prevalence of tone post stroke, although all authors indicate that tone is a common sequela of stroke (Ryu et al., 2010; Urban et al., 2010; Wissel et al., 2010; Dajpratham et al., 2009; Lundström et al., 2008; Ada et al., 2006; Welmer et al., 2006; Sommerfeld et al., 2004; Watkins et al., 2002). In order to clarify the different results from several studies, the prevalence of tone is discussed below under three categories, namely acute (less than six weeks post stroke), sub-acute (from six weeks to six months post stroke) and chronic (over six months post stroke).

Dajpratham et al. (2009) found that of 327 patients with stroke, 42% presented with spasticity on admission to a rehabilitation centre. The majority of these patients presented as a one on the modified Ashworth scale (MAS), indicating the lowest level of spasticity. In this study, admission occurred on a median of 31 days post stroke. These results are comparable to those of Ryu et al. (2010) who also found that 42% (of 245 patients) on admission to a stroke rehabilitation unit presented with spasticity, with a majority score of MAS one. Another study found that in as short a timeframe as two weeks post stroke, up to 25% of patients presented with increased tone (Wissel et al., 2010). This number slightly increased to 27% by six weeks. These patients were followed up for a further 10 weeks after that, and the results showed that of the spasticity that occurred 98% transpired within the first six weeks after stroke (Wissel et al., 2010).

During the sub-acute stage increased tone is shown to occur in 28-34% of hemiparetic patients at three months post stroke (Welmer et al., 2006; Sommerfeld et al., 2004), and up to 43% by six months (Urban et al., 2010). Urban et al. (2010) also found that of the 43% of patients with spasticity up to 16% presented with a MAS of three and greater showing a higher level of spasticity at six months when compared to the MAS results of patients in the acute phase, as discussed above (Ryu et al., 2010; Dajpratham et al., 2009). Furthermore, it has also been found that spasticity was greater in the upper limbs than the lower limbs of patients with stroke (Urban et al., 2010).

This predominant upper limb involvement agreed with the results found by Lundström et al. (2008) that by one year post stroke disabling spasticity was found to be more frequent in the upper limb than the lower limb. Of the 163 patients that were in this study, 17% had spasticity twelve months post stroke, of which 4% had disabling spasticity. However, some studies have shown that spasticity can be as high as 39-42% up to one year post stroke (Ada et al., 2006; Watkins et al., 2002). It should however be noted that these studies had a smaller sample size than Lundström et al. (2008). Ada et al. (2006) looked specifically at the upper limb and found that 51% of the patients also presented with elbow contractures.

When addressing spasticity over one year, one study was found, although with a small sample size, that looked at the prevalence of spasticity 18 months after stroke (Welmer et al., 2006). Of the 66 patients included in the study, 58% had hemiplegia and 34% of these patients with hemiplegia presented with spasticity at three months post stroke. Of these 34%, 69% still had spasticity at 18 months. Although this percentage appears high, it only equates to a final number of nine patients, however, this is the only data available to date for a period of 18 months post stroke.

Certain factors have been found to be predictive of patients developing spasticity. These include low motor function/the degree of paresis, sensory loss and the involvement of two joints or more (Ryu et al., 2010; Urban et al., 2010; Wissel et al., 2010).

Although changes in upper limb tone post stroke are mostly discussed under the heading of spasticity, flaccidity also plays a role in a patient's recovery with a delayed onset of muscle tone relating to later motor recovery (Formisano et al., 2005). Kwakkel et al. (2003) found that patients who had not developed upper limb spasticity by four weeks post stroke (i.e. still had a flaccid upper limb) had a poorer functional outcome at six months post stroke.

One can see from the above literature that spasticity occurs in patients in the acute, sub-acute and chronic phases post stroke. However, the clinical relevance of the presence of spasticity is at times questioned as it has been found that there is a low correlation between a patient's disability score and their degree of spasticity (Sommerfeld et al., 2004), with muscle weakness being a larger contributor to activity limitation as opposed to spasticity (Ada et al., 2006).

Despite these findings, there have also been many studies done showing the impact of spasticity on a patient's functional outcomes and quality of life. Lundström et al. (2008) found that of the 163 patients that were included in their study, those with spasticity were more dependent on others in their activities of daily living. This corresponds with other research that showed a lower Barthel Index score (indicating poor functional abilities in activities of daily living) in patients with spasticity (Urban et al., 2010; Wissel et al., 2010; Watkins et al., 2002). Patients with spasticity have also been shown to have higher incidences of pain, lower scores for quality of life outcome measures, poorer functional gains and more likelihood of institutionalisation (Ryu et al., 2010; Wissel et al., 2010; Watkins et al., 2002).

In summary, it can be seen that the sequelae of stroke pertaining to the shoulder include shoulder subluxation, pain, loss of motor function and changes in upper limb tone. These all have an impact on the patient's activities of daily living and thus their participation within the community. Due to this, the management of the shoulder post stroke is very important and shall be discussed below.

2.6 Management of the shoulder post stroke

Despite the high prevalence of post stroke upper limb complications as discussed above, the literature does not give clear evidence for definitive treatment techniques that can be used effectively in the management of the shoulder following stroke. Winter et al. (2011) shows that there are few randomised control trials with a clear description of hands-on therapy.

Moderate to strong evidence is presented for the use of functional electrical stimulation, active therapy, constraint induced movement therapy and positioning (Murie-Fernández et al., 2012; Langhorne et al., 2009; Teasell et al., 2006; Teasell et al., 2003), with upper limb strength training being shown to improve the patient's grip strength and upper limb function (Harris and Eng, 2010).

Other techniques that have shown to have a positive effect (although not necessarily statistically significant) are mental practice, robotics, strapping, injections (Botox, steroids et cetera) and the use of repetitive, novel tasks (Murie-Fernández et al., 2012; Langhorne et al., 2009; Barreca et al., 2003).

Of the above-mentioned treatment methods that have been proposed in the literature, strapping in particular has stood out as a contentious option. Shoulder strapping is used clinically in patients with stroke, with a variety of techniques being employed; however, as shown below, the literature is neither conclusively supportive of it, nor definitive in the gold-standard technique (Appel et al, 2011).

Although the precise mechanisms by which strapping is thought to work are not distinct, it is proposed that it is through a combination of proprioceptive input and mechanical influence (Morrissey, 2000). It has also been suggested that the presences of taping creates awareness in the patient's caregivers, thus causing more careful handling (Ancliffe, 1992).

Morrissey (2000) proposes that the aims of strapping are to inhibit over-activity; facilitate underactivity; encourage coordination between joints; promote joint alignment; decrease pain associated with movement and "offload irritable neural tissue". While mechanically, strapping can promote better alignment of the shoulder joint (by providing proximal stability of the scapula) leading to increased stability (Peters and Lee, 2003). The suggested advantages of using shoulder strapping are that it provides a three dimensional rectification, which can be altered according to each patient's specific needs (Peters and Lee, 2003); and that it continues to provide therapeutic in-put for the patient beyond when the contact time has ended with the therapist (Morrissey, 2000).

The literature describes many different approaches to shoulder strapping techniques (Pandian et al., 2013; Appel et al., 2011; Griffin and Bernhardt, 2006; Peters and Lee, 2003; Kneeshaw, 2002; Hanger et al., 2000; Morrissey, 2000;), however, two main trends emerge from the descriptions:

a) Longitudinal Strapping Method

In this strapping method, there are two to three strips of strapping that are applied with a cephalad tension over the anterior, middle and posterior deltoid to end over the shoulder complex, sometimes with an anchor strip applied (Pandian et al., 2013; Peters and Lee, 2003; Kneeshaw, 2002; Morrissey 2000). (Depicted in Appendix A.)

b) Circumferential Strapping Method

The second trend of shoulder strapping is a circumferential technique that was used by Ancliffe (1992) and Griffin and Bernhardt (2006). This technique involved the application of strapping around the shoulder joint, originating on the clavicle, wrapping around the deltoid to go under the axilla and end on the spine of the scapula. (Depicted in Appendix B.)

This circumferential technique was originally developed clinically for patients with stroke, and then used in a pilot study by Ancliffe (1992). Since the results of this pilot study showed that the patients whose shoulders were strapped experienced a significant delay in the onset of shoulder pain post stroke, a larger study of similar design was undertaken (Griffin and Bernhardt, 2006). This study added a placebo group to the control and intervention groups, with a total of 32 participants. The results similarly showed that the mean number of pain free days between the strapped participants and the control group was significantly different, however the improvement in range of movement and function did not differ significantly. A limit of this study was that there was no follow up period after the removal of strapping so one does not know if the positive effects of the strapping were transient or not.

The largest post stroke shoulder strapping, randomised control trial to date compared longitudinal shoulder strapping with sham strapping in patients less than 48 hours post stroke (Pandian et al., 2013). For this study, 162 participants took part, with strapping and assessment for two weeks and a follow up at one month. The study found that although there was a trend towards decreased pain in the intervention group, the difference to the control group was not statistically significant (Pandian et al., 2013).

Another study looked at a combination of longitudinal and partially circumferential strapping in patients with stroke (Hanger et al., 2000). This randomised control trial assessed pain, movement and function in 98 subjects with a follow up period of no strapping. Despite the strengths of the participant numbers and the strapping-free follow-up period, the results (as for the Pandian et al., 2013 study) showed a trend towards less pain in the intervention group but overall no significant change in the outcome measures.

From these studies we are shown that strapping the hemiplegic shoulder seems to have an effect on pain, however methodological and sample size limitations have prevented a definitive answer from being given about its efficacy in other outcomes, such as range of movement, function and shoulder subluxation; yet it is still used clinically.

2.7 Conclusion

In summary, it has been shown that stroke is a prevalent condition at both an international and local level, and presents as one of the leading causes of death and disability within South Africa.

The resultant sequelae of stroke that pertains to the upper limb includes shoulder subluxation, shoulder pain of multiple aetiology, loss of motor function, and changes in tone. These four areas of upper limb disability impact on a patient's functional outcomes and thus their participation within the community and their quality of life.

Although the literature presents a variety of management options for the shoulder post stroke, many are debated, with an emphasis being placed on the efficacy of shoulder strapping. Generally two strapping techniques emerge from the literature: a longitudinal and a circumferential method.

It is proposed that shoulder strapping is effective through proprioceptive input, mechanical influence and creating awareness of the vulnerable joint; and although some studies have shown shoulder strapping to have an effect on pain, many questions are left unanswered by the literature with regards to technique, duration and influence on post stroke shoulder dysfunction other than pain.

One is left to consider where one stands when using shoulder strapping clinically, and how it affects shoulder pain, tone, motor function and shoulder subluxation post stroke since an effective management of these areas of shoulder dysfunction are crucial in the rehabilitation and reintegration of a patient with stroke.

CHAPTER 3

3. Method

3.1 Introduction

This chapter presents the methodology used in the study, as well as the procedure carried out in the pilot study.

3.2 Study Design

The study was a longitudinal randomised controlled trial with two experimental groups and one control group.

3.3 Source of participants

Participants were patients with stroke from the medical and/or neurological wards of Helen Joseph Hospital and Charlotte Maxeke Johannesburg Academic Hospital.

3.4 Sample size

For this study, it was calculated that 5 participants were needed per group. This was calculated as follows:

Sample size = Z(squared) x P x (1-P) / C(squared)

Whereby Z = 95% confidence interval (SD=1.96)

P = prevalence (%) taken as 300/100 000 (Connor et al., 2004)

C = P value (5%)

Thus:

Sample size = 1.96(squared) x 0,003 x (1-0.003) / 0.05(squared)

= 3.8416 x 0.003 x 0.997 / 0.0025

= 0.01149 / 0.0025

= 4.59 i.e. 5 people per group

We however felt that a total sample size of fifteen participants was not adequate, and with insufficient literature upon which to base an effect size, we opted for the central limit theorem, calling for approximately 30 participants per group. This meant that a total of 90 participants were considered adequate for the study and would allow meaningful statistics to be done.

3.5 Sample Selection

Consecutive sampling of patients with stroke who met the inclusion criteria was done until the number needed for the sample size was attained.

3.5.1 Inclusion Criteria:

- Patients admitted to hospital with a diagnosis of stroke that occurred less than 14 days prior.
- Patients with stroke presenting with hemiplegia.

3.5.2 Exclusion Criteria

- Previous osteopathic or neurological disorders or injury to the shoulder.
- Medical instability preventing the patient from being assessed or strapped.
- Unable to participate in the Motor Assessment Scale- Upper Limb Subscale due to:
    - Decreased level of consciousness
    - Receptive aphasia
    - Significant visual, perceptual or cognitive problems
- Patients with a co-morbidity of depression (as per diagnosis in medical file)

3.6 Outcome Measures and instrumentation

3.6.1 Outcome measures

The outcomes that were assessed in this study were:

- Shoulder pain using the Ritchie Articular Index.

- Upper limb muscle tone using the Modified Ashworth Scale.
- Shoulder subluxation using finger width measurement.
- Upper limb motor function using the Motor Assessment Scale- Upper Limb Subscale.

3.6.1.1 The Ritchie Articular Index

The Ritchie Articular Index is a four point scale used to describe a patient's pain in response to passive external rotation of the hemiplegic shoulder (Bohannon and LeFort, 1986). The scoring is as follows:

- 0 = no pain complaint
- 1 = pain complaint
- 2 = pain complaint and wincing
- 3 = pain complaint, wincing and withdrawal. Withdrawal includes the patient rolling towards their hemiplegic shoulder during testing in order to minimise the force.

The Ritchie Articular Index is a reliable measure of pain in the hemiplegic shoulders of patients with stroke (Kappa coefficient = 0.76) (Bohannon and LeFort, 1986). This index has been used in other shoulder strapping studies (Griffin and Bernhardt, 2006; Ancliffe, 1992). As Griffin and Bernhardt (2006) point out, the Ritchie Articular Index is beneficial to use in patients with communication or cognitive difficulties since it elicits non-verbal responses.

3.6.1.2 Modified Ashworth Scale

The Modified Ashworth Scale is a 6-point scale used to measure spasticity by passively moving the limb through the range of motion and grading the resistance (Bohannon and Smith, 1987). Table 3.1 below shows the scoring as set-out by Bohannon and Smith (1987) when the Ashworth scale was originally modified.

Table 3.1: Modified Ashworth scale

Grade	Description
0	No increase in muscle tone
1	Slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end of the range of motion when the affected part(s) is moved in flexion and extension
1+	Slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the remainder (less than half) of the ROM
2	More marked increase in muscle tone through most of the ROM, but affected part(s) easily moved
3	Considerable increase in muscle tone, passive movement difficult
4	Affected part(s) rigid in flexion or extension

In the development of the Modified Ashworth Scale, the clinicians determined that the tool had good inter-rater reliability with the Kendall's tau correlation being 0.85 (Bohannon and Smith, 1987). Similarly, Gregson et al. (1999) found the Kappa coefficient for inter-rater reliability to be 0.84 with the intra-rater reliability having a Kappa coefficient of 0.83, confirming Bohannon and Smith's (1987) finding on its reliability.

It is important to highlight that the above studies tested the elbow flexors and not the shoulder joint. Ansari et al. (2008) tested the inter-rater and intra-rater reliability of the Modified Ashworth Scale on the shoulder adductors and found it to have fair (Kappa coefficient=0.37) and good reliability (Kappa coefficient=0.65) respectively. Ansari et al. (2008) explain that the fair Kappa coefficient for the shoulder adductors may have been due to the shoulder pain experienced by 50% of the participants, which would have made testing and grading a challenge.

Although the reliability of the Modified Ashworth Scale has been shown as above, there has been some criticism of the content validity of the scale since spasticity is not necessarily the only limiting factor in resistance to passive movement and thus the Modified Ashworth scale may not be measuring spasticity itself (Pandyan et al., 1999). Additionally, Pandyan et al. (1999) found the ambiguity between the 1 and 1+ scores limits the use of the scale to nominal levels only. Although there is some debate about the use of the Modified Ashworth Scale, it seems to be the most widely used and applicable tool for measuring spasticity and has been utilised previously in another shoulder strapping study by Griffin and Bernhardt (2006). For the purpose of recording and analysing the data in this study, the scores were changed to 0, 1, 2, 3, 4 and 5 whereby 2 correlates with 1+ of the Modified Ashworth scale, 3 with 4 and 4 with 5.

3.6.1.3 Finger width measurement of shoulder subluxation

Although x-ray analysis is often seen as the optimal measure of shoulder subluxation (Paci et al., 2005) factors such as the price, procedure and radiation exposure can frequently make it impractical (Hall et al., 1995), as was the case in this study. Palpation and measurement of the subacromial space using finger breadth has been shown to be a reliable method of clinically measuring shoulder subluxation, with intra-rater reliability having an intra-class correlation coefficient averaging 0.92 across four raters (Boyd and Torrance, 1992). Using the palpation method, Hall et al. (1995) devised a scale of 0-5 to indicate the space palpated between the acromion and the superior aspect of the humeral head.

- 0 = no subluxation
- 1 = ½ finger's width
- 2 = 1 finger's width
- 3 = 1 ½ finger's width
- 4 = 2 finger's width
- 5 = 2½ finger's width

The finger width measurement of shoulder subluxation was therefore adopted for use in this study.

3.6.1.4 The Motor Assessment Scale- Upper Limb Subscale (UL-MAS)

The Motor Assessment Scale was developed to assess patients with stroke's motor function in the following eight areas: supine to side lying; supine to sitting over side of bed; balanced sitting; sitting to standing; walking; upper-arm function; hand movements; advanced hand activities (the last three of which pertain to upper limb function) (Carr et al., 1985). This scale was found to have a good test-retest reliability with an average correlation of 0.98 (Carr et al., 1985), and furthermore, the upper limb subscale of the Motor Assessment Scale (UL-MAS) can be used on its own in adult patients with stroke as a valid and reliable tool, with Cronbach's alpha equal to 0.83 (Lannin, 2004).

The motor assessment scale uses a seven point scale to rate motor behaviour. The scale ranges from 0 to 6 with 6 being the optimal score. There are three areas of upper limb motor function: upper arm function (UL-MAS 6); hand movements (UL-MAS 7); advanced hand movements (UL-MAS 8), each broken down into tasks differing in difficulty level (Appendix C) In the development of the Motor Assessment Scale, Carr et al. (1985) provided a written description of what the patient must do to attain each point. This is shown in Appendix C, along with a list of the items required to perform the UL-MAS.

3.6.2 Instrumentation

3.6.2.1 The Data Collection Form (See Appendix D)

- The Data Collection Form was divided into two sections: <u>Demographic data</u>: This section collected data on the patient's age, gender, date of stroke and side of lesion. <u>Outcome Measures:</u> Under this section all of the outcome measures' data and date of assessment were recorded as well as any other point that the researcher felt was noteworthy, such as transfer to another hospital or discharge home.

The Data Collection Form was coded, which correlated with the coding on the Patient Details

Form.

3.6.2.2 Patient details form (See Appendix E)

The patient details form documented the relevant patient information such as:

- Name and surname
- Date of birth
- Hospital number
- Patient Code
- Strapping group
- Two contact numbers
- Caregiver's name and relationship to the patient
- Area of residence

3.6.2.3 The Universal Standard Goniometer

The universal standard goniometer (from here on referred to as "goniometer") is a protractor used to measure joint range, comprising of a stationary arm and a moveable arm that rotates around an axis. Armstrong et al. (1998) showed the goniometer to have intra-rater reliability (average intra-class coefficient correlation=0.81 across 5 raters) when testing elbow range of motion. Shoulder abduction measurements were shown to have intra-rater reliability with an intra-class correlation coefficient=0.98 (Riddle et al., 1987). The goniometer was therefore a suitable instrument to measure shoulder range of movement.

3.6.2.4 Strapping Material

The strapping used was fifty millimetre wide Fixomull® Stretch (hypoallergenic) and thirty eight millimetre wide Leukotape P® supplied by BSN Medical.

3.6.2.5 Padding Material

Griffin and Bernhardt (2006) described the use of cottonwool padding material placed under the axilla in the circumferential technique. The padding material that was used in this study was a sponge material with a standard width of five centimetres and height of one centimetre. The length was measured according to each individual.

3.7 Variables

3.7.1 Independent variables

The independent variables were the type of strapping technique that the patient received, that is, either longitudinal or circumferential strapping.

3.7.2 Dependent variables

The dependent variables were hemiplegic shoulder pain, tone, subluxation and motor function.

3.8 Procedure

3.8.1 Pilot study

3.8.1.1 Pilot study aim

To familiarise and train the researcher and research assistants in using the tools and techniques for the study.

3.8.1.2. Pilot study objectives

1. To train the researcher in using the outcome measure's instrumentation. (See 3.5.1 Outcome Measures and 3.5.2 Instrumentation)
2. To train the research assistants in the application of the two strapping techniques.
3. To establish the time taken to work with one patient.
4. To check for any unseen and unanticipated issues that may have affected data

collection.

3.8.1.3 Pilot study methodology

Ten patients that met the study's inclusion and exclusion criteria were utilised in the pilot study. These patients were divided into two groups of five patients each and the pilot study was carried out over two sessions. Prior to the commencement of the assessment and strapping, the researcher and research assistants discussed and studied together the strapping techniques and the relevant anatomical landmarks.

The first five participants underwent the baseline assessment, performed by the principal researcher. This activity trained the researcher in using the abovementioned assessment tools.

Additionally, the five participants received the longitudinal strapping technique, applied by the research assistant. In the second session, this procedure was repeated with another five participants, however, the strapping was done with the circumferential technique.
An experienced and established neurology physiotherapist was invited to observe and critique the strapping, as well as aid in answering any questions or difficulties found in the use of the assessment tools.

3.8.1.4 Results

3.8.1.4.1 Assessment tools

During the use of the assessment tools in the first session, the researcher found that clarification on performance of some of the movements for the UL-MAS was required. This was done in between session one and two and by the second session the uncertainty was eradicated.
Additionally, during the activities performed in the UL-MAS, it was found that the opening of the teacup being used was too narrow for a large patient's hand to fit into and a wider teacup of an eight millimetre opening was used.

