The inter-examiner reliability and comparison of motion palpation findings of the knee joint in patellofemoral pain syndrome and asymptomatic knee joints.

By

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I, Claire Farrimond, do declare that this dissertation is representative of my own work in both conception and execution.

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DEDICATION

This work is dedicated to my Mom and Dad. Thank you for your unconditional love and support throughout the years.

To my husband, Shane, thank you for your love, friendship and encouragement, and for always being able to see the small rowing boat on the horizon.

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ABSTRACT

Background

Motion palpation is used to assess the functional status of a joint and is defined as “The manual palpation of bony structures and soft tissues, through pressure applied in various directions of joint motion to ascertain areas of joint hypomobility and hypermobility.” Motion palpation is a collection of manual examination procedures, used to identify the site and characteristics of altered joint motion and which has been an important part of chiropractic since its inception.

One of the most important goals for any clinical instrument is for it to have good reliability and reproducibility, this is because the clinical value of a test must be demonstrated before the results are considered valid. The extent to which a repeated test will produce the same result when evaluating an unchanged characteristic is its reliability. Reliability is evaluated by multiple blinded measurements performed on a sample of subjects. Inter-examiner reliability evaluates the consistency of different examiners and is determined through repeated assessment by two or more raters.

Objective

The aim of this study was to determine the inter-examiner reliability of motion palpation of knee joints with patellofemoral pain syndrome and asymptomatic knee joints, and to compare the inter-examiner reliability of motion palpation between the two groups.

Method

This quantitative, inter-examiner, clinical reliability study, included 30 patients each with one knee with patellofemoral pain syndrome and one asymptomatic knee. Each patient had both of their knees motion palpated by three independent examiners blinded to which was the symptomatic knee. The examiners were senior student interns at the DUT Chiropractic Clinic.

The motion palpation findings were recorded and statistically analyzed through the SPSS statistical package. Fleiss Kappa statistic was used to give a Kappa score for each direction of motion palpation and these scores evaluated the inter-examiner reliability of motion palpation in the symptomatic and the asymptomatic knee. A comparison of the inter-examiner reliability of motion palpation between the two groups

was performed using a paired Wilcoxin signed ranks test.

Results

The Kappa scores for motion palpation ranged from -0.2081 to 0.1802 for the symptomatic knee joint and -0.2836 to 0.0339 for the asymptomatic knee. This shows poor agreement in both cases.

There was no significant difference in Kappa values (p= 0.609) for the two groups for the Wilcoxin signed ranks test and the number of positive and negative ranks were similar. This indicates that the reliability of motion palpation in both groups was similar.

Conclusion

It was concluded that inter-examiner reliability of motion palpation of the knee joint was poor in knees with patellofemoral pain syndrome and in knees that were asymptomatic. Motion palpation was found to be equally reliable in both groups, indicating that motion palpation of a symptomatic joint does not improve its reliability. This research suggests that motion palpation should be used together with other diagnostic tests to identify patellofemoral pain syndrome as it is not a reliable tool when used in isolation.

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LIST OF ABBREVIATIONS

MP	Motion palpation
PFPS	Patellofemoral pain syndrome
T/F	Tibiofemoral joint
T/f	Proximal tibiofibular joint
P	Patellofemoral joint
AP	Anterior to posterior direction of motion palpation
PA	Posterior to anterior direction of motion palpation
ML	Medial to lateral direction of motion palpation
LM	Lateral to medial direction of motion palpation
SI	Superior to inferior direction of motion palpation
IS	Inferior to superior direction of motion palpation
Int rot	Internal rotation
Ext rot	External rotation
LAD	Long axis distraction

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Chapter 1: Introduction

1.1 The problem and its setting

Motion palpation is used to assess the functional status of a joint and is defined by Redwood and Cleveland (2003) as “The manual palpation of bony structures and soft tissues, through pressure applied in various directions of joint motion to ascertain areas of joint hypomobility and hypermobility.” Motion palpation is a collection of manual examination procedures, used to identify the site and characteristics of altered joint motion (Redwood and Cleveland, 2003). The joint range, pattern and quality of movement, from the neutral point to the end of passive range of motion is noted, and loss of the normal elastic end feel, or ‘springiness’ within the joint, indicates disorders within the joint, its capsule or the periarticular tissue (Bergmann, Peterson and Lawrence, 1993).