3.8.1.4.2 Strapping

The following discrepancies were found between the two strapping techniques:

1. The instructions "Don't wet; don't remove" were only indicated for writing on the one strapping technique. This was adjusted to be used on both techniques.
2. The procedure of preparing the skin with alcohol rub was not standardised. It was decided this be used for both strapping techniques in the main study.

When the experienced neurology physiotherapist observed the longitudinal strapping of the first three patients, she found that the strapping did not cross over the glenohumeral joint sufficiently. The necessary amendments were made to her satisfaction on the remaining patients.

During the circumferential strapping session, it was found that insufficient tension was applied and the decision was made to apply a firmer force when pulling the strapping around the joint. A further adjustment was made to the research assistant's technique in that the initial strap needed to be lengthened at the end point. This allowed for a more secure application.

In both strapping techniques a pillow was placed beneath the arm to allow for the shoulder to be strapped with minimal subluxation.

3.8.1.4.3 Time

The functional level of the patient had an effect on the time taken for the assessment tools, especially when performing the activities of the UL-MAS. The assessment of a low functioning patient took approximately three minutes, while a high functioning patient took up to ten minutes. Although the circumferential strapping technique was more complicated and thus took slightly more time than the application of the longitudinal technique, the allocation of fifteen minutes allowed enough time for the research assistant to position and strap the shoulder of the patient.

3.8.1.5 Conclusion

The pilot study served to train the researcher and research assistant with the use of the assessment tools and the strapping techniques respectively. It was found that an assessment and strapping session should not take longer than half an hour.

3.8.2 Main study

Permission was obtained from Helen Joseph Hospital, Charlotte Maxeke Johannesburg Academic Hospital and from the Gauteng Department of Health. Ethical clearance was obtained from the Human Research Ethics Committee of the University of the Witwatersrand (certificate number M10903) (see Appendix F).

Following approval, the staff of the physiotherapy and occupational therapy departments of hospitals were informed of the study and the inclusion criteria of the patients required. This was done via a notification letter with an introduction, short summary of the study and the list of inclusion and exclusion criteria and the researcher's contact details (see Appendix G). The staff of the physiotherapy and occupational therapy departments were informed about the study so that when they received ward patient referrals for patients suitable to the study, the researcher could be notified.

Following either receipt of the abovementioned notification, or following screening of the wards, the researcher approached the patient in the ward, informed them of the study and invited them to participate (see Appendix H). If they were agreeable, they signed the informed consent form (see Appendix I).

a) Randomisation

The patients were placed into three groups through blocked randomisation using computer generated random numbers. The numbers were placed into opaque envelopes by the research assistant. Once the patient was included in the study, the research assistant then drew the envelope and opened it to reveal the group in which they belonged. The groups were as follows:

1. Group A was the control group with no shoulder strapping but continued with usual treatment
2. Group B received circumferential strapping
3. Group C received longitudinal strapping

b) Baseline Assessment

The patient was assisted into a sitting position.

1. Measurement of shoulder subluxation:
   i. With the patient seated with their feet supported on the ground and their hemiplegic upper limb in a dependent position (i.e. hanging freely) the researcher used her right hand to palpate the space in between the acromion and the superior aspect of the humeral head. The measurement was taken using the right hand second and third digits.

Following this, the patient was assisted into lying supine.

2. Measurement of shoulder pain, range of movement and muscle tone:

   i. Shoulder pain using the Ritchie Articular Index (as described by Bohannon and LeFort, 1986): whilst supine-lying fully supported, the patient's upper limb was positioned by the researcher as follows (Clarkson and Gilewich, 1989):
      - A goniometer was placed with the axis over the midpoint of the anterior aspect of the glenohumeral joint with the stationary arm parallel to the sternum. The moveable arm was placed parallel to the humeral longitudinal axis. Using these reference points the shoulder was positioned at 30° abduction.
      - The goniometer axis was then placed over the lateral epicondyle of

the humerus. The stationary arm lay parallel to the humeral longitudinal axis directed towards the lateral end of the acromion. The moveable arm was aligned parallel to the radial longitudinal axis, directed towards the radial styloid process. With this alignment the elbow was flexed to 90°.

- The forearm was maintained in neutral supination.

The researcher used one hand to stabilise the shoulder and chest, while the other hand moved the shoulder into external rotation to maximum 90°. The patient was observed by the researcher throughout and was asked at the end if the movement elicited pain. Based on the patient's response and reactions the score was given according to the Ritchie Articular Index.

ii. Shoulder muscle tone using the Modified Ashworth Scale (described by Ansari et al., 2008): the patient was asked to relax their limb completely while lying supine with their head in the midline and the hemiplegic arm alongside the trunk. The elbow was flexed to 90° and the researcher gripped beneath the elbow and over the wrist joint. Counting "one thousand and one" (to allow for approximately one second) in her head, the researcher moved the patient's upper limb into 100° shoulder abduction all the while feeling for resistance to movement. This was performed three times, followed by the researcher recording one score according to the Modified Ashworth Scale. (For the detailed description on positioning the elbow in 90° flexion and the shoulder at 100° abduction, please see the goniometer placement description above: i. Ritchie Articular Index)

iii. Upper limb motor control using the UL-MAS

With the patient either lying supine or sitting on edge of bed they were instructed to move through the six stages (as discussed in 3.6.1.4 and Appendix C) of each component of the UL-MAS. Each requirement was attempted three times and the score allocated to the best attempt (Carr et al., 1985).

c. Shoulder Strapping:

The researcher was blinded to the group allocation therefore, following the baseline assessment, the researcher left the room while the research assistant performed the strapping according to the group that the patient was allocated to (or no strapping if the patient was in the control group).

1. The Longitudinal Strapping:

The longitudinal strapping was derived from a combination of the guidelines set out by Peters and Lee (2003) and the depiction by J McConnell in Carr and Shepherd (2010):

- The shoulder area was prepared by wiping it with alcohol rub to enhance adhesiveness.
- The first layer of strapping was Fixomull® Stretch, followed by a layer of Leukotape P® which was applied with a cephalad tension
- With the patient seated, the arm was positioned with a pillow beneath the elbow in an attempt to reduce any presence of subluxation.
- Two to three strips were applied, starting just below the deltoid insertion:
  - Anteriorly, over the glenohumeral joint to end on the spine of the scapula.
  - Posteriorly, over the glenohumeral joint to end on the mid-clavicle but before the suprasternal notch.
  - Laterally, over the glenohumeral joint to end just beyond the acromio-clavicular joint. This strip was omitted if the patient's shoulder and upper arm were undersized.
  - The final strip was applied over the distal part of the three strips to secure them.
- The research assistant wrote on the tape "Do not wet; do not remove" (Griffin and Bernhardt, 2006).
- See Appendix A for depiction.

2. The circumferential strapping

The circumferential strapping was done as follows (as described by Ancliffe, 1992):

- The shoulder area was prepared by wiping it with alcohol rub to enhance adhesiveness.

- Fixomull® Stretch was used as the strapping material.
- With the patient seated, the arm was positioned with a pillow beneath the elbow in an attempt to reduce any presence of subluxation. (Although this was not described for the circumferential taping by Ancliffe (1992), it was employed in both strapping techniques.)
- Taping commenced along the length of the lateral half of the clavicle.
- The tape was then applied diagonally across the deltoid muscle, with a slight stretch applied in the same direction of the posterior fibres of deltoid. The stretch was not over-exerted as this could have caused vascular compression.
- The tape then travelled under the axilla, over padding material that was positioned on the inner surface of the upper arm for protection and comfort. The padding material did not extend the full way around the arm, as this was not necessary.
- The tape ended on the first quarter of the spine of the scapular.
- A second strip of tape was applied in the same way, but two centimetres inferiorly.
- The beginning and end of the taping was secured with a third strip of tape that ran over the shoulder.
- The research assistant wrote on the tape "Do not wet; do not remove" (Griffin and Bernhardt, 2006).
- Shortly thereafter the research assistant checked the patient's upper limb for signs of vascular compression i.e. swelling and/or colour change distal to the strapping. (See Appendix B for depiction).

Once the patient's shoulder had been strapped (or not, for the control group), the patient continued with their physiotherapy and/or occupational therapy as per normal. It was standard procedure for the physiotherapy and occupational therapy staff to educate all hemiplegic patients how to perform their own upper limb passive movements (within the limits of pain-free range) using the unaffected arm to grasp the affected wrist/hand.

Additionally, patients were educated on the importance of hemiplegic upper limb care, such as handling and positioning of the affected upper limb. When motor function could be elicited then active exercises were given as per standard treatment. No patients were strapped as standard care.

Irrespective of the strapping technique, the research assistant checked the patients regularly to see if they had developed skin reactions to the tape, or if the tape was no longer sticking properly. In the former case, the strapping was removed and the patient withdrawn from the study. In the latter case, the strapping was re-applied. Regardless of the state of the strapping, the patient was strapped every three to four days to limit the effects of the strapping stretching.

After one week the researcher did a re-assessment. The strapping was removed by the research assistant prior to the researcher entering the room to ensure blinding. The re-assessment followed the same assessment procedure as explained earlier for the baseline assessment. After the researcher had left the room the research assistant strapped the patient's shoulder again.

One week later (in total two weeks of strapping) the patient had their second follow-up assessment according to the same procedure already discussed. The shoulder was not strapped again. After a further four weeks (six weeks in total since baseline assessment) the patient underwent their final assessment. If during the course of the six weeks the patient was discharged, they were contacted telephonically by the research assistant to return at the allocated time for shoulder strapping and/or re-assessment. Transport money was given to the patients.

3.9 Data Analyses

3.9.1 Data Management

Data was captured on Microsoft Excel. During data cleaning missing values were addressed by the researcher by returning to the patient's file to ascertain if the information could be gathered from there (e.g. demographic data). The complete data was the imported from Microsoft Excel into Stata version 12 for analysis purposes.

3.9.2 Data Analyses

Demographic data were analysed using descriptive statistics and were presented in tables using frequencies and percentages for the following variables: age, gender and side of stroke. For this study the tracking of the number of participants presenting with the outcomes that were being measured was important. We therefore used the two-sample test of proportions to determine differences among the groups over the study period. Given the small numbers in the study groups we used non-para-metric tests. Therefore, the overall within group effect was tested using the Cochran's Q test. The generalized estimated equations were was used to determine the overall effects of the intervention overtime adjusting for groups as well as using population levels. For all the statistical tests, significance level was set at $p \leq 0.05$

3.10 Ethical Considerations

- Ethical clearance was applied for from the Human Research Ethics Committee of the University of Witwatersrand. (Appendix F)
- Furthermore, permission was applied for and granted from the Gauteng Department of Health, Helen Joseph Hospital and Charlotte Maxeke Johannesburg Academic Hospital.
- Informed consent was sought from the patients without any coercion and they were told that they could withdraw from the study at any point without any prejudice against them and without any jeopardy to any treatment that they would normally receive.
- The data collection form and patient information were kept separately. Access to the results was limited to the researcher and her supervisor and they were only used for the purposes of this study.

CHAPTER 4

4. RESULTS

4.1 Introduction

The results of the study are presented in this chapter addressing each of the study's objectives. For each objective the distribution of the scores are given, followed by the statistical analysis of the comparison of data.

4.2 The distribution of the participants throughout the study period

The number of participants at each assessment is shown in the flowchart below (Figure 4.1).

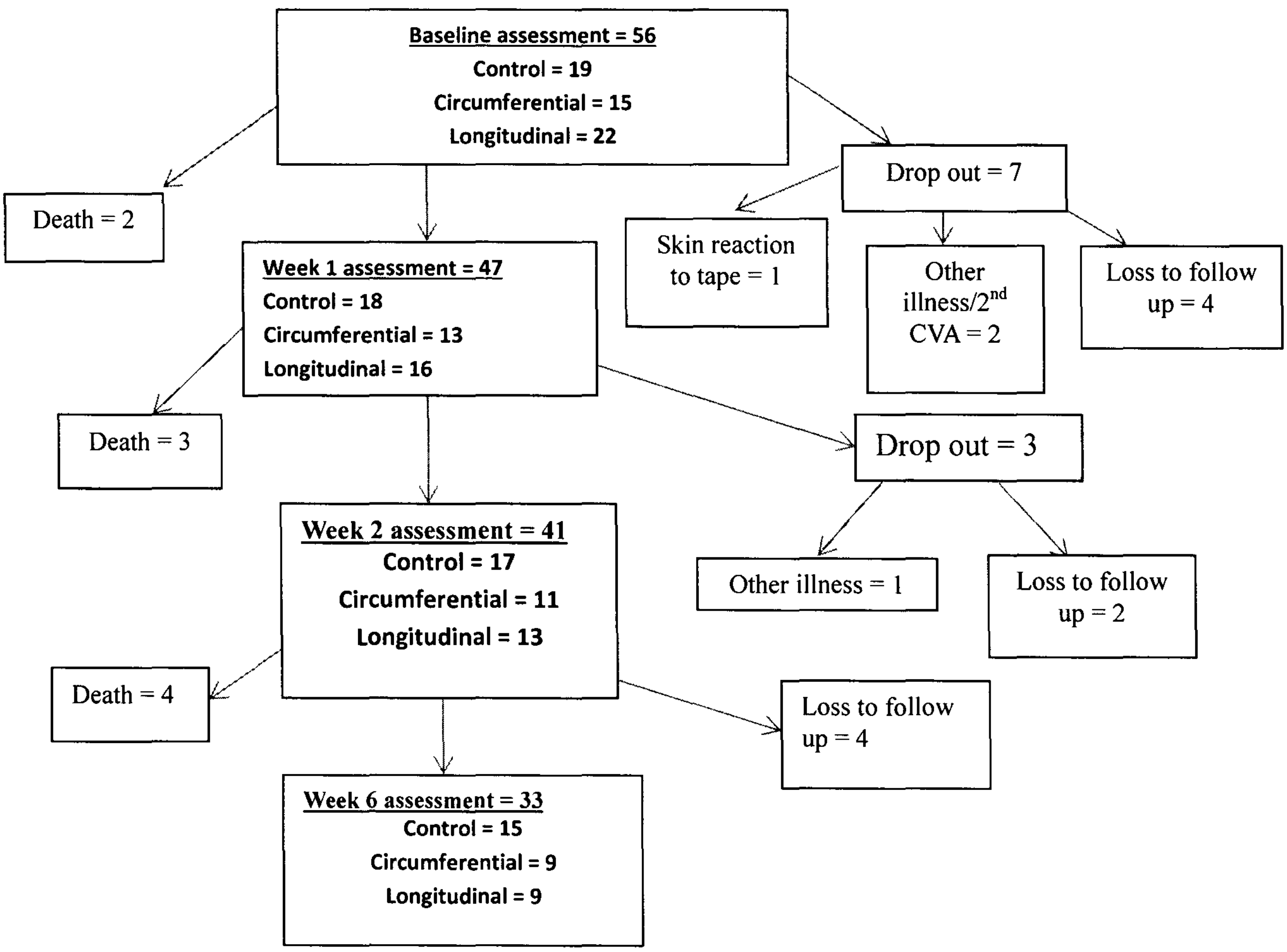

Figure 4.1: Flowchart showing participant recruitment and assessment

4.3 Demographic details of the study sample

The demographic details of the participants are shown in Table 4.1 below.

Table 4.1: Demographic information (n=56)

Demographic Detail	**n = 56 (%)**
Male	27 (48.2)
Female	29 (51.8)
Left Cerebrovascular Accident	22 (39.3)
Right Cerebrovascular Accident	34 (60.7)
Mean Age (S.D)	49.4 (± 13.8) Years

The majority of the participants were female (51.8%) and the mean age was 49.4 (± 13.8) years.

4.4 The effects of strapping

The following sections give the results for the effects of strapping. The results are in four parts with the first part showing the results of longitudinal strapping versus the control group. In the second part the results of circumferential strapping against the control group are presented. This is followed by the results of circumferential strapping versus longitudinal strapping. Lastly the results of combined strapping versus no strapping are presented. For each section the distribution of the number of participants for each outcome measures are shown in tables and figures over the study period.

Demographic data were summarised using descriptive statistics and were presented in tables using frequencies and percentages for the following variables: age, gender and side of stroke. The two-sample test of proportions was used to determine differences among the groups over the study period. Using the Cochran's Q test the overall within group effect was tested. The generalized estimated equations were was used to determine the overall effects of the intervention overtime adjusting for groups as well as using population levels. For all the statistical tests, significance level was set at $p \leq 0.05$

4.4.1 The effects of longitudinal strapping

The distribution of the outcome measure scores across the study period for the participants in the longitudinal and control strapping groups are shown in Tables 4.2 to 4.5 and Figures 4.2 to 4.7 below. The percentages depicted in Figures 4.2 to 4.7 below are the sum of the percentage of participants scoring one or higher on assessment for each outcome measure. The distribution of the shoulder subluxation scores is shown in Table 4.2 below.

Table 4.2: Distribution of the shoulder subluxation scores for the study period (control vs. longitudinal)

SHOULDER SUBLUXATION SCORE	GROUP	BASELINE n = 56 n (%)	WEEK1 n=47 n (%)	WEEK 2 n=41 n (%)	WEEK 6 n=33 n (%)
0	Control	14 (25.0)	10 (21.3)	10 (24.4)	9 (27.3)
	Longitudinal	15 (26.8)	9 (19.1)	8 (19.5)	6 (18.2)
1	Control	1 (1.8)	4 (8.5)	1 (2.4)	3 (9.1)
	Longitudinal	3 (5.4)	4 (8.5)	2 (4.9)	1 (3.0)
2	Control	3 (5.4)	4 (8.5)	6 (14.6)	3 (9.1)
	Longitudinal	3 (5.4)	3 (6.4)	3 (7.3)	1 (3.0)
3	Control	1(1.8)	0 (0)	0 (0)	0 (0)
	Longitudinal	1(1.8)	0 (0)	0 (0)	1 (3.0)
4	Control	0 (0)	0 (0)	0 (0)	0 (0)
	Longitudinal	0 (0)	0 (0)	0 (0)	0 (0)
5	Control	0 (0)	0 (0)	0 (0)	0 (0)
	Longitudinal	0 (0)	0 (0)	0 (0)	0 (0)

The percentage of participants that had shoulder subluxation over the study period increased in the control group while it declined in the longitudinal strapping group. This is summarised in Figure 4.2 below which shows the distribution of participants with shoulder subluxation over the study period.

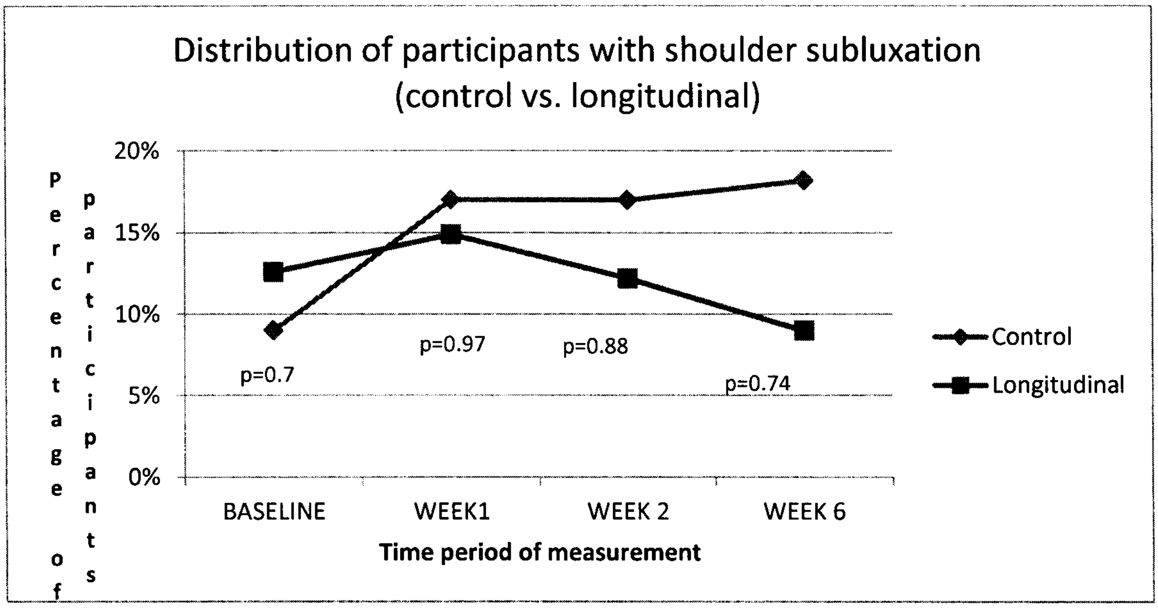

Figure 4.2: Distribution of participants with shoulder subluxation for the study period (control vs. longitudinal)

The differences in the number of participants between the two groups that had shoulder subluxation were not statistically significant at week one, two and six.

The distribution of the shoulder pain scores between the control and longitudinal strapping groups are shown in Table 4.3 below.

Table 4.3: Distribution of the shoulder pain scores for the study period (control vs. longitudinal)

RITCHIE ARTICULAR INDEX SCORE	GROUP	BASELINE n = 56 n (%)	WEEK1 n=47 n (%)	WEEK 2 n=41 n (%)	WEEK 6 n=33 n (%)
0	Control	10 (17.9)	8 (17.0)	9 (22.0)	7 (21.2)
	Longitudinal	13 (23.2)	10 (21.3)	5 (12.2)	4 (12.1)
1	Control	8 (14.3)	9 (19.1)	6 (14.6)	3 (9.1)
	Longitudinal	5 (8.9)	0 (0)	4 (9.8)	0 (0)
2	Control	1 (1.8)	1 (2.1)	2 (4.9)	2 (6.1)
	Longitudinal	2 (3.6)	2 (4.3)	4 (9.8)	4 (12.1)
3	Control	0 (0)	0 (0)	0 (0)	3 (9.1)
	Longitudinal	2 (3.6)	4 (8.5)	0 (0)	1 (3.0)

Marginally fewer participants in the longitudinal strapping group experienced shoulder pain by the end of the study, while there was an increase in the number of participants in the control group who experienced shoulder pain. A summary of these results are shown in Figure 4.3 below.

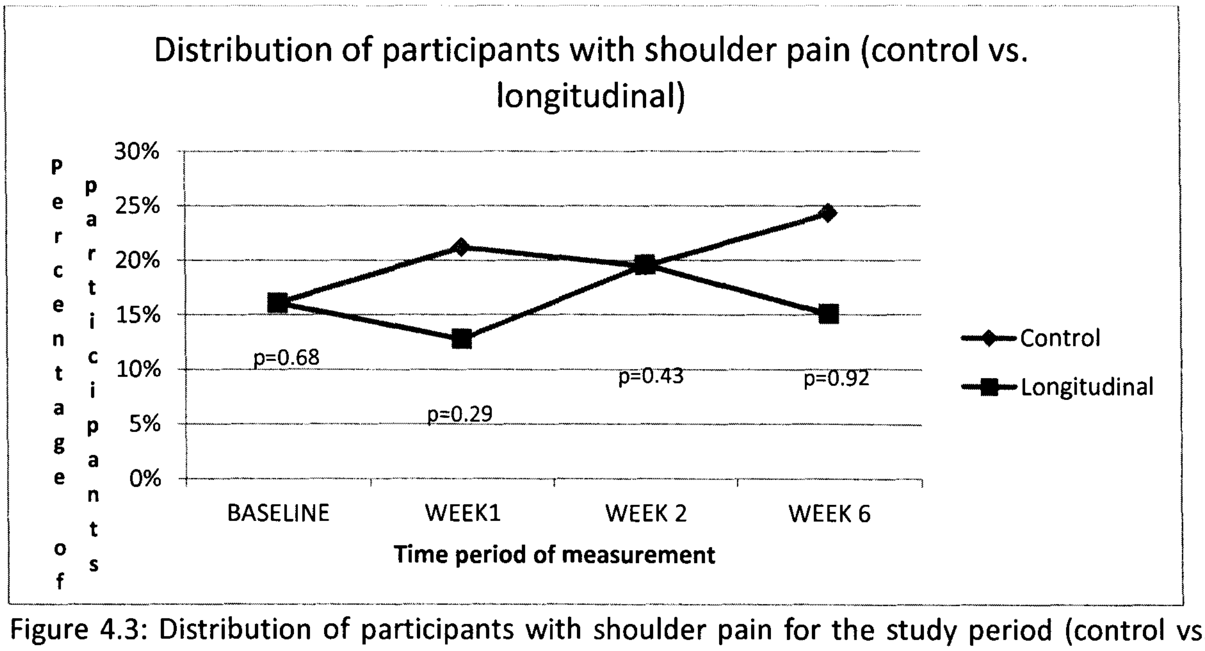

Figure 4.3: Distribution of participants with shoulder pain for the study period (control vs. longitudinal)

The differences in shoulder pain between the two groups did not reach statistically significant levels.

The distribution of the participants who had increased shoulder tone between the control and longitudinal strapping groups for the study period is shown in Table 4.4 below.

Table 4.4: Distribution of the shoulder tone scores for the study period (control vs. longitudinal)

MODIFIED ASHWORTH SCALE SCORE	GROUP	BASELINE n = 56 n (%)	WEEK1 n=47 n (%)	WEEK 2 n=41 n (%)	WEEK 6 n=33 n (%)
0	Control	17 (30.4)	14 (29.8)	14 (34.1)	13 (39.4)
	Longitudinal	16 (28.6)	10 (21.3)	8 (19.5)	5 (15.2)
1	Control	1 (1.8)	2 (4.3)	0 (0)	0 (0)
	Longitudinal	2 (3.6)	2 (4.3)	1 (2.4)	0 (0)
2	Control	1 (1.8)	1 (2.1)	2 (4.9)	1 (3.0)
	Longitudinal	1 (1.8)	1 (2.1)	3 (7.3)	2 (6.1)
3	Control	0 (0)	1 (2.1)	1 (2.4)	1 (3.0)
	Longitudinal	2 (3.6)	3 (6.4)	1 (2.4)	2 (6.1)
4	Control	0 (0)	0 (0)	0 (0)	0 (0)
	Longitudinal	1 (1.8)	0 (0)	0 (0)	0 (0)
5	Control	0 (0)	0 (0)	0 (0)	0 (0)
	Longitudinal	0 (0)	0 (0)	0 (0)	0 (0)

Both the control and the longitudinal group experienced a rise in the number of participants who had increased shoulder tone by the end of the study. This is depicted in Figure 4.4 below.

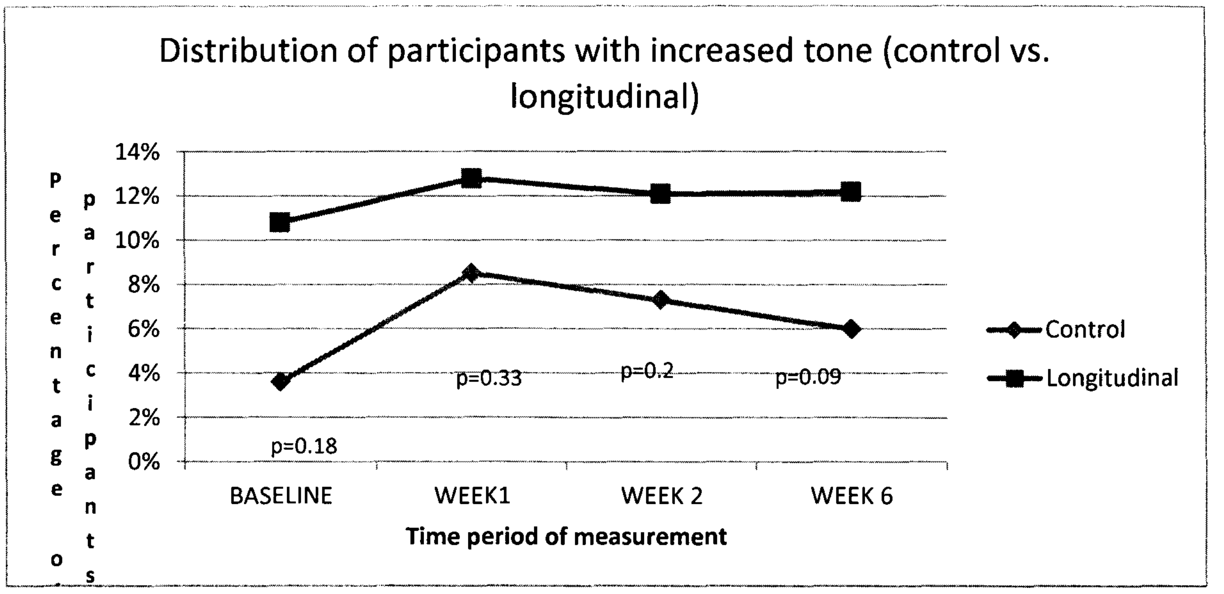

Figure 4.4: Distribution of participants with increased tone for the study period (control vs. longitudinal)

The control group had a greater number of participants with changes in tone than those in the longitudinal group, however it was not a statistically significant difference.

The distribution of upper limb motor function scores for the participants in the control and longitudinal groups are shown in Table 4.5 below.

Table 4.5: Distribution of upper limb subscales 6, 7 and 8 (of the motor assessment scale) for the study period (control vs. longitudinal)

Time Series			UPPER LIMB MOTOR FUNCTION SCORES						
			0 N (%)	1 N (%)	2 N (%)	3 N (%)	4 N (%)	5 N (%)	6 N (%)
Baseline (N=56)	Subscale 6	Control	15 (26.8)	2 (3.6)	0 (0)	1 (1.8)	0 (0)	0 (0)	1 (1.8)
		Longitudinal	21 (37.5)	1 (1.8)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	Subscale 7	Control	18 (32.1)	0 (0)	0 (0)	1 (1.8)	0 (0)	0 (0)	0 (0)
		Longitudinal	22 (39.3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	Subscale 8	Control	17 (30.4)	2 (3.6)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
		Longitudinal	22 (39.3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Week 1 (N=47)	Subscale 6	Control	12 (25.5)	0 (0)	1 (2.1)	2 (4.3)	2 (4.3)	0 (0)	1 (2.1)
		Longitudinal	12 (25.5)	3 (6.4)	1 (2.1)	0 (0)	0 (0)	0 (0)	0 (0)
	Subscale 7	Control	15 (31.9)	1 (2.1)	0 (0)	1 (2.1)	1 (2.1)	0 (0)	0 (0)
		Longitudinal	16 (34.0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	Subscale 8	Control	16 (34.0)	0 (0)	2 (4.3)	0 (0)	0 (0)	0 (0)	0 (0)
		Longitudinal	16 (34.0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Week 2 (N=41)	Subscale 6	Control	10 (24.4)	0 (0)	1 (2.4)	0 (0)	1 (2.4)	1 (2.4)	4 (9.8)
		Longitudinal	9 (22.0)	0 (0)	1 (2.4)	0 (0)	0 (0)	1 (2.4)	2 (4.9)
	Subscale 7	Control	13 (31.7)	0 (0)	0 (0)	0 (0)	2 (4.9)	1 (2.4)	1 (2.4)
		Longitudinal	10 (24.4)	0 (0)	0 (0)	1 (2.4)	0 (0)	2 (4.9)	0 (0)
	Subscale 8	Control	11 (26.8)	3 (7.3)	3 (7.3)	0 (0)	0 (0)	0 (0)	0 (0)
		Longitudinal	10 (24.4)	1 (2.4)	2 (4.9)	0 (0)	0 (0)	0 (0)	0 (0)
Week 6 (N=33)	Subscale 6	Control	7 (21.2)	1 (3.0)	0 (0)	1 (3.0)	0 (0)	0 (0)	6 (18.2)
		Longitudinal	6 (18.2)	2 (6.1)	0 (0)	0 (0)	0 (0)	0 (0)	1 (3.0)
	Subscale 7	Control	9 (27.3)	0 (0)	0 (0)	0 (0)	0 (0)	2 (6.1)	4 (12.1)
		Longitudinal	7 (21.2)	0 (0)	1 (3.0)	0 (0)	0 (0)	0 (0)	1 (3.0)
	Subscale 8	Control	9 (27.3)	1 (3.0)	3 (9.1)	0 (0)	0 (0)	0 (0)	2 (6.1)
		Longitudinal	7 (21.2)	0 (0)	1 (3.0)	0 (0)	0 (0)	0 (0)	1 (3.0)

Participants in both the control and longitudinal groups exhibited an improvement in upper limb motor function across the study period, however the control group experienced a greater improvement than the longitudinal group. This is depicted in Figures 4.5 to 4.7 below.

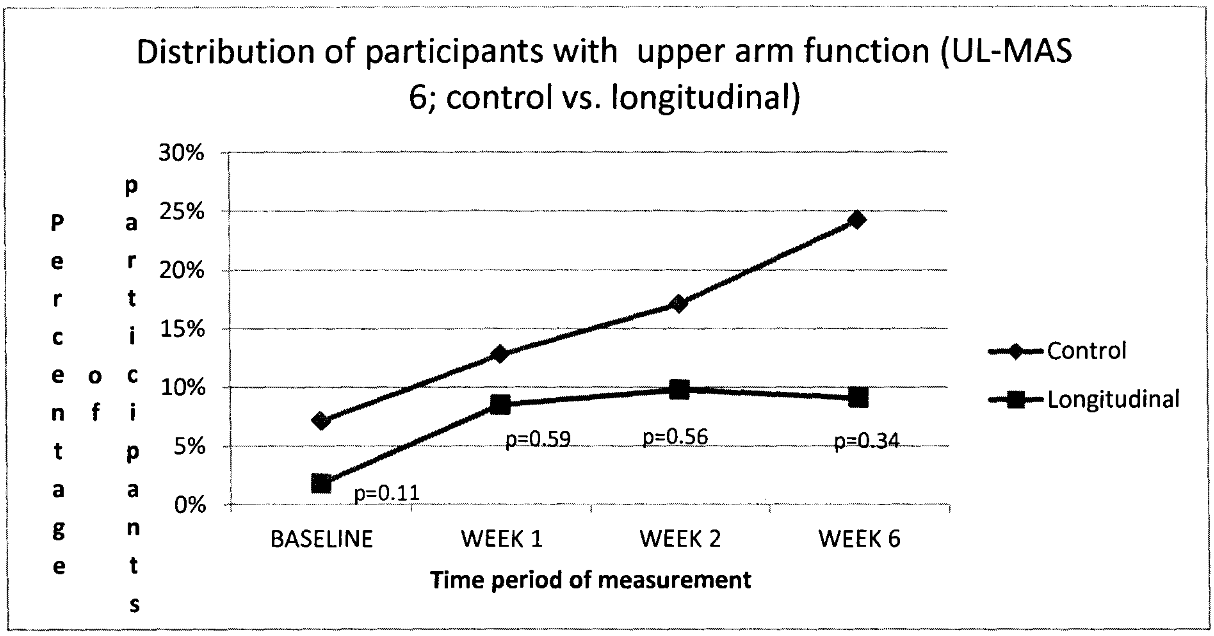

Figure 4.5: Distribution of participants with upper arm function (UL-MAS 6) for the study period (control vs. longitudinal)

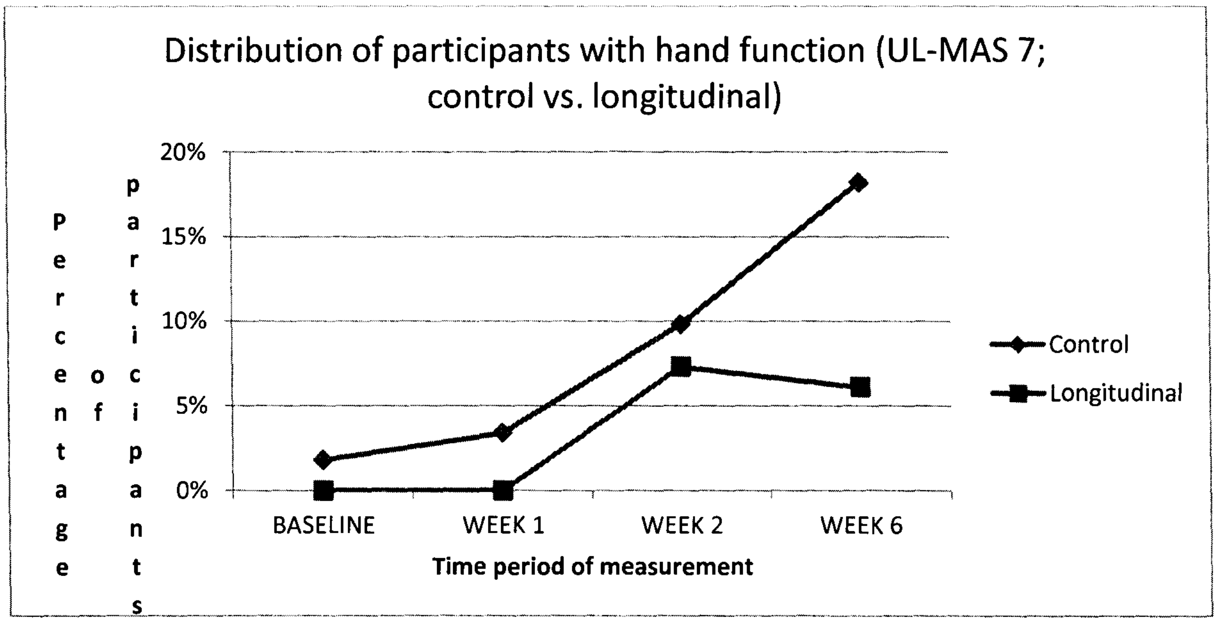

Figure 4.6: Distribution of participants with hand movements (UL-MAS 7) for the study period (control vs. longitudinal)

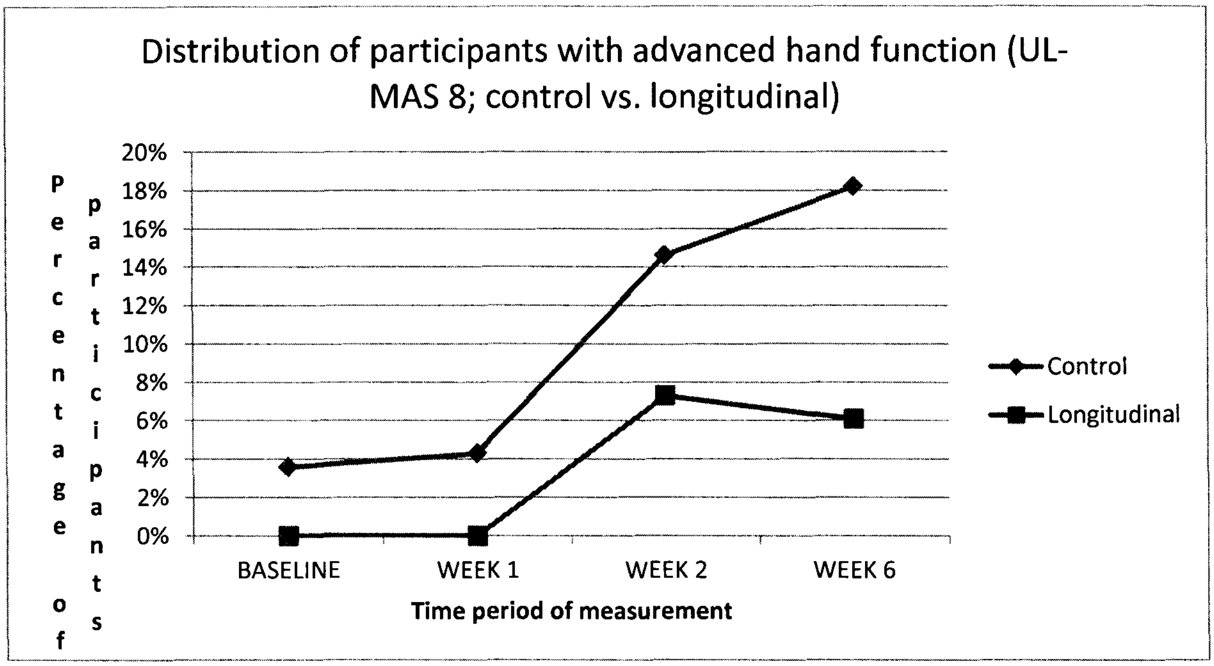

Figure 4.7: Distribution of participants with advanced hand activities (UL-MAS 8) for the study period (control vs. longitudinal)

It should be noted that the final numbers for UL-MAS 7 and 8 were too small to run statistical analysis for the p values at each assessment period, however the overall effect is still reflected on the graph. No significant difference was found between the longitudinal and the control strapping group with regards to the scores for UL-MAS 6.

4.4.2 The effects of circumferential strapping

The distribution of the outcome measure scores across the study period for the participants in the circumferential and control strapping groups are shown in Tables 4.6 to 4.9 and Figure 4.8 to 4.13 below. The percentage of participants in Figures 4.8 to 4.13 were calculated for subluxation, pain, tone or motor function changes by the summation of the scores of one or above on assessment for each outcome measure respectively.

The distribution of the shoulder subluxation scores between the control and circumferential strapping groups are shown in Table 4.6 below.

Table 4.6: Distribution of the shoulder subluxation scores for the study period (control vs. circumferential)

SHOULDER SUBLUXATION SCORE	GROUP	BASELINE n = 56 n (%)	WEEK1 n=47 n (%)	WEEK 2 n=41 n (%)	WEEK 6 n=33 n (%)
0	Control	14 (25.0)	10 (21.3)	10 (24.4)	9 (27.3)
	Circumferential	9 (16.1)	6 (12.8)	5 (12.2)	3 (9.1)
1	Control	1 (1.8)	4 (8.5)	1 (2.4)	3 (9.1)
	Circumferential	2 (3.6)	3 (6.4)	1 (2.4)	4 (12.1)
2	Control	3 (5.4)	4 (8.5)	6 (14.6)	3 (9.1)
	Circumferential	4 (7.1)	3 (6.4)	4 (9.8)	2 (6.1)
3	Control	1(1.8)	0 (0)	0 (0)	0 (0)
	Circumferential	0 (0)	1 (2.1)	1 (2.4)	0 (0)
4	Control	0 (0)	0 (0)	0 (0)	0 (0)
	Circumferential	0 (0)	0 (0)	0 (0)	0 (0)
5	Control	0 (0)	0 (0)	0 (0)	0 (0)
	Circumferential	0 (0)	0 (0)	0 (0)	0 (0)

Figure 4.8 below shows that participants of both the control and circumferential groups had an increase in shoulder subluxation across the study period.