According to Lewit and Liebenson (1993) one of the most important goals for any clinical instrument is for it to have good reliability and reproducibility, this is because the clinical value of a test must be demonstrated before the results are considered valid. The extent to which a repeated test will produce the same result when evaluating an unchanged characteristic is its reliability (Haas, 1995). Gatterman (2005) asserts that reliability is evaluated by multiple blinded measurements performed on a sample of subjects. Inter-examiner reliability evaluates the consistency of different examiners and is determined through repeated assessment by two or more raters.

Research into the inter-examiner reliability of motion palpation in the assessment of spinal joint dysfunction has been conducted and has produced mixed results (Haas, Panzer, Peterson, and Rapheal, 1995; Boline, Haas, Meyer, Kassak, Nelson, and Keating, 1993 and Keating, Bergman, Jacobs, Finer, and Larson, 1990). Furthermore, only three studies pertaining to the inter-examiner reliability of the extremity joints have been conducted and these too have not produced definitive results (Brantingham, Wood, Parkin-Smith Van der Meulen and Weston, 1997; Bezuidenhout, 2002 and Vaghmaria, 2006).

Motion palpation is one of the main assessment tools used in manipulative therapy and forms an important part of the diagnosis and assessment of knee joint pathologies (Schafer and Faye, 1990; Lewit and Liebenson, 1993). Consequently, to gain the most accurate information from motion palpation and to ensure correct diagnosis, it is necessary that it is a reliable procedure (Bezuidenhout, 2002).

1.2 Aim

The aim of this study was to determine the inter-examiner reliability of motion palpation of knee joints with patellofemoral pain syndrome and asymptomatic knee joints.

1.3 Objectives

Objective 1
To determine the inter-examiner reliability of motion palpation of knee joints with patellofemoral pain syndrome.

Objective 2
To determine the inter-examiner reliability of motion palpation of asymptomatic knee joints.

Objective 3
To determine the effectiveness of motion palpation in identify a knee joint with patellofemoral pain syndrome, when compared to an asymptomatic knee joint.

Objective 4
To compare the inter-examiner reliability of motion palpation of symptomatic and asymptomatic knees.

1.4 Hypotheses

Hypothesis 1
It is hypothesized that there will be inter-examiner reliability of motion palpation of knee joints with patellofemoral pain syndrome.

Hypothesis 2
It is hypothesized that there will be inter examiner reliability of motion palpation of asymptomatic knee joints.

Hypothesis 3
It is hypothesised that motion palpation will be effective at identifying a knee joint with patellofemoral pain syndrome, when compared to an asymptomatic knee joint.

Hypothesis 4
It is hypothesized that there will be no difference when comparing the inter-examiner reliability of motion palpation of symptomatic and asymptomatic knees.

1.5 Limitations

In this study the examiners were final year students, rather than qualified chiropractors due to time and practical constraints. This is considered a limitation as students do not have the experience of a qualified practitioner, however, studies have shown that clinical experience does not affect the reliability of manual examinations (Stochkendahl, Christensen, Hartvigsen, Vach, Haas, Hestbaek, Adams and Bronfort, 2006 and Seffinger, Najm. Mishra, Adams, Dickerson, Murphy and Reinsch, 2004).

1.6 Conclusion

The results of this study may assist the establishment of motion palpation as a reliable diagnostic tool for assessing the knee joint.

Chapter 2: Literature review

2.1 Introduction

This chapter provides a review of all the available literature related to this study, focusing on motion palpation and reliability and the research that has been done in these areas to date. Information on the relevant anatomy and biomechanics of the knee joint, as well as an outline of patellofemoral pain syndrome is included.

2.2 Palpation

Palpation is the application of manual pressures through the surface of the body to determine the shape, size, consistency, position and inherent motility of the tissues beneath the skin (ACA Council on Technique, 1998). According to Bergmann *et al.* (1993), palpation is among the oldest, but one of the most important techniques used by chiropractors to identify joint dysfunction.
They propose that there are two sub categories of this application, namely:

- Static palpation
- Motion palpation

2.2.1 Static palpation

Chiropractors perform static palpation with the patient in a stationary position and it includes assessment of the bony and soft tissues (Redwood and Cleveland, 2003). Almost a century ago, Gregory (1912) defined it as “the gentle application of the hand or fingers to the surface of the body for the purpose of determining the condition of the surface and adjacent parts of a certain locality or organ of the body”.