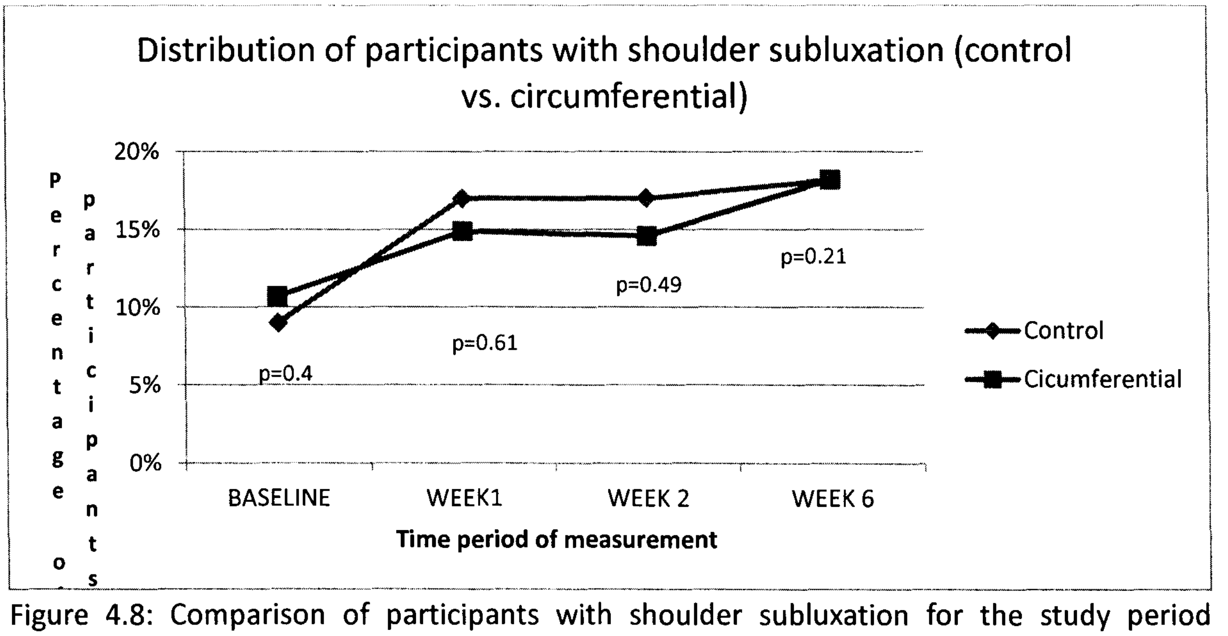

Figure 4.8: Comparison of participants with shoulder subluxation for the study period (control vs. circumferential)

There was no statistically significant difference between the two groups' changes over the study period.

The distribution of the shoulder pain scores between the control and circumferential strapping groups are shown in Table 4.7 below.

Table 4.7: Distribution of the shoulder pain scores for the study period (control vs. circumferential)

RITCHIE ARTICULAR INDEX SCORE	GROUP	BASELINE n = 56 n (%)	WEEK1 n=47 n (%)	WEEK 2 n=41 n (%)	WEEK 6 n=33 n (%)
0	Control	10 (17.9)	8 (17.0)	9 (22.0)	7 (21.2)
	Circumferential	5 (8.9)	7 (14.9)	4 (9.8)	3 (9.1)
1	Control	8 (14.3)	9 (19.1)	6 (14.6)	3 (9.1)
	Circumferential	4 (7.1)	3 (6.4)	2 (4.9)	1 (3.0)
2	Control	1 (1.8)	1 (2.1)	2 (4.9)	2 (6.1)
	Circumferential	6 (10.7)	3 (6.4)	3 (7.3)	4 (12.1)
3	Control	0 (0)	0 (0)	0 (0)	3 (9.1)
	Circumferential	0 (0)	0 (0)	2 (4.9)	1 (3.0)

There was a slight increase in the number of participants with shoulder pain in the circumferential participants by the end of the study, with a more marked increase in the control group, however the difference was not statistically significant. This is shown in Figure 4.9 below.

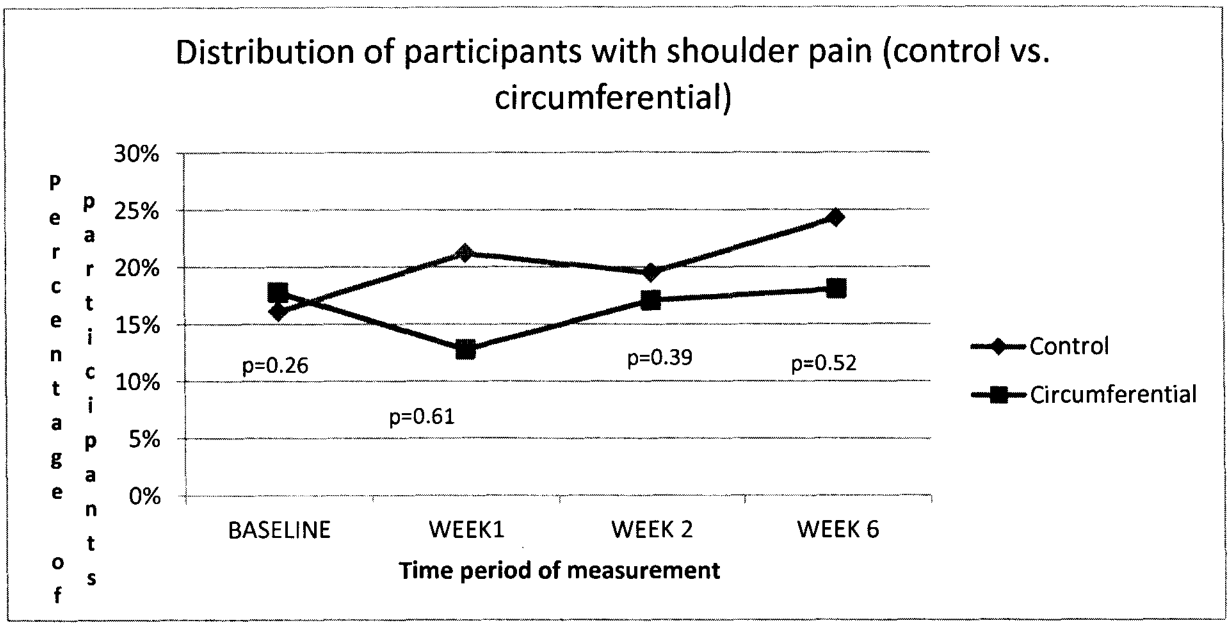

Figure 4.9: Distribution of participants with shoulder pain for the study period (control vs. circumferential)

The distribution of scores for changes in shoulder tone is shown in Table 4.8 below.

Table 4.8: Distribution of the shoulder tone scores for the study period (control vs. circumferential)

MODIFIED ASHWORTH SCALE SCORE	GROUP	BASELINE n = 56 n (%)	WEEK1 n=47 n (%)	WEEK 2 n=41 n (%)	WEEK 6 n=33 n (%)
0	Control	17 (30.4)	14 (29.8)	14 (34.1)	13 (39.4)
	Circumferential	12 (21.4)	8 (17.0)	7 (17.1)	8 (24.2)
1	Control	1 (1.8)	2 (4.3)	0 (0)	0 (0)
	Circumferential	1 (1.8)	2 (4.3)	1 (2.4)	0 (0)
2	Control	1 (1.8)	1 (2.1)	2 (4.9)	1 (3.0)
	Circumferential	1 (1.8)	2 (4.3)	0 (0)	0 (0)
3	Control	0 (0)	1 (2.1)	1 (2.4)	1 (3.0)
	Circumferential	0 (0)	1 (2.1)	3 (7.3)	1 (3.0)
4	Control	0 (0)	0 (0)	0 (0)	0 (0)
	Circumferential	1 (1.8)	0 (0)	0 (0)	0 (0)
5	Control	0 (0)	0 (0)	0 (0)	0 (0)
	Circumferential	0 (0)	0 (0)	0 (0)	0 (0)

The distribution of participants in the control group showed an increase in the number of participants with increased shoulder tone over the study period while the number of participants with increased tone decreased in the circumferential group. This is summarised in Figure 4.10 below.

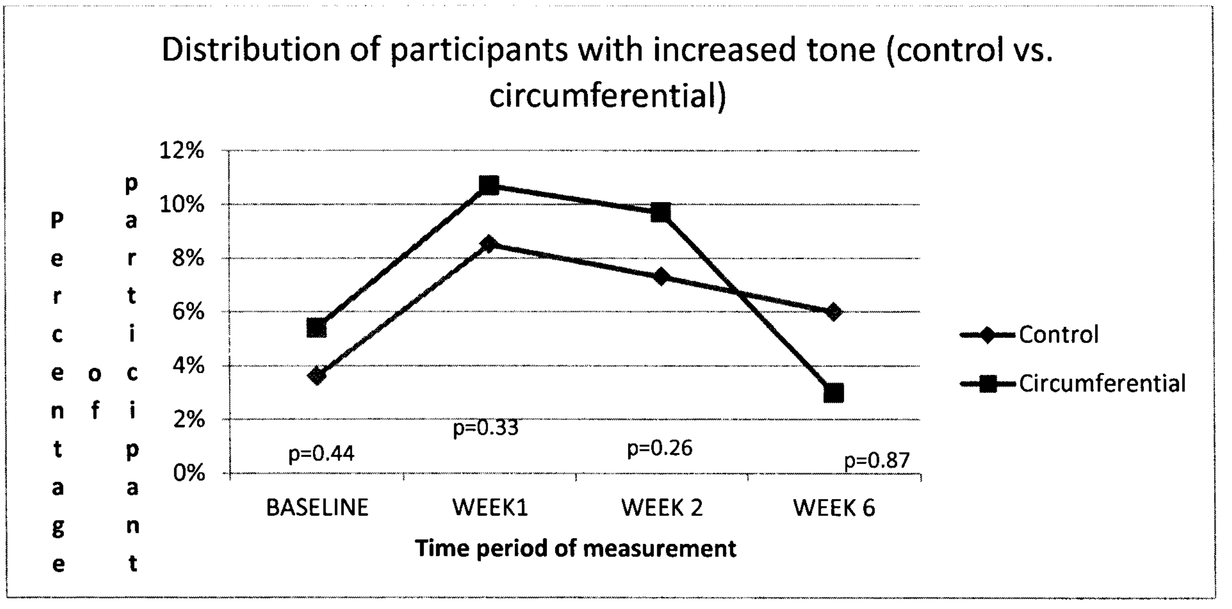

Figure 4.10: Distribution of participants with increased tone for the study period (control vs. circumferential)

The differences in changes shown in Table 4.8 and Figure 4.10 above were not statistically significant.

Table 4.9 shows the distribution of upper limb motor function scores for measured for subscale 6, 7 and 8 of the motor assessment scale

Table 4.9: Distribution of upper limb function as measured by subscales 6, 7 and 8 (of the motor assessment scale) for the study period (control vs. circumferential)

Time Series			UPPER LIMB MOTOR FUNCTION SCORES						
			0 n (%)	1 n (%)	2 n (%)	3 n (%)	4 n (%)	5 n (%)	6 n (%)
Baseline (n=56)	Subscale 6	Control	15 (26.8)	2 (3.6)	0 (0)	1 (1.8)	0 (0)	0 (0)	1 (1.8)
		Circumferential	14 (25.0)	1 (1.8)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	Subscale 7	Control	18 (32.1)	0 (0)	0 (0)	1 (1.8)	0 (0)	0 (0)	0 (0)
		Circumferential	15 (26.8)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	Subscale 8	Control	17 (30.4)	2 (3.6)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
		Circumferential	15 (26.8)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Week 1 (n=47)	Subscale 6	Control	12 (25.5)	0 (0)	1 (2.1)	2 (4.3)	2 (4.3)	0 (0)	1 (2.1)
		Circumferential	6 (12.8)	5 (10.6)	1 (2.1)	0 (0)	0 (0)	1 (2.1)	0 (0)
	Subscale 7	Control	15 (31.9)	1 (2.1)	0 (0)	1 (2.1)	1 (2.1)	0 (0)	0 (0)
		Circumferential	12 (25.5)	1 (2.1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	Subscale 8	Control	16 (34.0)	0 (0)	2 (4.3)	0 (0)	0 (0)	0 (0)	0 (0)
		Circumferential	12 (25.5)	1 (2.1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Week 2 (n=41)	Subscale 6	Control	10 (24.4)	0 (0)	1 (2.4)	0 (0)	1 (2.4)	1 (2.4)	4 (9.8)
		Circumferential	4 (9.8)	5 (12.2)	0 (0)	0 (0)	0 (0)	1 (2.4)	1 (2.4)
	Subscale 7	Control	13 (31.7)	0 (0)	0 (0)	0 (0)	2 (4.9)	1 (2.4)	1 (2.4)
		Circumferential	10 (24.4)	1 (2.4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	Subscale 8	Control	11 (26.8)	3 (7.3)	3 (7.3)	0 (0)	0 (0)	0 (0)	0 (0)
		Circumferential	11 (26.8)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Week 6 (n=33)	Subscale 6	Control	7 (21.2)	1 (3.0)	0 (0)	1 (3.0)	0 (0)	0 (0)	6 (18.2)
		Circumferential	3 (9.1)	3 (9.1)	0 (0)	0 (0)	0 (0)	2 (6.1)	1 (3.0)
	Subscale 7	Control	9 (27.3)	0 (0)	0 (0)	0 (0)	0 (0)	2 (6.1)	4 (12.1)
		Circumferential	6 (18.2)	2 (6.1)	0 (0)	0 (0)	0 (0)	1 (3.0)	0 (0)
	Subscale 8	Control	9 (27.3)	1 (3.0)	3 (9.1)	0 (0)	0 (0)	0 (0)	2 (6.1)
		Circumferential	8 (24.2)	1 (3.0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Motor function across all three subscales improved in both groups by the end of the study period but a larger improvement was shown by the control group, especially in UL-MAS 8. See Figures 4.11-4.13 below for a depiction of this.

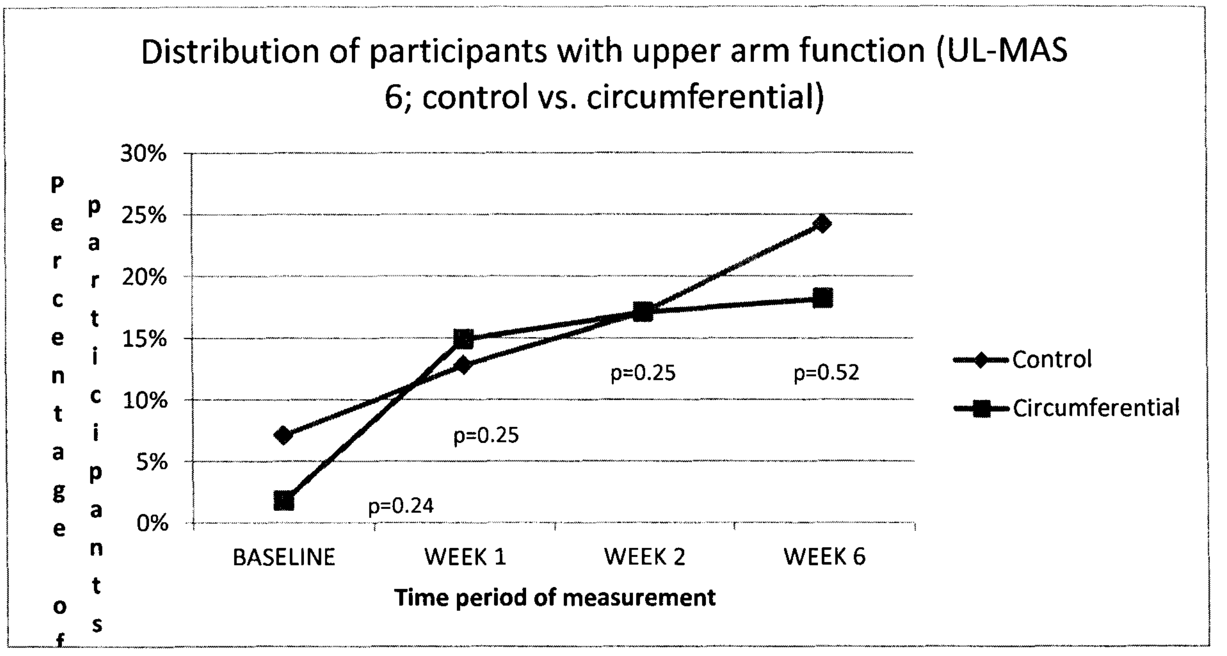

Figure 4.11: Distribution of participants with upper arm function (UL-MAS 6) for the study period (control vs. circumferential)

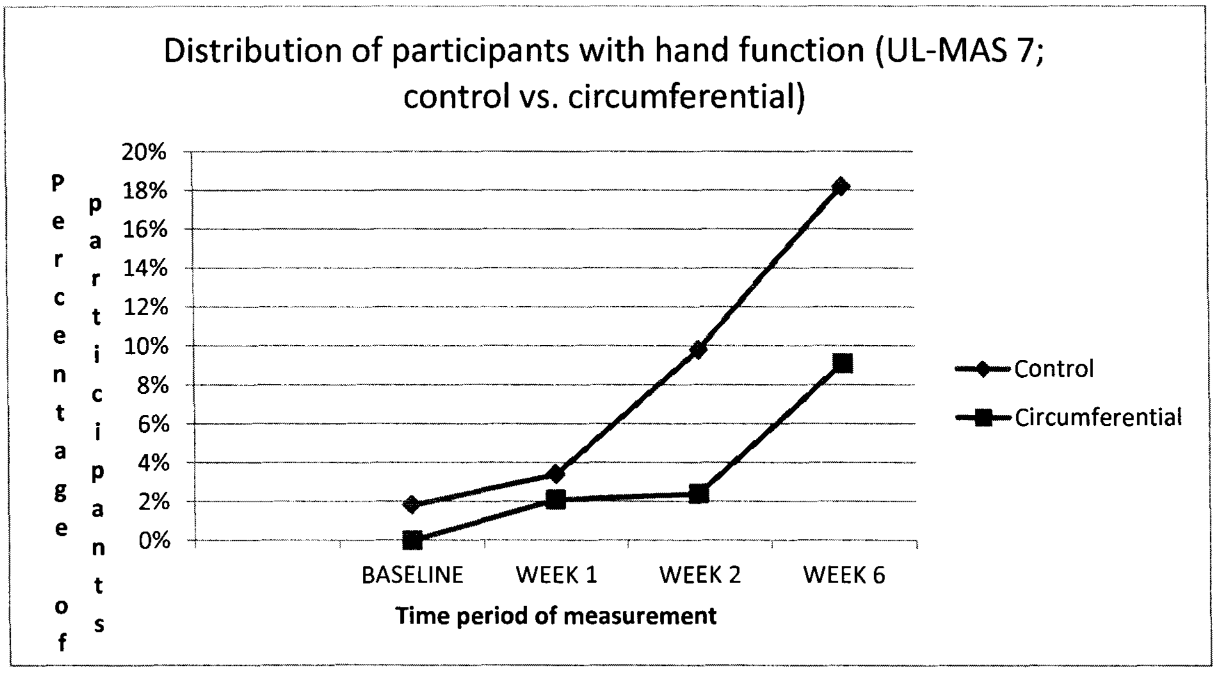

Figure 4.12: Distribution of participants with hand movements (UL-MAS 7) for the study period (control vs. circumferential)

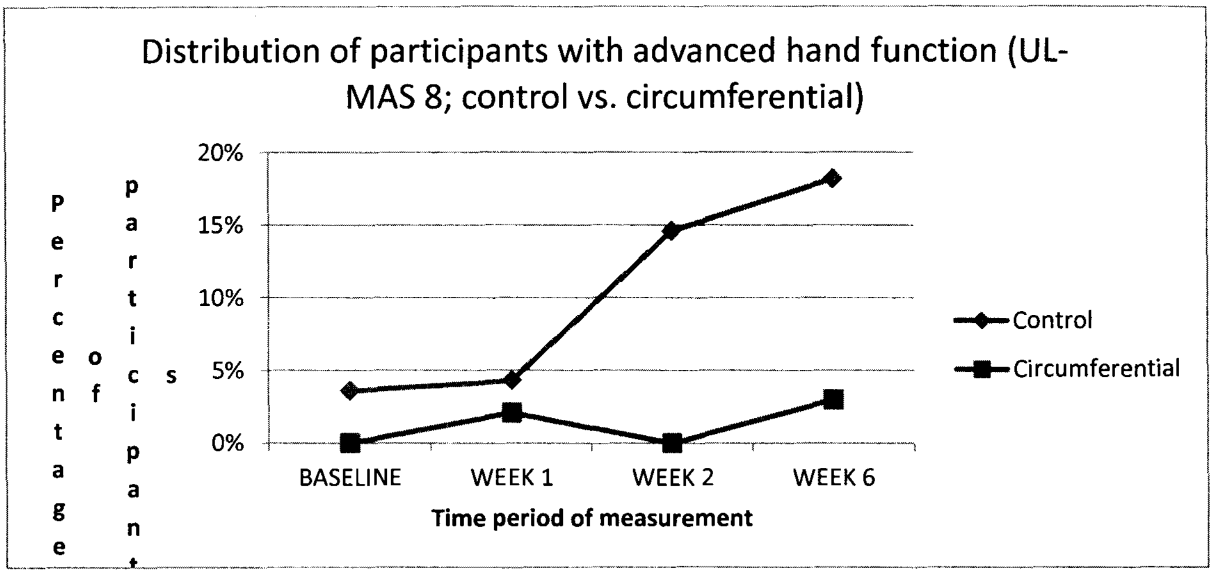

Figure 4.13: Distribution of participants with advanced hand activities (UL-MAS 8) for the study period (control vs. circumferential)

It should be noted that the final numbers for UL-MAS 7 and 8 were too small to run statistical analysis for the p values at each assessment period, however the overall effect is still reflected on the graph. No significant difference was found between the circumferential and the control strapping groups for UL-MAS 6.

4.4.3 The effects of longitudinal versus circumferential strapping

The distribution of the outcome measure scores across the study period for the participants in the longitudinal and circumferential strapping groups are shown in Tables 4.10 to 4.13 and Figures 4.14 to 4.19 below. The percentages depicted in Figures 4.14 to 4.19 below are the sum of the percentage of participants scoring one or higher on assessment for each outcome measure.

Table 4.10 below shows the distribution of shoulder subluxation scores across the study period for the longitudinal and circumferential strapping groups.

Table 4.10: Distribution of the shoulder subluxation scores for the study period (longitudinal vs. circumferential)

SHOULDER SUBLUXATION SCORE	GROUP	BASELINE n = 56 n (%)	WEEK1 n=47 n (%)	WEEK 2 n=41 n (%)	WEEK 6 n=33 n (%)
0	Longitudinal	15 (26.8)	9 (19.1)	8 (19.5)	6 (18.2)
	Circumferential	9 (16.1)	6 (12.8)	5 (12.2)	3 (9.1)
1	Longitudinal	3 (5.4)	4 (8.5)	2 (4.9)	1 (3.0)
	Circumferential	2 (3.6)	3 (6.4)	1 (2.4)	4 (12.1)
2	Longitudinal	3 (5.4)	3 (6.4)	3 (7.3)	1 (3.0)
	Circumferential	4 (7.1)	3 (6.4)	4 (9.8)	2 (6.1)
3	Longitudinal	1 (1.8)	0 (0)	0 (0)	1 (3.0)
	Circumferential	0 (0)	1 (2.1)	1 (2.4)	0 (0)
4	Longitudinal	0 (0)	0 (0)	0 (0)	0 (0)
	Circumferential	0 (0)	0 (0)	0 (0)	0 (0)
5	Longitudinal	0 (0)	0 (0)	0 (0)	0 (0)
	Circumferential	0 (0)	0 (0)	0 (0)	0 (0)

During the study period the distribution of participants with shoulder subluxation increased in the circumferential strapping group and decreased in the longitudinal group. This is shown in summary below (Figure 4.14).

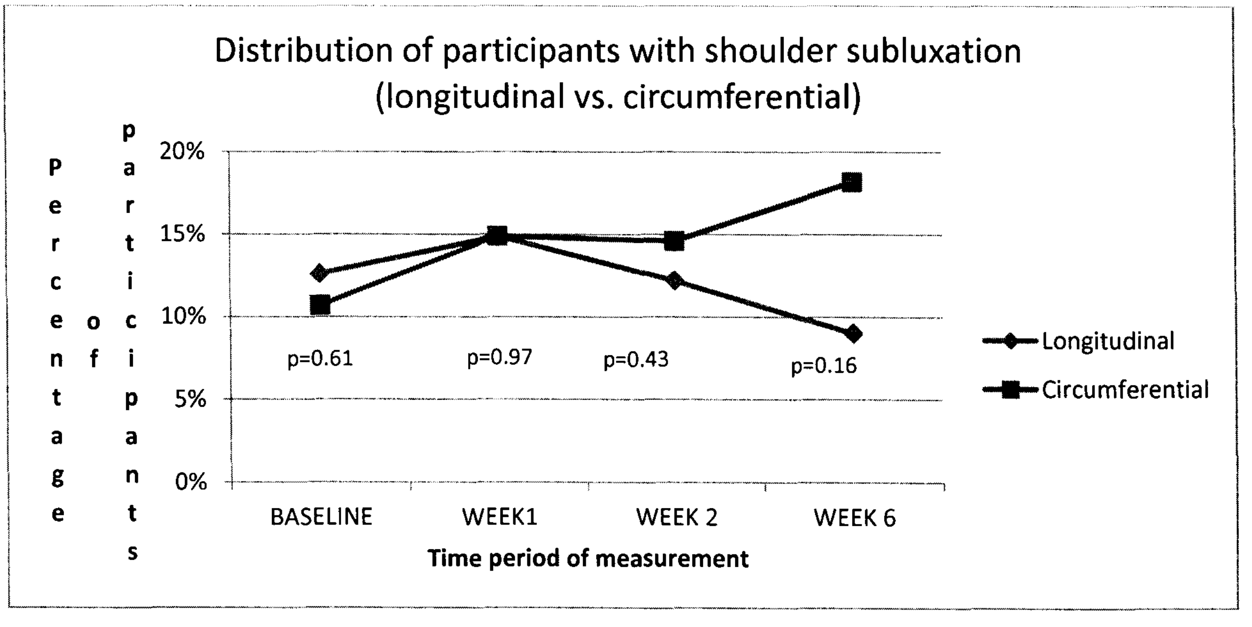

Figure 4.14: Distribution of participants with shoulder subluxation for the study period

(longitudinal vs. circumferential)

The difference between the two groups' changes was not statistically significant.
The distribution of shoulder pain scores for the longitudinal and circumferential groups are shown in Table 4.11 below.

Table 4.11: Distribution of the shoulder pain scores for the study period (longitudinal vs. circumferential)

RITCHIE ARTICULAR INDEX SCORE	GROUP	BASELINE n = 56 n (%)	WEEK1 n=47 n (%)	WEEK 2 n=41 n (%)	WEEK 6 n=33 n (%)
0	Longitudinal	13 (23.2)	10 (21.3)	5 (12.2)	4 (12.1)
	Circumferential	5 (8.9)	7 (14.9)	4 (9.8)	3 (9.1)
1	Longitudinal	5 (8.9)	0 (0)	4 (9.8)	0 (0)
	Circumferential	4 (7.1)	3 (6.4)	2 (4.9)	1 (3.0)
2	Longitudinal	2 (3.6)	2 (4.3)	4 (9.8)	4 (12.1)
	Circumferential	6 (10.7)	3 (6.4)	3 (7.3)	4 (12.1)
3	Longitudinal	2 (3.6)	4 (8.5)	0 (0)	1 (3.0)
	Circumferential	0 (0)	0 (0)	2 (4.9)	1 (3.0)

Figure 4.15 below shows that the distribution of patients with shoulder pain marginally decreases and increases for the longitudinal and circumferential groups respectively during the study.

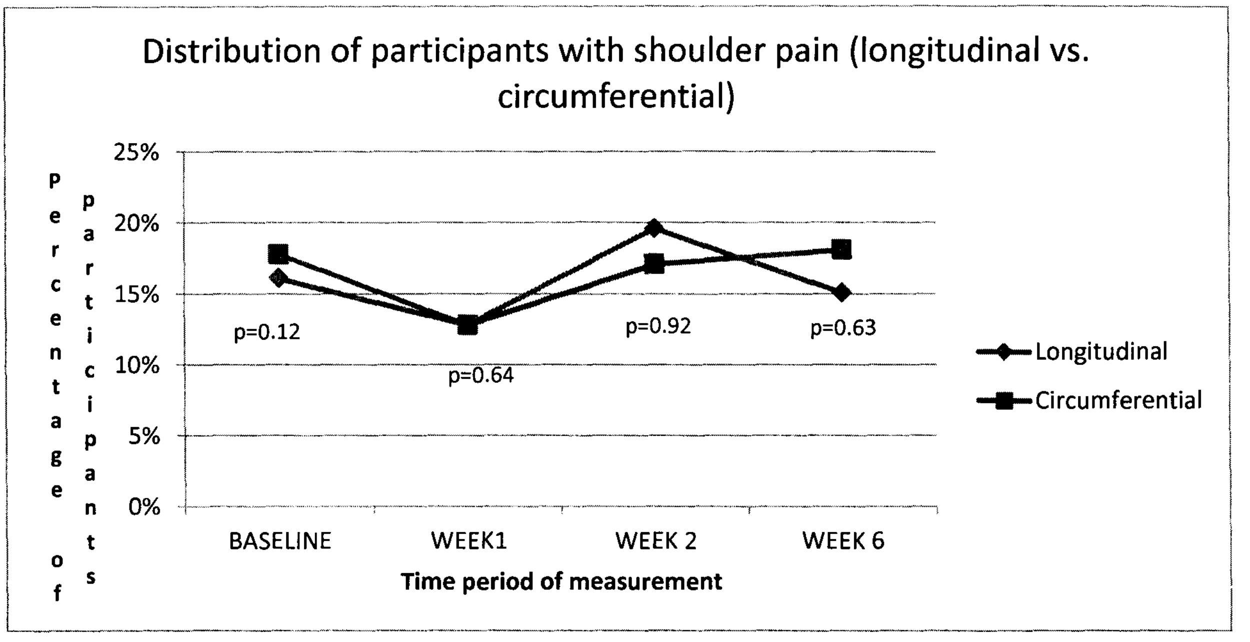

Figure 4.15: Distribution of participants with shoulder pain for the study period (longitudinal vs. circumferential)

There was no statistical significance in the changes depicted in Figure 4.15 above.

Table 4.12 below shows the distribution of participants in the longitudinal and circumferential groups experiencing changes in shoulder tone.

Table 4.12: Distribution of the shoulder tone scores for the study period (longitudinal vs. circumferential)

MODIFIED ASHWORTH SCALE SCORE	GROUP	BASELINE n = 56 n (%)	WEEK1 n=47 n (%)	WEEK 2 n=41 n (%)	WEEK 6 n=33 n (%)
0	Longitudinal	16 (28.6)	10 (21.3)	8 (19.5)	5 (15.2)
	Circumferential	12 (21.4)	8 (17.0)	7 (17.1)	8 (24.2)
1	Longitudinal	2 (3.6)	2 (4.3)	1 (2.4)	0 (0)
	Circumferential	1 (1.8)	2 (4.3)	1 (2.4)	0 (0)
2	Longitudinal	1 (1.8)	1 (2.1)	3 (7.3)	2 (6.1)
	Circumferential	1 (1.8)	2 (4.3)	0 (0)	0 (0)
3	Longitudinal	2 (3.6)	3 (6.4)	1 (2.4)	2 (6.1)
	Circumferential	0 (0)	1 (2.1)	3 (7.3)	1 (3.0)
4	Longitudinal	1 (1.8)	0 (0)	0 (0)	0 (0)
	Circumferential	1 (1.8)	0 (0)	0 (0)	0 (0)
5	Longitudinal	0 (0)	0 (0)	0 (0)	0 (0)
	Circumferential	0 (0)	0 (0)	0 (0)	0 (0)

There was a rise in the distribution of participants with increased shoulder tone in the longitudinal group over the study period, while the circumferential participants decreased, however the change held no statistical significance. This is summarised in Figure 4.16 below.

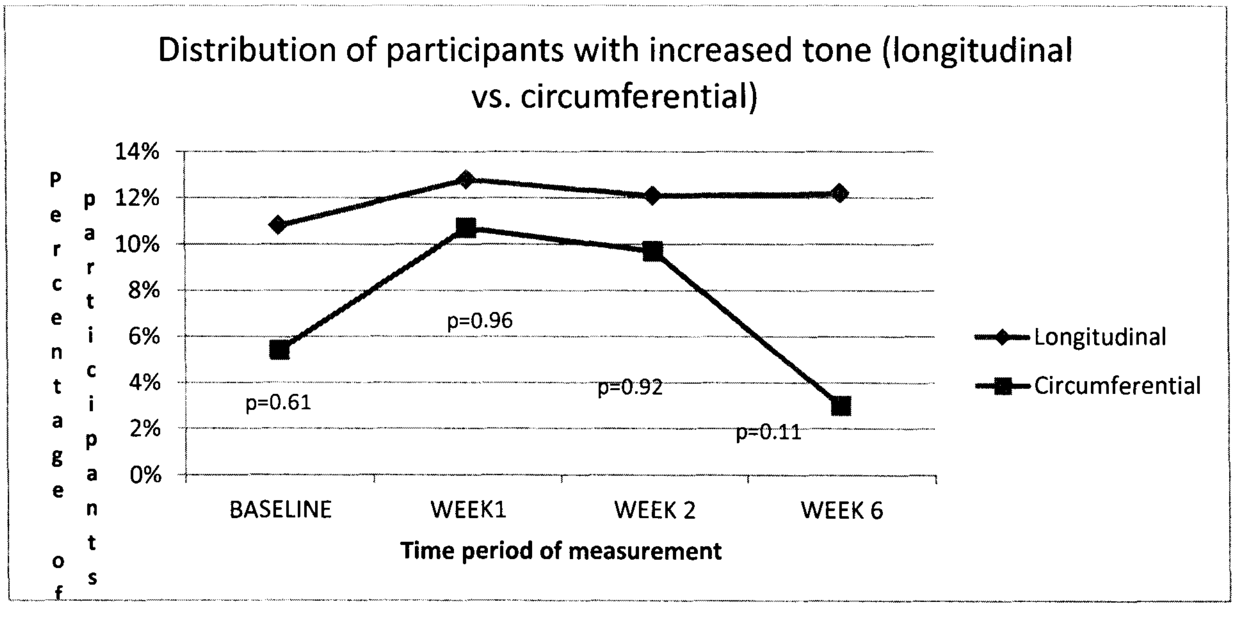

Figure 4.16: Distribution of participants with increased tone for the study period (longitudinal vs. circumferential)

Table 4.13 below shows the distribution of scores for the assessment of motor function for the study period for the longitudinal and circumferential groups.

Table 4.13: Distribution of upper limb subscales 6, 7 and 8 (of the motor assessment scale) for the study period (longitudinal vs. circumferential)

TIME SERIES			UPPER LIMB MOTOR FUNCTION SCORES						
			0 n (%)	1 n (%)	2 n (%)	3 n (%)	4 n (%)	5 n (%)	6 n (%)
BASELINE (N=56)	Subscale 6	Longitudinal	21 (37.5)	1 (1.8)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
		Circumferential	14 (25.0)	1 (1.8)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	Subscale 7	Longitudinal	22 (39.3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
		Circumferential	15 (26.8)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	Subscale 8	Longitudinal	22 (39.3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
		Circumferential	15 (26.8)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Week 1 (n=47)	Subscale 6	Longitudinal	12 (25.5)	3 (6.4)	1 (2.1)	0 (0)	0 (0)	0 (0)	0 (0)
		Circumferential	6 (12.8)	5 (10.6)	1 (2.1)	0 (0)	0 (0)	1 (2.1)	0 (0)
	Subscale 7	Longitudinal	16 (34.0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
		Circumferential	12 (25.5)	1 (2.1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	Subscale 8	Longitudinal	16 (34.0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
		Circumferential	12 (25.5)	1 (2.1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Week 2 (n=41)	Subscale 6	Longitudinal	9 (22.0)	0 (0)	1 (2.4)	0 (0)	0 (0)	1 (2.4)	2 (4.9)
		Circumferential	4 (9.8)	5 (12.2)	0 (0)	0 (0)	0 (0)	1 (2.4)	1 (2.4)
	Subscale 7	Longitudinal	10 (24.4)	0 (0)	0 (0)	1 (2.4)	0 (0)	2 (4.9)	2 (4.9)
		Circumferential	10 (24.4)	1 (2.4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	Subscale 8	Longitudinal	10 (24.4)	1 (2.4)	2 (4.9)	0 (0)	0 (0)	0 (0)	0 (0)
		Circumferential	11 (26.8)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Week 6 (n=33)	Subscale 6	Longitudinal	6 (18.2)	2 (6.1)	0 (0)	0 (0)	0 (0)	0 (0)	1 (3.0)
		Circumferential	3 (9.1)	3 (9.1)	0 (0)	0 (0)	0 (0)	2 (6.1)	1 (3.0)
	Subscale 7	Longitudinal	7 (21.2)	0 (0)	1 (3.0)	0 (0)	0 (0)	0 (0)	1 (3.0)
		Circumferential	6 (18.2)	2 (6.1)	0 (0)	0 (0)	0 (0)	1 (3.0)	0 (0)
	Subscale 8	Longitudinal	7 (21.2)	0 (0.0)	1 (3.0)	0 (0)	0 (0)	0 (0)	1 (3.0)
		Circumferential	8 (24.2)	1 (3.0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

The scores showed that participants of both intervention groups showed improvement across all three subscales over the study period with the circumferential group showing greater improvement for UL-MAS 6 and 7. This is summarized in Figures 4.17-4.19 below.

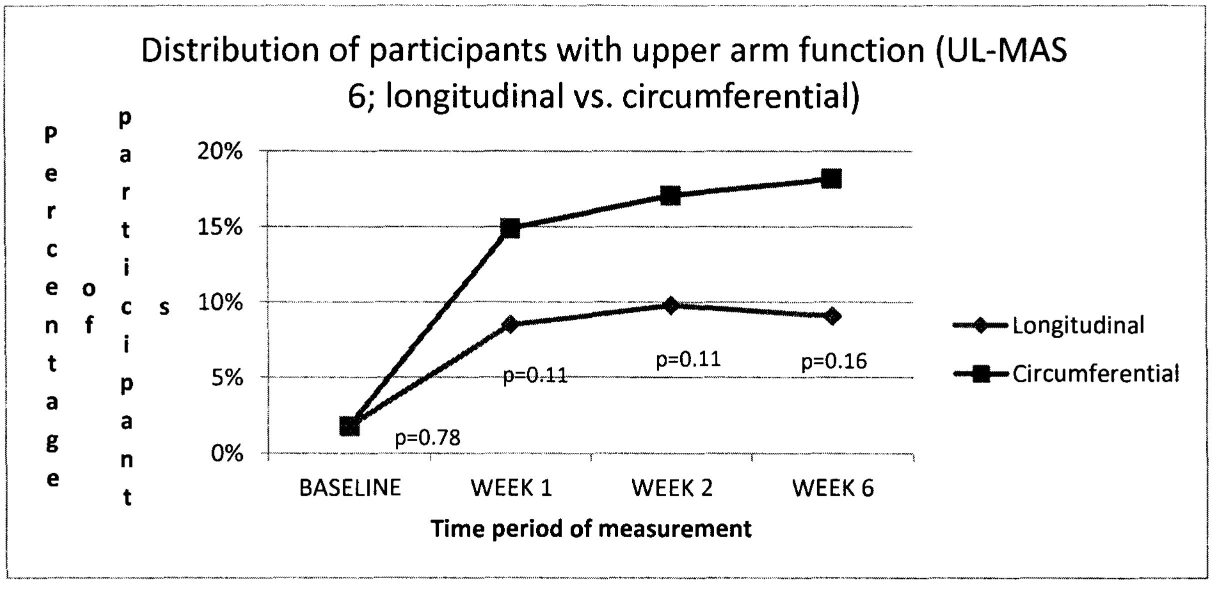

Figure 4.17: Distribution of participants with upper arm function (UL-MAS 6) for the study period (longitudinal vs. circumferential)

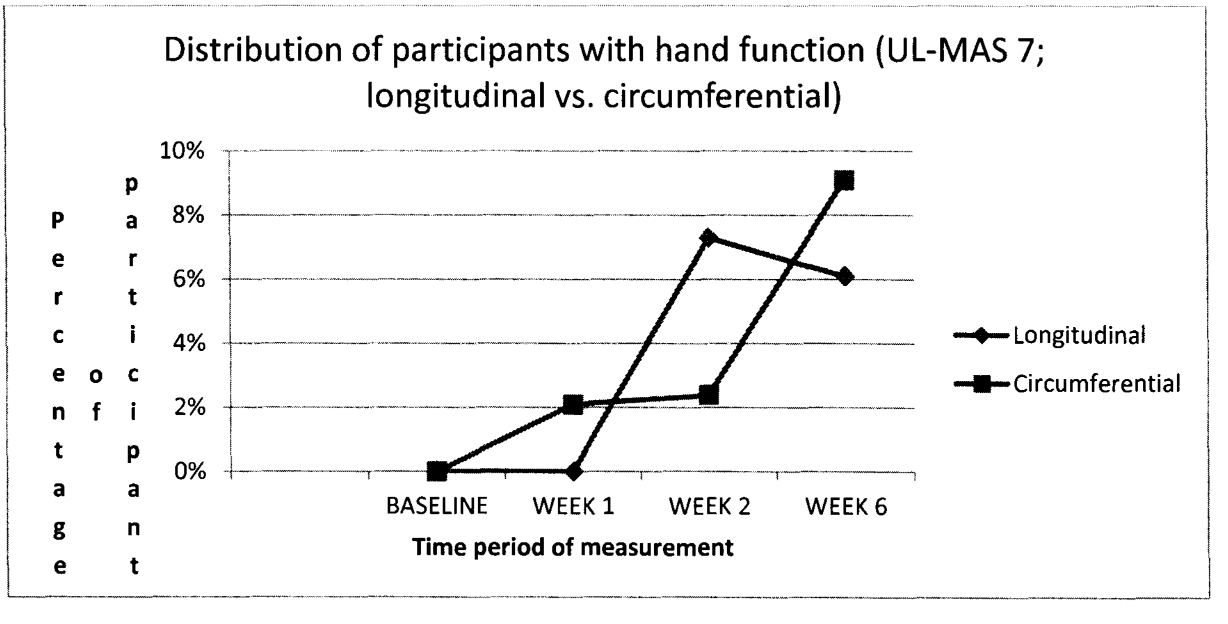

Figure 4.18: Distribution of participants with hand movements (UL-MAS 7) for the study period (longitudinal vs. circumferential)

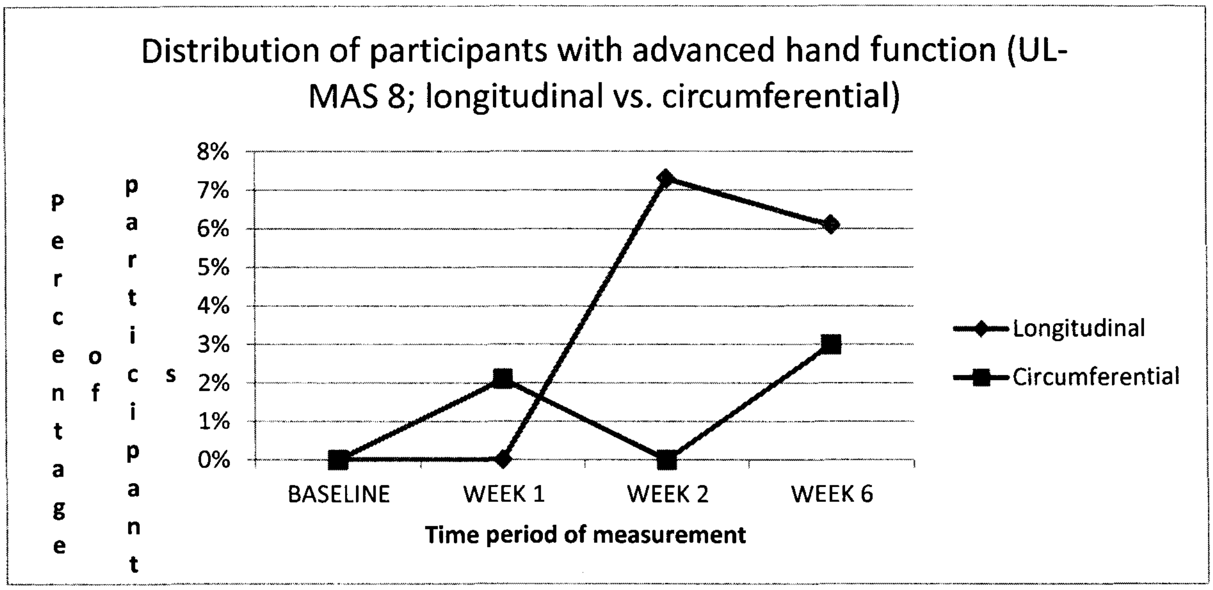

Figure 4.19: Distribution of participants with advanced hand activities (UL-MAS 8) for the study period (longitudinal vs. circumferential)

It should be noted that the final numbers for UL-MAS 7 and 8 were too small to run statistical analysis for the p values at each assessment period, however the overall effect is still reflected on the graph. No significant difference was found between the longitudinal and circumferential strapping group with regards to the scores for UL-MAS 6.