2.2.2 Motion palpation

Motion palpation is used to assess the functional status of a joint and is defined by Redwood and Cleveland (2003) as “The manual palpation of bony structures and soft tissues, through pressure applied in various directions of joint motion to ascertain areas of joint hypomobility and hypermobility and areas of normal mobility”.
Motion palpation is a collection of manual examination procedures, used to identify the

site and characteristics of altered joint motion during active and passive movement (Redwood and Cleveland, 2003). The examiner uses one hand to guide the movement of the joint, while the other hand palpates the joint movement. The joint range, pattern and quality of movement, from the neutral point to the end of passive range of motion is noted (Bergmann *et al.* 1993).

Motion palpation has been an important part of chiropractic since its inception in 1895 (Bergmann *et al.* 1993) but only became widely used after a formalized system of motion palpation was developed by Gillet (Gillet, 1960; 1969 and 1981), and then expanded by Schafer and Faye (Schafer and Faye, 1989).

2.2.2.1 Active movement

According to Bergmann *et al.* (1993) active movements are the result of voluntary muscle contraction, their range of motion is determined by the architecture of the joint, and the elasticity of its associated myofascial and ligamentous structures. During an assessment, the patient provides the muscular force, with the examiner guiding and evaluating the consistency of the movement and the periarticular soft tissues (Redwood and Cleveland, 2003).

2.2.2.2 Passive movement

Bergmann *et al.* (1993), describe passive joint movements as involuntary movements, their range also depending on the joint structure and flexibility of related articular soft tissues. To assess passive range of motion, the patient is in a relaxed position while the examiner moves the joint through its natural arc of motion Passive range of motion is greater than active range of motion due to decreased muscle tension (Redwood and Cleveland, 2003).

Categories of passive joint movement include:

Accessory movement

Accessory joint movements are involuntary movements, and so grouped under passive joint motion. It is the small amount of ‘give’ necessary for normal joint function (Bergmann *et al.* 1993). Schafer and Faye (1989) propose that the surfaces of joints are somewhat incongruent, and therefore, their motion is not entirely smooth. This causes extra movement as the joint passes through its range of motion. To prevent abnormal friction, the joint capsule must accommodate this, allowing additional shift and joint separation (Bergmann *et al.* 1993).

Motion palpation is used to assess accessory joint movement, by means of end feel and joint play (Bergmann *et al.* 1993), which is defined as follows:

End feel

At the end of passive range of motion, the elastic limits of the joint are challenged, providing additional resistance. This resistance is known as end feel. Each spinal and extremity joint has its own characteristic end feel qualities, determined by the bony and soft tissue structures of the joint (Bergmann *et al.* 1993).
End feel is assessed by applying overpressure to the joint at the end of the passive range of motion. The point at which resistance is met and the quality of the resistance is evaluated. Loss of expected end feel elasticity is suggestive of dysfunction of the joint, its capsule or the periarticular soft tissue (Bergmann *et al.* 1993) and is noted as restricted movement by the examiner.

Joint Play

Peterson and Bergmann (2002) define joint play as "the qualitative evaluation of the joint's resistance to movement when it is in the neutral position". Joint play is assessed in the neutral or loose packed position, because this is where the joint is under the least amount of stress and the ligaments and joint capsule are in the position of the greatest laxity (Redwood and Cleveland, 2003). In this position the greatest amount of play between the two joint surfaces occurs, and this provides the best opportunity for isolation of the joint capsule movement from the effects of the periarticular muscles (Bergmann *et al.* 1993).

2.3 Reliability

2.3.1 Introduction

Lewit and Liebenson (1993) state that one of the most important goals for any clinical instrument is for it to have good reliability and reproducibility, because the clinical value of a test must be proven before the results are considered valid. According to Haas (1995), reliability is the extent to which a repeated test will produce the same result when evaluating an unchanged characteristic. It is therefore, the consistency of the outcome of measurement of a clinical instrument (Haas, 1991). Gatterman (2005), states that reliability estimates the contribution of a test to the clinical decision making process beyond what would be expected by an examiner guessing or through measurement error.