4.4.4 The effects of strapping versus no strapping

For this section, the results from the two intervention groups were combined and analysed against the control group to see if any strapping in general (hereon referred to as strapping) had an effect on shoulder subluxation, tone, pain and motor function. The decision was made to combine the two strapping groups due to the small numbers in the individual groups.

Tables 4.14 to 4.17 and Figures 4.20 to 4.25 below show the distribution of the outcome measure scores across the study period for strapping in general compared to the participants of the control group. In order to determine the total percentage of participants who experienced shoulder subluxation, pain, tone or motor function for Figures 4.20 to 4.25

below, all participants who scored one or above on the outcome measures were added together.

Table 4.14 below shows the distribution of scores for shoulder subluxation for the strapped versus control participants through the study.

Table 4.14: Distribution of the shoulder subluxation scores for the study period (control vs. strapping)

SHOULDER SUBLUXATION SCORE	GROUP	BASELINE n = 56 n (%)	WEEK1 n=47 n (%)	WEEK 2 n=41 n (%)	WEEK 6 n=33 n (%)
0	Control	14 (25.0)	10 (21.3)	10 (24.4)	9 (27.3)
	Longitudinal and Circumferential	24 (42.9)	15 (31.9)	13 (31.7)	9 (27.3)
1	Control	1 (1.8)	4 (8.5)	1 (2.4)	3 (9.1)
	Longitudinal and Circumferential	5 (8.9)	7 (14.9)	3 (7.3)	5 (15.2)
2	Control	3 (5.4)	4 (8.5)	6 (14.6)	3 (9.1)
	Longitudinal and Circumferential	7 (12.5)	6 (12.8)	7 (17.1)	3 (9.1)
3	Control	1(1.8)	0 (0)	0 (0)	0 (0)
	Longitudinal and Circumferential	1(1.8)	1 (2.1)	1 (2.4)	1 (3.0)
4	Control	0 (0)	0 (0)	0 (0)	0 (0)
	Longitudinal and Circumferential	0 (0)	0 (0)	0 (0)	0 (0)
5	Control	0 (0)	0 (0)	0 (0)	0 (0)
	Longitudinal and Circumferential	0 (0)	0 (0)	0 (0)	0 (0)

Shoulder subluxation increased for both the control group and the strapping groups across the study period which is depicted in Figure 4.20 below.

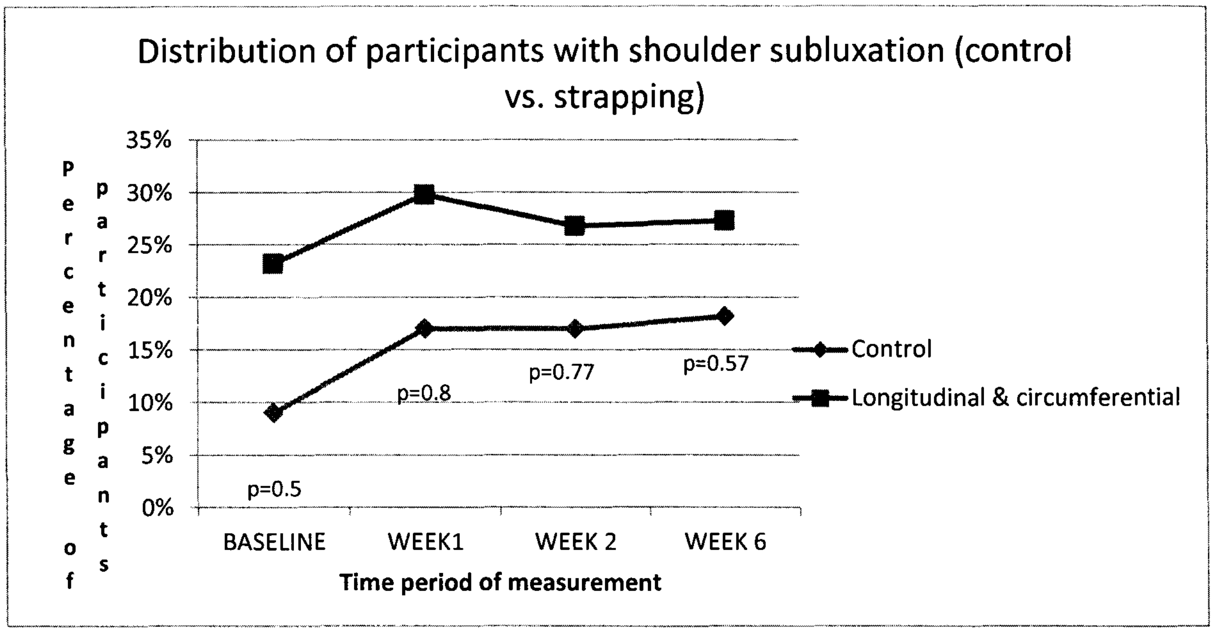

Figure 4.20: Distribution of participants with shoulder subluxation for the study period (control vs. strapping)

The differences between the shoulder subluxation experienced by the control group and that of the strapped groups were not statistically significant.

The distribution of shoulder pain scores for the strapped participants versus the control participants is shown in Table 4.15 below.

Table 4.15: Distribution of the shoulder pain scores for the study period (control vs. strapping)

RITCHIE ARTICULAR INDEX SCORE	GROUP	BASELINE n = 56 n (%)	WEEK1 n=47 n (%)	WEEK 2 n=41 n (%)	WEEK 6 n=33 n (%)
0	Control	10 (17.9)	8 (17.0)	9 (22.0)	7 (21.2)
	Longitudinal and Circumferential	18 (32.1)	17 (36.2)	9 (22.0)	7 (21.2)
1	Control	8 (14.3)	9 (19.1)	6 (14.6)	3 (9.1)
	Longitudinal and Circumferential	9 (16.1)	3 (6.4)	6 (14.6)	1 (3.0)
2	Control	1 (1.8)	1 (2.1)	2 (4.9)	2 (6.1)
	Longitudinal and Circumferential	8 (14.3)	5 (10.6)	7 (17.1)	8 (24.2)
3	Control	0 (0)	0 (0)	0 (0)	3 (9.1)
	Longitudinal and Circumferential	2 (3.6)	4 (8.5)	2 (4.9)	2 (6.1)

The control group experienced an increase in shoulder pain over the study period, while the participants with strapping did not. Although these comparisons generally yielded non-statistically significant differences, there was a statistically significant (p=0.03) difference at week two between the two strapping groups. See Figure 4.21 below for a summary.

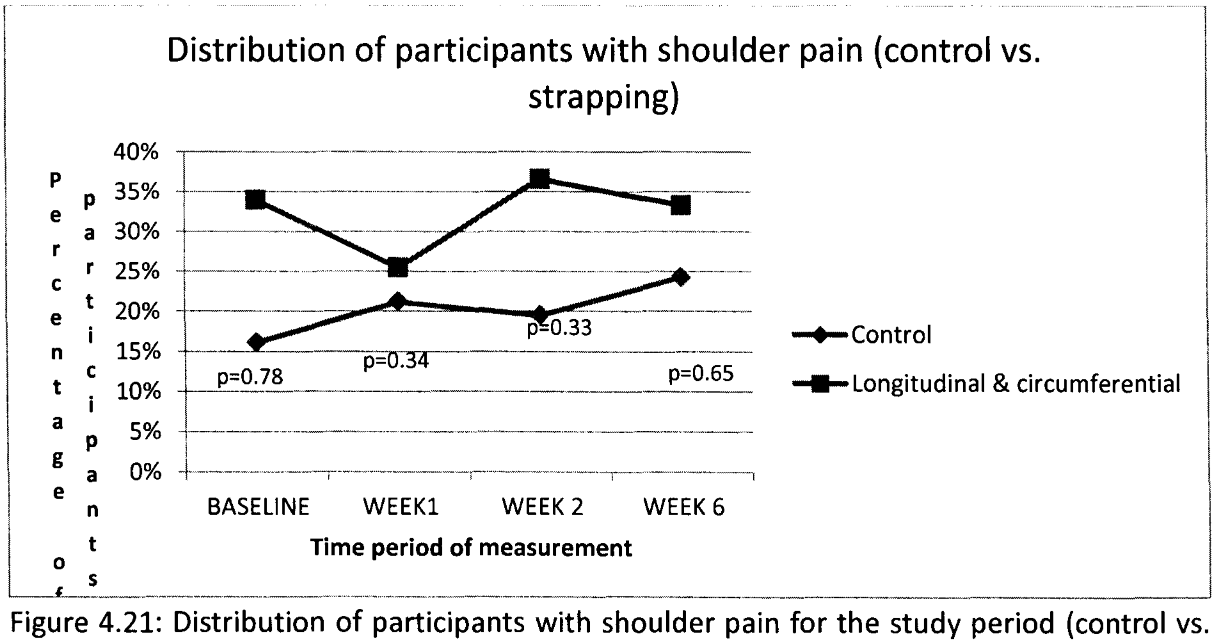

Figure 4.21: Distribution of participants with shoulder pain for the study period (control vs. strapping)

Table 4.16 below shows the distribution of scores for changes in shoulder tone for the strapped groups versus the control group.

Table 4.16: Distribution of the shoulder tone scores for the study period (control vs. strapping)

MODIFIED ASHWORTH SCALE SCORE	GROUP	BASELINE n = 56 n (%)	WEEK1 n=47 n (%)	WEEK 2 n=41 n (%)	WEEK 6 n=33 n (%)
0	Control	17 (30.4)	14 (29.8)	14 (34.1)	13 (39.4)
	Longitudinal and Circumferential	28 (50.0)	18 (38.3)	15 (36.6)	13 (39.4)
1	Control	1 (1.8)	2 (4.3)	0 (0)	0 (0)
	Longitudinal and Circumferential	3 (5.4)	4 (8.5)	2 (4.9)	0 (0)
2	Control	1 (1.8)	1 (2.1)	2 (4.9)	1 (3.0)
	Longitudinal and Circumferential	2 (3.6)	3 (6.4)	3 (7.3)	2 (6.1)
3	Control	0 (0)	1 (2.1)	1 (2.4)	1 (3.0)
	Longitudinal and Circumferential	2 (3.6)	4 (8.5)	4 (9.8)	3 (9.1)
4	Control	0 (0)	0 (0)	0 (0)	0 (0)
	Longitudinal and Circumferential	2 (3.6)	0 (0)	0 (0)	0 (0)
5	Control	0 (0)	0 (0)	0 (0)	0 (0)
	Longitudinal and Circumferential	0 (0)	0 (0)	0 (0)	0 (0)

There was an increase in the distribution of participants in the control group that experienced an increase in tone by the end of the study period and conversely the strapped participants decreased by final assessment. This is depicted in Figure 4.22 below.

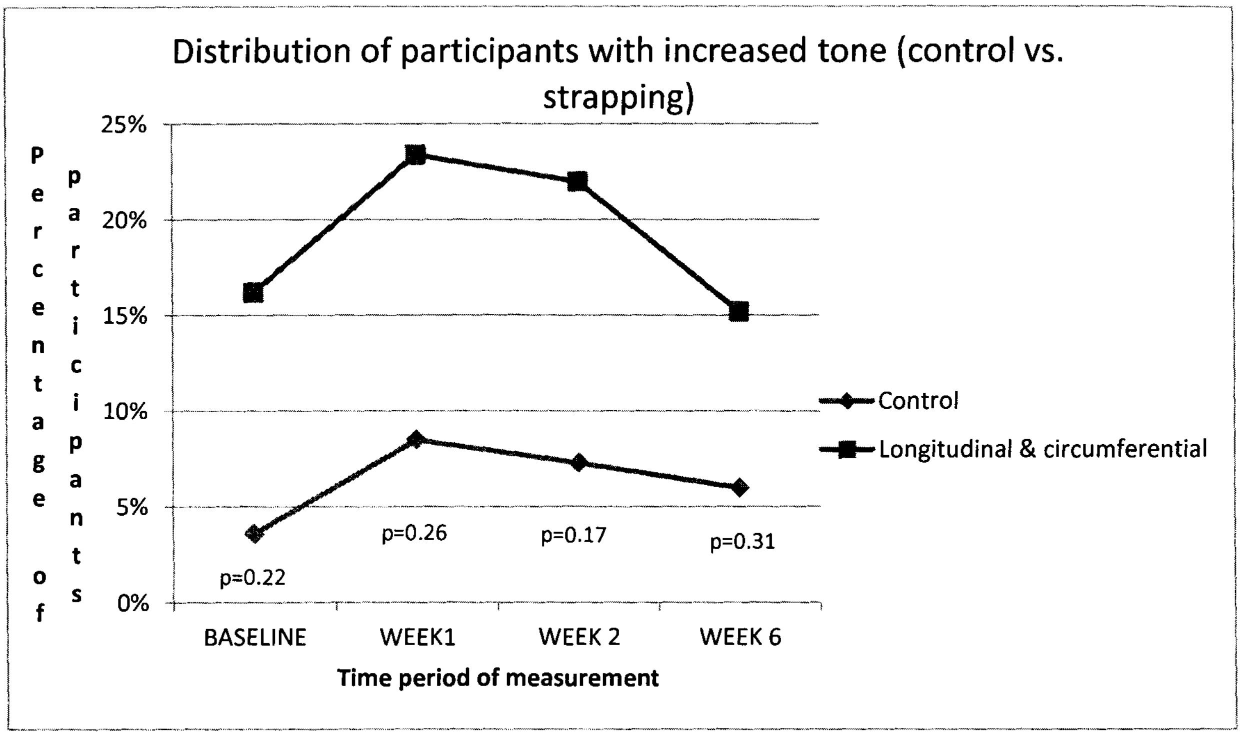

Figure 4.22: Distribution of participants with increased tone for the study period (control vs. strapping)

The differences in the changes between the groups were not statistically significant.

The changes in upper limb motor function for the strapped versus control groups are shown in Table 4.17 below.

Table 4.17: Distribution of upper limb subscale 6, 7 and 8 (of the motor assessment scale) for the study period (control vs. strapping)

TIME SERIES			UPPER LIMB MOTOR FUNCTION SCORES						
			0 n (%)	1 n (%)	2 n (%)	3 n (%)	4 n (%)	5 n (%)	6 n (%)
Baseline (n=56)	Subscale 6	Control	15 (26.8)	2 (3.6)	0 (0)	1 (1.8)	0 (0)	0 (0)	1 (1.8)
		Longitudinal and Circumferential	35 (62.5)	2 (3.6)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	Subscale 7	Control	18 (32.1)	0 (0)	0 (0)	1 (1.8)	0 (0)	0 (0)	0 (0)
		Longitudinal and Circumferential	37 (66.1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	Subscale 8	Control	17 (30.4)	2 (3.6)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
		Longitudinal and Circumferential	37 (66.1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Week 1 (n=47)	Subscale 6	Control	12 (25.5)	0 (0)	1 (2.1)	2 (4.3)	2 (4.3)	0 (0)	1 (2.1)
		Longitudinal and Circumferential	18 (38.3)	8 (17.0)	2 (4.3)	0 (0)	0 (0)	1 (2.1)	0 (0)
	Subscale 7	Control	15 (31.9)	1 (2.1)	0 (0)	1 (2.1)	1 (2.1)	0 (0)	0 (0)
		Longitudinal and Circumferential	28 (59.6)	1 (2.1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	Subscale 8	Control	16 (34.0)	0 (0)	2 (4.3)	0 (0)	0 (0)	0 (0)	0 (0)
		Longitudinal and Circumferential	28 (59.6)	1 (2.1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Week 2 (n=41)	Subscale 6	Control	10 (24.4)	0 (0)	1 (2.4)	0 (0)	1 (2.4)	1 (2.4)	4 (9.8)
		Longitudinal and Circumferential	13 (31.7)	5 (12.2)	1 (2.4)	0 (0)	0 (0)	2 (4.9)	3 (7.3)
	Subscale 7	Control	13 (31.7)	0 (0)	0 (0)	0 (0)	2 (4.9)	1 (2.4)	1 (2.4)
		Longitudinal and Circumferential	20 (48.8)	1 (2.4)	0 (0)	1 (2.4)	0 (0)	2 (4.9)	0 (0)
	Subscale 8	Control	11 (26.8)	3 (7.3)	3 (7.3)	0 (0)	0 (0)	0 (0)	0 (0)
		Longitudinal and Circumferential	21 (51.2)	1 (2.4)	2 (4.9)	0 (0)	0 (0)	0 (0)	0 (0)
Week 6 (n=33)	Subscale 6	Control	7 (21.2)	1 (3.0)	0 (0)	1 (3.0)	0 (0)	0 (0)	6 (18.2)
		Longitudinal and Circumferential	9 (27.3)	5 (15.2)	0 (0)	0 (0)	0 (0)	2 (6.1)	2 (6.1)
	Subscale 7	Control	9 (27.3)	0 (0)	0 (0)	0 (0)	0 (0)	2 (6.1)	4 (12.1)
		Longitudinal and Circumferential	13 (39.4)	2 (6.1)	1 (3.0)	0 (0)	0 (0)	1 (3.0)	1 (3.0)
	Subscale 8	Control	9 (27.3)	1 (3.0)	3 (9.1)	0 (0)	0 (0)	0 (0)	2 (6.1)
		Longitudinal and Circumferential	15 (45.5)	1 (3.0)	1 (3.0)	0 (0)	0 (0)	0 (0)	1 (3.0)

Participants in both the control and strapped groups showed a trend of increased motor function across all three subscales of upper limb function as summarised in Figures 4.23-4.25 below.

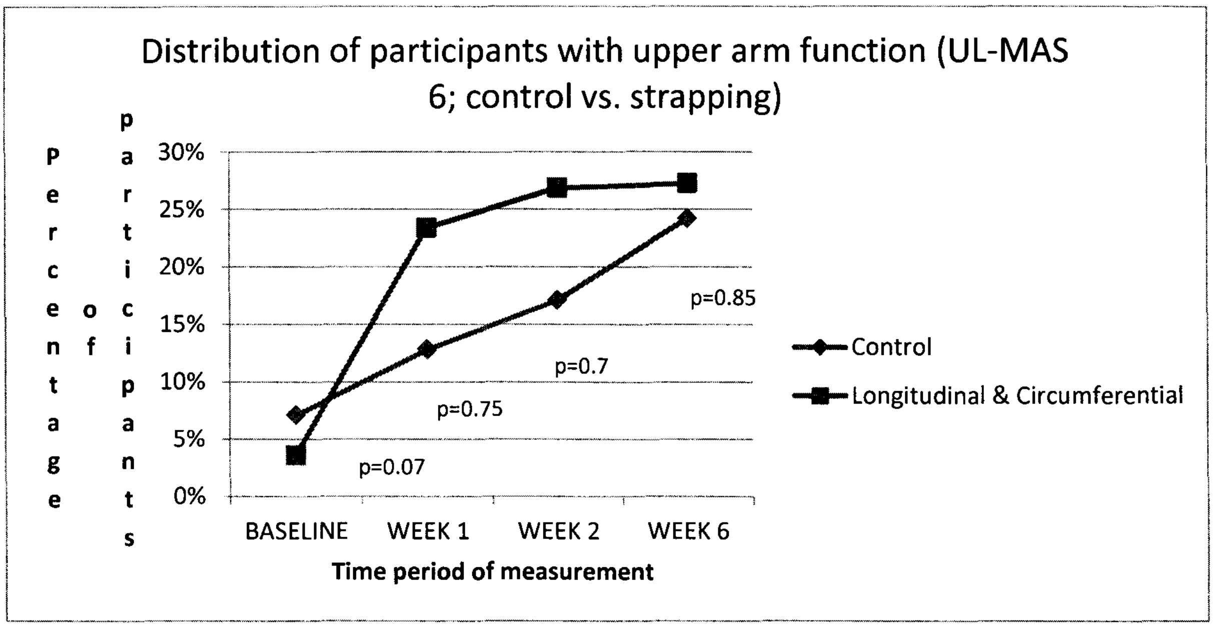

Figure 4.23: Distribution of participants with upper arm function (UL-MAS 6) for the study period (control vs. strapping)

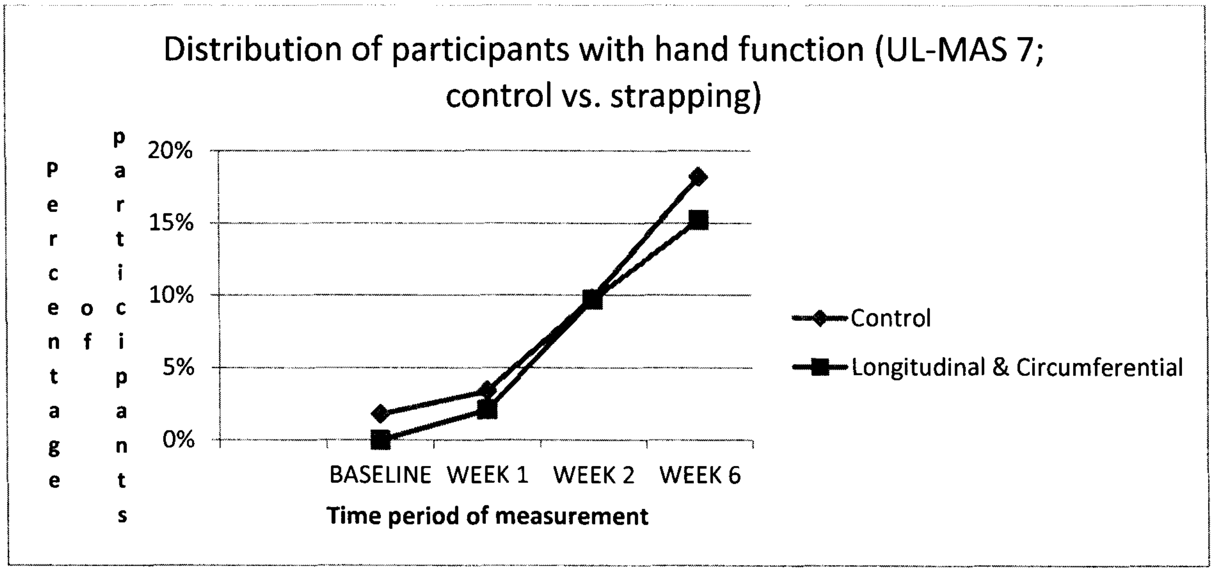

Figure 4.24: Distribution of participants with hand function (UL-MAS 7) for the study period (control vs. strapping)

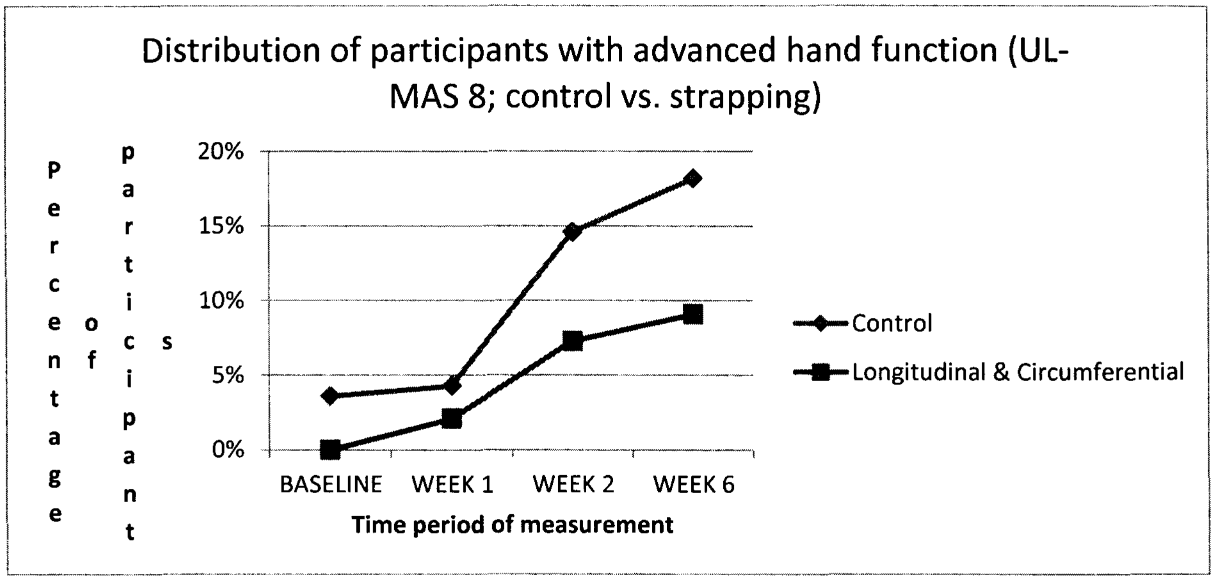

Figure 4.25: Distribution of participants with advanced hand function (UL-MAS 8) for the study period (control vs. strapping)

It should be noted that the final numbers for UL-MAS 7 and 8 were too small to run statistical analysis for the p values at each assessment period, however the overall effect is still reflected on the graph. No significant difference was found between the participants with strapping and the control group with regards upper limb motor function in UL-MAS 6.

4.5 The within group changes for each outcome measure across the study period

Table 4.18 below shows the overall within group changes across the study period for each of the outcome measures. The significant p values are highlighted.

Table 4.18: The overall within group effects for each outcome measure

		P VALUE
SHOULDER SUBLUXATION	Control	0.48
	Longitudinal	0.47
	Circumferential	0.46
SHOULDER PAIN	Control	0.72
	Longitudinal	0.39
	Circumferential	0.75
TONE	Control	0.59
	Longitudinal	0.1
	Circumferential	0.11
UL-MAS 6	Control	**0.02**
	Longitudinal	0.1
	Circumferential	**0.01**
UL-MAS 7	Control	**0.01**
	Longitudinal	0.11
	Circumferential	0.07
UL-MAS 8	Control	**0.01**
	Longitudinal	0.11
	Circumferential	0.39

Table 4.18 above shows that the participants for the control group had a significant change in motor function across all three upper limb outcome measures. The participants in the circumferential group also had significant change in upper arm function.

4.6 The overall between group effects for each outcome measure across the study period

The overall effects of the strapping on shoulder subluxation over time adjusting for groups are shown in Table 4.19 below. The control group was used as the constant variable against which all the other variables were compared.

Table 4.19: The overall effects of strapping on shoulder subluxation over time.

Shoulder subluxation	O.R .	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Circumferential	1.93	1.11	1.22	0.25	0.63	5.95
Longitudinal	1.11	0.66	0.20	0.84	0.39	3.18
Longitudinal & Circumferential	1.41	0.73	0.72	0.47	0.55	3.59
_cons	0.55	0.21	-1.55	0.12	0.26	1.17

There were no significant differences in the odds of participants developing shoulder subluxation over the study period in the various groups when compared to the control group.

The overall effects of strapping on muscle tone over time adjusting for groups are shown in Table 4.20 below. The control group was used as the reference point.

Table 4.20: The overall effects of strapping on muscle tone over time

Muscle Tone	O.R.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Circumferential	1.96	1.35	0.98	0.33	0.51	7.58
Longitudinal	3.26	2.03	1.90	0.06	0.96	11.05
Longitudinal & Circumferential	2.66	1.54	1.70	0.09	0.86	8.25
_cons	0.18	0.09	-3.46	0.001	0.07	0.47

There were no significant differences in the odds of participants developing increased muscle tone over the study period in the various groups when compared to the control group.

The overall effects of strapping over time on upper limb function subscale 6 (UL-MAS 6) is shown in Table 4.21 below. The control group was used as the constant variable against which all the other variables were compared.

Table 4.21: The overall effects of strapping over time on upper limb function (UL-MAS 6)

Upper arm function	O.R.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Circumferential	1.24	0.72	0.37	0.71	0.39	3.89
Longitudinal	0.44	0.26	-1.37	0.17	0.13	1.42
Longitudinal & Circumferential	0.71	0.36	0.67	0.50	0.27	1.92
_cons	0.54	0.21	-1.56	0.12	0.25	1.17

There were no significant differences in the odds of participants improving upper limb motor function for subscale 6 over the study period in the various groups when compared to the control group.

The overall effects of strapping over time on upper limb function subscale 7 (UL-MAS 7) is shown in Table 4.22 below. The control group was used as the constant variable against which all the other variables were compared.

Table 4.22: The overall effects of strapping over time on upper limb function (UL-MAS 7)

Hand movements	O.R.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Circumferential	0.45	0.33	-1.10	0.27	0.11	1.86
Longitudinal	0.32	0.23	-1.58	0.11	0.08	1.31
Longitudinal & Circumferential	0.38	0.22	-1.70	0.09	0.12	1.16
_cons	0.25	0.10	-3.53	0.000	0.12	0.54

There were no significant differences in the odds of participants improving upper limb motor function for subscale 7 over the study period in the various groups when compared to the control group.

The overall effects of strapping over time on upper limb function subscale 8 (UL-MAS 8) is shown in Table 4.23 below. The control group was used as the constant variable against which all the other variables were compared.

Table 4.23: The overall effects of strapping over time on upper limb function (UL-MAS 8)

Advanced hand activities	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Circumferential	0.17	0.17	-1.76	0.08	0.02	1.22
Longitudinal	0.28	0.21	-1.70	0.09	0.06	1.22
Longitudinal & Circumferential	0.23	0.155	-2.19	**0.03**	0.06	0.86
_cons	0.28	0.12	-3.11	0.002	0.13	0.63

In general the strapped group (combined strapping) had better odds of having improved upper limb function scores for subscale 8 than the control group.

4.7 Summary of results

Table 4.24 below shows a summary of the trend that was observed in each group over time.

Table 4.24: Trends observed across the study period for increases (↑) or decreases (↓) in outcome measures for all groups

	SHOULDER SUBLUXATION	SHOULDER PAIN	TONE	MOTOR FUNCTION
CONTROL	↑	↑	↑	↑
LONGITUDINAL	↓	↓ (slight)	↑	↑
CIRCUMFERENTIAL	↑	↑ (slight)	↓	↑
LONGITUDINAL AND CIRCUMFERENTIAL	↑	↓	↓	↑

CHAPTER 5

5. DISCUSSION

5.1 Introduction

This chapter addresses the objectives of this study with a discussion around the interpretation of the results and their implications. The results will also be compared to similar studies and the study's limitation/s will be addressed via a discussion on the sample size.

5.2 The effects of the longitudinal strapping technique on hemiplegic shoulder pain, tone, subluxation and motor function in patients with stroke.

Although the longitudinal strapping technique had no statistically significant effect on the participant's shoulder pain, tone, subluxation and motor function compared to those in the control group, changes to the individual outcome measures will be discussed below.

The number of participants who had shoulder subluxation in the group that received longitudinal strapping declined over time (from 13% at baseline to 9% at six weeks), while the number of participants in the control group who experienced shoulder subluxation doubled from baseline to six weeks (9% to 18%). If one considers the cephalad tension applied in the longitudinal method, it makes clinical sense that the strapped participants were less likely to develop a shoulder subluxation. Of interest one should note that the decrease in shoulder subluxation was maintained over time after the strapping had been removed (i.e. from week two to week six) whereas the participants in the control group continued to increase in number of shoulder subluxations.

Although, after six weeks, the end difference in the numbers between the two groups was not statistically significant ($p=0.74$) it still goes to show that a person post stroke is at an increased risk of shoulder subluxation, especially if the shoulder is left unstrapped. This leaves one to consider the option of prophylactically strapping the shoulder post stroke, at least until motor function begins to return and the patient is at less risk of shoulder subluxation as research has shown that lower levels of function correlate with higher incidence of subluxation (Suethanapornkul et al., 2008).

Regardless of receiving longitudinal strapping or not, participants' upper limb tone tended to increase over time with no significant difference between the groups (p=0.09) at week 6. This shows that longitudinal strapping plays no role in preventing increased upper limb tone post stroke. One would not necessarily expect to see strapping inhibit tone changes post stroke as there is no clinical explanation behind it. The only role perhaps that strapping could be attributed with is in decreasing pain (which is described in the discussion below) which in turn could influence tone positively.

Unfortunately one is unable to compare the above results for shoulder subluxation and tone as no other published studies have been found that show the effects of longitudinal strapping on changes in tone or subluxation. This thus emphasises the importance of the findings of this study in adding to the pool of knowledge of the clinical presentation of patients post stroke and the use of strapping in their management.

With regards to the effect of longitudinal strapping on shoulder pain post stroke, this study found that there was a slight decrease in the number of participants with shoulder pain in the longitudinal group (from 16% to 15% baseline to week six respectively) compared to the control group who increased from 16% to 24% at the end of the study period. One would expect the rise in shoulder pain post stroke as exhibited by the control group as a trend of increased shoulder pain over time is supported by many studies (Suethanapornkul et al., 2008; Lindgren et al., 2007; Ratnasabapathy et al., 2003; Gamble et al., 2002). Although the decrease in pain in the intervention group is a minimal change, it showed that strapping may have a role in decreasing (or at best keeping constant) shoulder pain following a stroke.
One is left to consider the reasons as to why strapping could affect shoulder pain post stroke. Although there is inconclusive literature on the link between shoulder subluxation and shoulder pain (Ada et al., 2009; Kumar and Swinkels, 2009; Suethanapornkul et al., 2008; Teasell et al., 2006; Foongchomcheay et al., 2005; Zorowitz, 2001) one could consider the decrease in shoulder subluxation in the strapped participants to be a potential cause of the decreased pain.

Furthermore, the strapping may have affected the shoulder pain by creating awareness of the area causing less mishandling of the limb by caregivers. It should be noted that in other strapping randomised control trials studies (Pandian et al., 2013; Griffin and Bernhardt, 2006; McCulloch 2002) there were groups with placebo strapping. It has been suggested that strapping could work by creating awareness of the affected limb thus causing caregivers and involved persons to handle it with more care (Ancliffe, 1992). However, McCulloch (2002) compared the results of placebo strapping to a control group with no strapping and found that there was no significant difference in the participants' pain showing that there was no placebo or visual cuing playing a role in shoulder management post stroke. This was further validated by the fact that the third group, the experimental group, had an improvement in pain compared to the placebo group. This is in contrast to what Griffin and Bernhardt (2006) found whereby the number of pain free days was delayed further in the intervention group than in placebo group showing a difference between those participants strapped effectively and those strapped with no tension. Despite different findings between authors, one cannot fully dismiss the proposal that strapping can be a visual reminder to handle the limb with more care and thus decrease the likelihood of shoulder pain.

It is expected that with time motor function begins to improve in the upper limb post stroke due to natural recovery (Newman, 1972) and this was encountered when both groups showed an improvement in motor function across the study period. Across the three subscales, the control group showed a significant recovery (within group analysis) while none were observed for the longitudinal strapping group. This result is unexpected because the longitudinal group had more positive scores for shoulder subluxation and pain than the control participants and one would expect a greater functional improvement. However, the difference in improvements was not statistically significant and one can assume that this trend was an anomaly.

This study showed a trend in improvement in shoulder pain and in motor function. This trend was also found in a study of 162 acute stroke patients where longitudinal strapping was ineffective in significantly reducing shoulder pain and dysfunction post stroke, although it was noted that a trend to improvement was observed in the experimental group (Pandian et al., 2013).

The study of Pandian et al. (2013) is the only published randomised control trial for longitudinal strapping to be found (other literature merely gives descriptions of the strapping technique and/or case study results (Peters and Lee, 2003; Kneeshaw, 2002; Morrissey 2000). Unpublished data from a research report suggest that longitudinal strapping can significantly reduce shoulder pain post stroke, however, this study had a small sample size (n=39 across three groups) with no indication of how the sample size was derived (McCulloch, 2002).

In conclusion, previous studies have found longitudinal strapping to decrease shoulder pain (Pandian et al., 2013; McCulloch, 2002) and improve motor function (Pandian et al., 2013) as was found in this study. Furthermore, this study showed longitudinal strapping has a role to play in limiting shoulder subluxation. Although the results do not show a statistically significant change in the outcomes, there is enough clinical evidence to suggest that longitudinal strapping of the hemiplegic shoulder may be used in the rehabilitation of the upper limb post stroke. Due to the fact that the rehabilitation of the upper limb is a challenging area this finding provides the therapist with another option of treatment and is thus of clinical value.

5.3 The effects of the circumferential strapping technique on hemiplegic shoulder pain, tone, subluxation and motor function in patients with stroke.

In addition to the longitudinal strapping, this study investigated the effects of circumferential strapping on the shoulder post stroke. The circumferential strapping had no significant effect on the between group differences for motor function after six weeks, although the clinically expected trend in improvement was observed, as was for the longitudinal group. The within group change for UL-MAS 6 reached statistical significance (p=0.01) showing that the circumferential strapping was clinically effective in improving upper arm function post stroke.

As shown in the literature the circumferential strapping technique was described in two other studies, one of which also investigated the effect on upper limb motor function and found that the strapping had no significant results for improvement in motor function (Griffin and Bernhardt, 2006). As with the longitudinal strapping technique, the control group showed improvement in motor function and none were observed for the circumferential group (within group analysis). The participants in the circumferential strapping group had an increase in number of participants with shoulder subluxation and pain and thus one would expect an impact on motor improvement.

With regards to the effect of the circumferential strapping technique on shoulder pain, there was no significant difference between the groups at six weeks (p=0.52), however, the participants with the strapping had a relatively constant occurrence of shoulder pain (18% across the six weeks) compared to the control group participants whose shoulder pain rose from 16% to 24% by the final assessment. In both of the previously mentioned studies the circumferential strapping resulted in a significant delay in the onset of shoulder pain post stroke (Griffin and Bernhardt, 2006; Ancliffe, 1992). As postulated for the longitudinal strapping technique, one could attribute the effect of strapping on shoulder pain to the increased awareness of the affected limb leading to more careful handling by the caregivers. It could also be considered that the strapping provided cutaneous stimulation through the large fibers (c fibers) which would be introducing a competing sensation to pain and hence the perception that pain has decreased (Melzack and Wall, 1965).

Participants in both the control and circumferential strapping groups showed an increase in the number of people with shoulder subluxation from baseline to final assessment (9% to 18% and 11% to 18% respectively with no statistical significance between the groups, (p=0.21). This showed that the circumferential technique was ineffective in preventing shoulder subluxation post stroke. When looking at the method of applying the circumferential strapping one sees that very little anti-gravity tension is given thus clinically one would not expect to see the circumferential strapping having a positive effect on shoulder subluxation.

The participants with circumferential strapping who had increased muscle tone decreased over time (5% to 3%) as opposed to the control participants who increased in numbers (4% to 6%). This improvement exhibited by the intervention group may be attributed to them not experiencing increased shoulder pain, although the changes between the two groups did not have statistical significance (p=0.87) and one cannot categorically state that circumferential strapping prevented an increase in upper limb tone post stroke.

Thus, in conclusion, circumferential strapping had no significant effect on any of the outcomes compared to the control group, however, it seemed to positively influence shoulder pain more than in the control participants, and had no positive effect on shoulder subluxation post stroke. Furthermore, circumferential strapping caused a significant improvement for upper arm function (UL-MAS 6).

5.4 A comparison of the circumferential versus longitudinal strapping techniques on hemiplegic shoulder pain, tone, subluxation and motor function in patients with stroke.

When comparing the results of each intervention group against each other there was no statistically significant difference between the two groups. However, the following was observed: the number of participants with shoulder subluxation and shoulder pain among those strapped with the longitudinal technique improved marginally from 13% to 9% and 16% to 15% (respectively), with p=0.16 and 0.63 at the week six follow up. The potential reasons for this improvement stand as discussed in section 5.2.

While both groups had an improvement in motor function, less participants with circumferential strapping had an increase in tone (from 5% to 3% with p=0.11 at six weeks) by the end of the study, compared to the longitudinal group who showed a slight increase (11% to 12%). Since there is no clear clinical link for how strapping would influence tone, one cannot attribute specific reasons as to why these outcomes arose, especially as the changes were not statistically significant.

Although not part of this study, it was noted that the research assistants found the longitudinal technique easier to apply and that it was less time intensive than the circumferential technique. Additionally, the circumferential technique required padding material (over and above the strapping) and this was a further resource and cost.. These are inconsequential considerations if the circumferential technique had been found to be far superior in its results compared to the longitudinal technique. However, it was not and thus the longitudinal technique, with its positive effect on shoulder subluxation and pain, would appear to be the preferred method of the two.

5.5 The combined effects of the longitudinal and circumferential strapping techniques on hemiplegic shoulder pain, tone, subluxation and motor function in patients with stroke.

Due to the smaller sample size than originally planned the results were combined for the two intervention groups to see if strapping in general had an effect on shoulder pain, tone, subluxation and motor function post stroke.

The results showed that shoulder subluxation increased for both the strapped and control participants across the study period (from 23%-27% and 9%-18% respectively) but with no significant difference between the groups by the end of the study (p=0.57). This could be because post stroke (and the subsequent paralysis) shoulder stability is compromised, allowing gravity to pull the head of the humerus inferiorly, which then stretches the capsule and causes shoulder subluxation (Ada and Foongchomcheay, 2002). It is, therefore, possible that shoulder strapping did not improve shoulder stability and hence the increase in the number of participants who had shoulder subluxation in all the groups.

With regards to increase in muscle tone: either type of strapping resulted in marginally fewer participants with increased tone at the end of the study (16% to 15%), as well as an improvement in motor function (as would be expected as this occurred across all three groups). Possible reasons for this finding have already been discussed above.

The strapped participants' distribution of shoulder pain showed a minor decrease from 34% to 33%. However, shoulder pain in the control group increased noticeably over the study period (16% to 24%). Although the final difference between the groups was not statistically significant (p=0.65) this shows that shoulder strapping might have a role in the prevention of shoulder pain post stroke.

5.6 Demographic details and study sample

Once data collection began it became apparent to the researcher that finding participants who met the inclusion criteria was a challenge. The patients were required to have hemiplegia but were excluded for receptive aphasia or any significant visual, perceptual or cognitive problems. Combining these inclusion and exclusion criteria considerably diminished the availability of participants. Similarly, Appel et al. (2011) found that targeting such a specific population resulted in only recruiting 10% of stroke admissions for their study on shoulder strapping.

Despite increasing the catchment area for participants by expanding to surrounding hospitals it took over three years to include 56 participants. At this point, the decision was taken to cease with the data collection phase.

Figure 4.1 shows that of the 56 participants only 33 reached final assessment. The two main reasons for loss of participants were morbidity (16% of 56 participants) and loss to follow up (18% of 56 participants). The high morbidity rate was on par with previous results found in a Johannesburg hospital in patients with stroke, whereby 26% of patients with stroke died within three months post discharge (Mudzi et al., 2012).

The loss to follow up was mainly due to participant transport problems as the majority of the participants used public transport which was costly and difficult to access within the province, especially post stroke. Of those lost to follow up, many participants left Johannesburg to join family who would be able to care for them. The researcher acquired funding where possible to help with the cost of transport and often travelled herself to access participants, however some remained inaccessible and thus were unable to complete the full study period.

Although the sample size was far above that which was originally calculated the final amount of participants still leaves an overall small sample size making generalisation to the entire stroke population difficult. Although there is this limitation to the study, the clinical implications and recommendations are worth considering and shall be discussed below.

CHAPTER 6

6. CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter presents the conclusion for the overall study and recommendations are proposed for clinical practice and future research in the area of shoulder strapping post stroke.

6.2 Conclusion

Longitudinal strapping showed a trend in decreasing shoulder subluxation post stroke and lessening the risk thereof compared to participants who did not receive strapping. Similar results were found for shoulder pain post stroke, with the control participants showing greater shoulder pain post stroke than those receiving longitudinal strapping. Longitudinal strapping did not markedly influence motor function and furthermore, it had no positive effect on changes in tone in the upper limb post stroke.

Similarly, between group changes in motor function did not appear to be strongly influenced by circumferential strapping, but of note was the exception of the within group improvement in upper arm function. Those receiving circumferential strapping were at a lower risk of increased shoulder pain across the six weeks. This decreased risk of shoulder pain may have positively affected tone as there was a slight decrease in shoulder tone in the intervention group after six weeks. As expected clinically from the application technique, circumferential strapping was unsuccessful in preventing shoulder subluxation.

When weighing one type of strapping up against another, the longitudinal technique positively influenced shoulder subluxation and should pain (slightly) and was reported to be more therapist and resource friendly. These factors make it the more practical option.

Overall, the study showed trends in changes in the shoulder post stroke but no significant differences were found between the groups in any of the outcomes, even when both intervention groups were combined and analysed against the control participants.

Although the study produced overall results that did not have statistical significance one cannot discredit the use of the strapping. Even if strapping had purely a placebo effect it would still serve a purpose by creating awareness in the patient, caregivers and medical personal and thus ensure more cautious handling of the affected upper limb.

Thus, when rehabilitating the shoulder post stroke, there appears to be enough clinical evidence to suggest that strapping, more precisely longitudinal strapping, of the hemiplegic shoulder may be used.

6.3 Recommendations

6.3.1 Clinical recommendations

Due to the lack of statistically significant differences found between the groups one cannot categorically state if one type of strapping is superior to another (or to any at all) when managing the upper limb of patients with stroke. However, the results suggest clinically that the longitudinal technique could possibly decrease the likelihood of shoulder subluxation and shoulder pain post stroke.

The longitudinal technique requires less material and in a poverty-struck country such as South Africa this is a key factor. Furthermore, it was reported by the research assistant that the longitudinal strapping was more therapist-friendly than the circumferential technique.

Taking all of these factors into consideration it would be the recommendation of the researcher that the longitudinal technique of strapping may be utilised when managing the upper limb of patients post stroke, especially those at greater risk of shoulder pain or subluxation due to poor sensory and/or motor function.

6.3.2 Recommendations for further research

The recommendations made from this study for future research would be to:

- include placebo strapping in the control group;
- factor in the time and distance required to collect a larger sample size;
- compare the outcome measures for participants strapped with the longitudinal technique using Leukotape P® versus kinesio tape
- administer a questionnaire to clinicians to ascertain preferred methods of shoulder taping used clinically.
- Decentralize the study and use a multi-centred approach

CHAPTER 7

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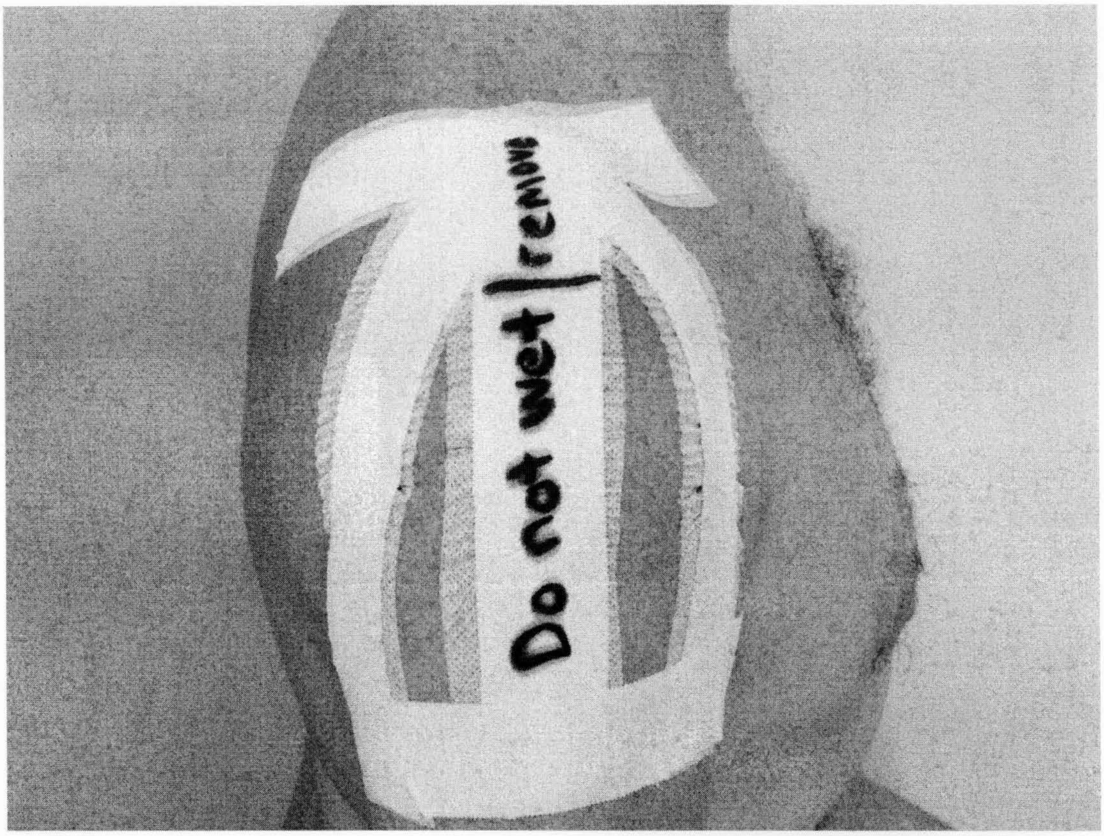
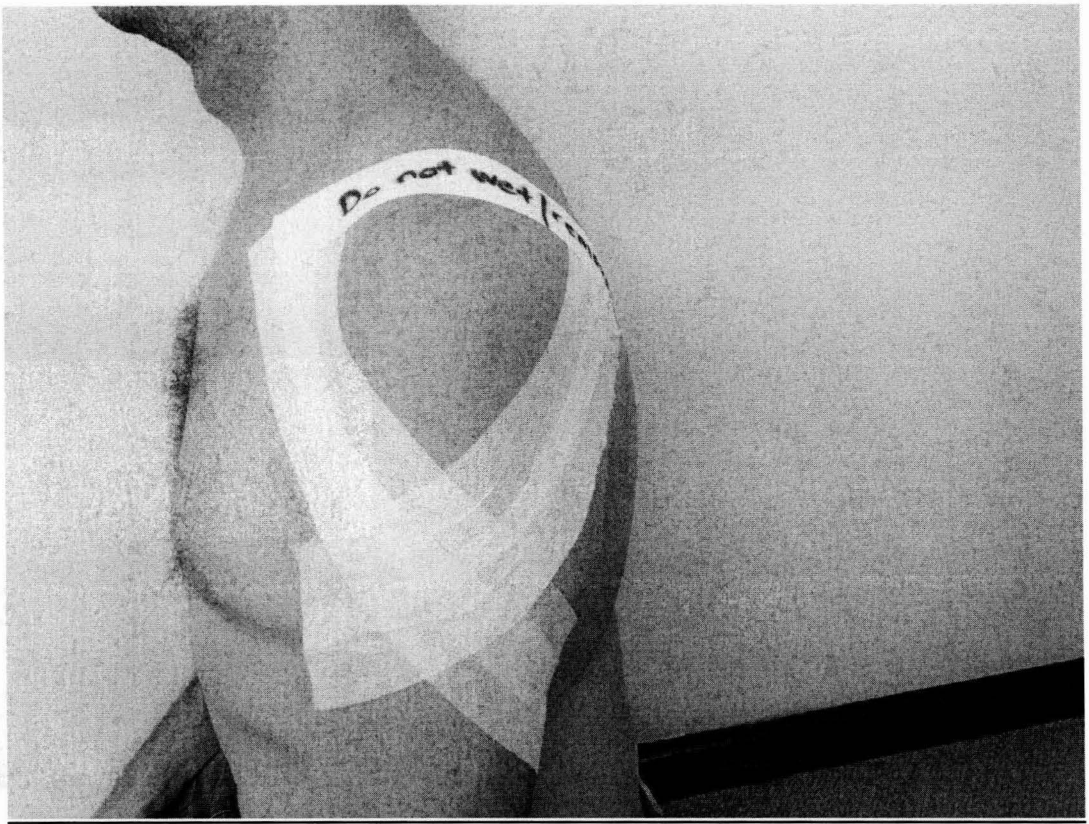
APPENDIX A

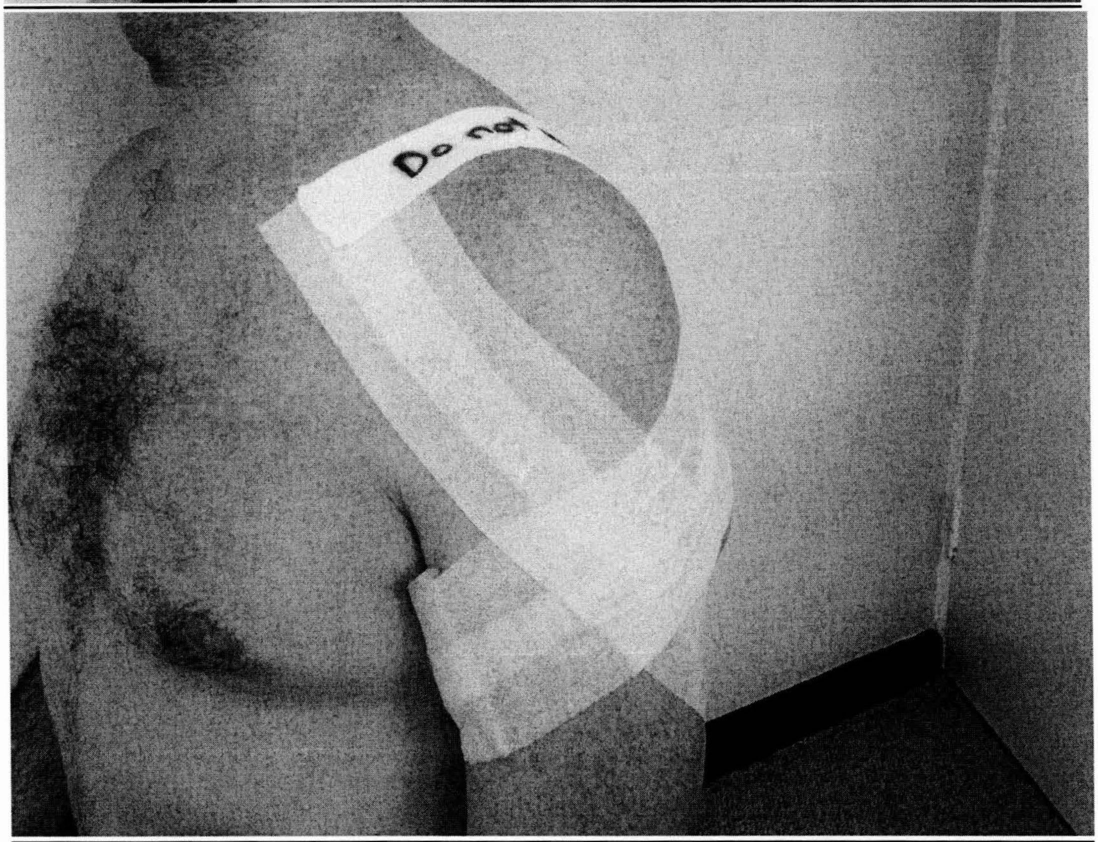
LONGITUDINAL STRAPPING



APPENDIX B

CIRCUMFERENTIAL STRAPPING





APPENDIX C

MOTOR ASSESSMENT SCALE- Upper Limb Subscale

UL-MAS 6: Upper-Arm Function

1. Lying, protract shoulder girdle with arm in elevation. (Therapist places arm in position and supports it with elbow in extension.)
2. Lying, hold extended arm in elevation for 2 seconds. (Physical therapist should place arm in position and patient must maintain position with some external rotation. Elbow must be held within 20° of full extension.)
3. Flexion and extension of elbow to take palm to forehead with arm as in 2. (Therapist may assist supination of forearm.)
4. Sitting, hold extended arm in forward flexion at 90 degrees to body for 2 seconds. (Therapist should place arm in position and patient must maintain position with some external rotation and elbow extension. Do not allow excess shoulder elevation.)
5. Sitting, patient lifts arm to above position, holds it there for 10 seconds, and then lowers it. (Patient must maintain position with some external rotation. Do not allow pronation.)
6. Standing, hand against wall. Maintain arm position while turning body toward wall. (Have arm abducted to 90° with palm flat against the wall.)

UL-MAS 7: Hand Movements

1. Sitting, extension of wrist. (Therapist should have patient sitting at a table with forearm resting on the table. Therapist places cylindrical object in palm of patient's hand. Patient is asked to lift object off the table by extending the wrist. Do not allow elbow flexion.)
2. Sitting, radial deviation of wrist. (Therapist should place forearm in midpronation-supination, i.e., resting on ulnar side, thumb in line with forearm and wrist in extension, fingers around a cylindrical object. Patient is asked to lift hand off table. Do not allow elbow flexion or pronation.)
3. Sitting, elbow into side, pronation and supination. (Elbow unsupported and at a right

angle. Three-quarter range is acceptable.)

4. Reach forward, pick up large ball of 14-cm (5-in) diameter with both hands and put it down. (Ball should be on table so far in front of patient that he has to extend arms fully to reach it. Shoulders must be protracted, elbows extended, wrist neutral or extended. Palms should be kept in contact with the ball.)
5. Pick up a polystyrene cup from table and put it on table across other side of body. (Do not allow alteration in shape of cup.)
6. Continuous opposition of thumb and each finger more than 14 times in 10 seconds. (Each finger in turn taps the thumb, starting with index finger. Do not allow thumb to slide from one finger to the other, or to go backwards.)

<u>UL-MAS 8: Advanced Hand Activities</u>

1. Picking up the top of a pen and putting it down again. (Patient stretches arm forward, picks up pen top, releases it on table close to body.)
2. Picking up one jellybean from a cup and placing it in another cup. (Teacup contains eight jellybeans. Both cups must be at arms' length. Left hand takes jellybean from cup on right and releases it in cup on left.)
3. Drawing horizontal lines to stop at a vertical line 10 times in 20 seconds. (At least five lines must touch and stop at the vertical line.)
4. Holding a pencil, making rapid consecutive dots on a sheet of paper. (Patient must do at least 2 dots a second for 5 seconds. Patient picks pencil up and positions it without assistance. Patient must hold pen as for writing. Patient must make a dot not a stroke.)
5. Taking a dessert spoon of liquid to the mouth. (Do not allow head to lower towards spoon. Do not allow liquid to spill.)
6. Holding a comb and combing hair at back of head.

In order to perform the UL-MAS accordingly the following items are required:

- Cylindrical object (for this study a deodorant can will be used)
- Large ball of 14 centimetres diameter

- Table
- Seating area (for this study the plinth in the physiotherapy gym will be used)
- Polystyrene cup
- Pen lid
- 8 jellybeans
- Piece of paper with a vertical line (see following page)
- Pencil
- Plain sheet of paper
- Dessert spoon of liquid
- Hair comb

Carr et al. (1985)

APPENDIX D

DATA COLLECTION FORM

Patient code:

1) Demographic Data

1. Patient's age:
2. Patient's gender:
3. Date of stroke:
4. Side of lesion:

2) Outcome Measures

	Baseline Assessment	**Week 1 Assessment**	**Week 2 Assessment**	**Week 6 Assessment**
Date				
Shoulder Subluxation				
Ritchie Articular Index				
Modified Ashworth Scale				
UL-MAS 6				
UL-MAS 7				
UL-MAS 8				
Hrs/week of upper limb therapy				
Other				

APPENDIX E

PATIENT DETAILS FORM

Patient Details

Name	
Surname	
Date of Birth	
Hospital Number	
Patient Code	
Contact number 1	
Contact number 2	
Area of residence	
Caregiver's name	
Caregiver's relationship	

APPENDIX F

ETHICS CLEARANCE CERTIFICATE

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Mrs Nicolette Comley-White

CLEARANCE CERTIFICATE	**M10903**
PROJECT	A Comparison of Two Shoulder Strapping Techniques in Patients with Stroke
INVESTIGATORS	Mrs Nicolette Comley-White.
DEPARTMENT	Department of Physiotherapy
DATE CONSIDERED	01/10/2010
DECISION OF THE COMMITTEE*	Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 01/10/2010 **CHAIRPERSON** ....
(Professor PE Cleaton-Jones)

*Guidelines for written 'informed consent' attached where applicable
cc: Supervisor : Dr W Mudzi

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES...

APPENDIX G

ALLIED HEALTH CARE WORKER'S NOTIFICATION LETTER

Staff Letter

To the physiotherapy and occupational therapy staff of Helen Joseph Hospital,

I, Nicolette Comley-White, am doing my physiotherapy Masters dissertation in a comparison of two shoulder strapping techniques in patients with stroke. I will be looking at the effects of shoulder strapping on pain, tone, subluxation and motor function in patients with stroke.

In order to do this, I require patients who meet the following inclusion criteria:

- Patients admitted to Helen Joseph Hospital with a diagnosis of stroke that occurred less than 14 days prior.
- Patients with stroke presenting with hemiplegia.

Patients will be excluded for the following:

- Previous osteopathic or neurological disorders or injury to the shoulder.
- Medical instability preventing the patient from being able to be transferred from the ward to the physiotherapy gym for assessment.
- Unable to participate in the Motor Assessment Scale- Upper Limb Subscale due to:
  - Decreased level of consciousness
  - Receptive aphasia
  - Significant visual, perceptual or cognitive problems
- Patients with a co-morbidity of depression

When you receive a doctor's referral for a patient that meets these criteria, I would appreciate it if you could let me know as soon as possible. Please see below for my contact details.

Thank you,

Nicolette Comley-White

011 489 0336
082 393 0834
nixecw@gmail.com

APPENDIX H

INFORMATION LETTER

Patient Information Sheet

A comparison of two shoulder strapping techniques in patients with stroke.

Hello, my name is Nicolette Comley-White and I am a Physiotherapy Masters student. For my Masters I am doing research on what the effects are of two different types of shoulder strapping on patients with stroke. Research is just a way of finding the answer to a question. In this study I want to learn if there are any changes in the shoulder of patients with stroke when they are strapped in one of two different ways.

I am inviting you to be a part of this research. What you will be asked to do is to come to the physiotherapy gym (I will help you to do this). In the gym I will examine your shoulder and ask you to do a few, brief activities. This should take about 45 minutes. Some parts of it may cause some discomfort. For example, if you have pain in your shoulder, the examination may aggravate this pain briefly.

Depending on which group you are put into, your shoulder will either be strapped or perhaps not at all. To have your shoulder strapped means that another physiotherapist will put some sticky bandage around the shoulder. When we take the strapping off, the skin may tingle a bit but it soon goes away. The strapping may make your skin itchy, in which case we will remove it and you can stop being part of the study.

You will be asked to do the assessment again after one week, and then once more a week later. The strapping will be changed every 2 to 3 days, but after 2 weeks it is removed completely. After a total of 6 weeks from today, you will be asked to come back to the hospital to have the last assessment. If you are sent home before the first 2 weeks are over then you will be asked to come back to the hospital for the strapping and assessment. When you return to the hospital for the study, the same amount of time will be required from you as when you were still sleeping at the hospital, that is, about 10 minutes for the strapping and about 45 minutes for the assessment. When you are asked to come back to the hospital, I will give you R40 to pay for transport.

Although you won't benefit from this study, the results will be able to assist other therapists in whether or not to strap future patients' shoulders, and which strapping method to use.

Participation in this study is completely voluntary and if you refuse to be a part of it you will not be treated any differently from what you were before the study. If during the study you decide to stop being a part of it, you are free to withdraw with no negative consequences. The information from this study is confidential and I will not share it with anyone without your permission.

If you would like to contact me at any time, you can reach me on 011 489 0336 or 082 393 0834. If you have any complaints that you want to report, you can contact Prof. Cleaton-Jones (Chairman on the Research Ethics Committee) on 011 717 1234.

Thank you,

Mrs Nicolette Comley-White

011 489 0336

082 393 0834

APPENDIX I

CONSENT FORM

Informed Consent

Patient Code:

I, the patient, have been fully informed of what is involved in the study, what is expected of me, the time frames involved and the potential discomfort. I have read the information sheet and have had the opportunity to receive answers to my questions. I understand that being involved in this study is voluntary and that I can leave it at any time. By signing this consent I agree to participate in the study.

Name of Patient: ____________________________

Signature of Patient: _________________________

Date: ________________

APPENDIX J

TURN-IT-IN REPORT

Turnitin Originality Report
NComleyWhitethesisforturnitin.docx by Nicolette Comley-White
From Research Reports
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http://www.ebrsr.com/uploads/Module-11_hemiplegic-shoulder.pdf

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http://www.jneuroengrehab.com/content/pdf/1743-0003-4-45.pdf

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