Gatterman (2005) states that evaluation of reliability is a fundamental step in determining clinical usefulness of a diagnostic procedure, but the accuracy or validity of a test (to what degree the test is on the mark, and to what degree it evaluates what is intended) is also of paramount importance. Redwood and Cleveland (2003) suggest that demonstrating the reliability of motion palpation will promote its validity. Therefore, in order to gain the most accurate information from motion palpation and to ensure correct diagnosis it is necessary that this is a reliable procedure (Bezuidenhout, 2002).

Reliability is evaluated by multiple blinded measurements performed on a sample of subjects. There are two types of reliability pertinent to motion palpation; intra-examiner reliability and inter-examiner reliability (Gatterman, 2005).
Intra-examiner reliability is a measure of self consistency. In assessing it, each rater must perform at least two examinations, and the results of these are compared. Intra-examiner reliability tends towards overestimation due to consistency of measurement error and difficulty of rater blinding (Gatterman, 2005).
Inter-examiner reliability was used in this study, it evaluates the consistency of different examiners and is determined through repeated assessment by two or more raters (Gatterman, 2005).

2.3.2 Reliability of motion palpation of the spine

Research into the inter-examiner reliability of motion palpation in the assessment of spinal joint dysfunction has been conducted and has produced mixed results (Stochkendahl *et al*. 2006; Haas *et al.* 1995; Boline *et al.* 1993; Panzer, 1992 and Keating *et al.* 1990).

In studies conducted by Schneider, Erhard, Brach, Tellin, Imbarlina and Delitto (2008) Huijbregts (2002), Brinkley, Stratford and Gill (1995), Lewit and Leibenson (1993) Haas (1991); Mootz, Keating, Kontz, Milus and Jacobs (1989) and Love and Brodeur (1987) agreement was found to be poor. Humphreys, Delahaye, and Peterson (2004) and Lebeouf, Gardner, Carter, and Scott (1989) completed studies which found inter-examiner agreement to be from fair to strong. The inconsistent findings in the literature has indicated the need for further study in this area.

2.3.3 Reliability of motion palpation of the extremity joints

Only three studies pertaining to inter-examiner reliability of motion palpation of extremity joints have been done. In a pilot study by Brantingham *et al.* (1997) (unpublished), the inter-examiner reliability of the circumduction test for general foot dysfunction, was measured. Two examiners assessed the feet and ankles of 17 patients with moderate to severe foot pain. Inter-examiner agreement was determined using the Kappa coefficient and was found to be 0.598 (moderate agreement) as to whether there was decreased mobility in the asymptomatic foot and 0.64 (strong agreement) as to whether there was decreased mobility in the symptomatic foot.

A weakness in this study was that the examiners were not blinded to the symptomatic foot. This could have created presumptions or examiner bias as to the presence and grade of joint dysfunction.
It was also noted that the examiners were of a different level of experience. This could create inconsistencies whereby the examiners work from a different frame of reference and will have a different level of skill of motion palpation (Bezuidenhout, 2002).

Two inter-examiner reliability studies have been done on motion palpation of the patellofemoral joint. Bezuidenhout (2002) (unpublished), investigated the inter-examiner reliability of motion palpation findings in asymptomatic patients. A sample of fifty students had both of their patellofemoral joints motion palpated by four senior chiropractic student examiners. Pearsons Chi-Square test ($p<0.05$) demonstrated inter-examiner consistency of motion palpation findings. The Kappa scores for inter-examiner reliability ranged from 0.00-0.048 (fair agreement). These results showed consistency between the examiners, but the Kappa statistic did not support these findings.

Bezuidenhout (2002) recommended more research be conducted on motion palpation of the extremity joints, in order to quantify the findings of this study. He also concluded that future studies of this kind should incorporate both symptomatic and asymptomatic patients, as motion palpation is a diagnostic method that looks for pathomechanics of a joint.

In a study by Vaghmaria (2006) (unpublished) the inter-examiner reliability of motion palpation findings of the patellofemoral joint in patients with patellofemoral pain syndrome and patients with osteoarthritis was assessed. Thirty joints with each condition were motion palpated by four examiners, blinded to the condition the patient was suffering from. Inter-examiner reliability showed fair agreement for both conditions, with the Kappa score being 0.20 for the patellofemoral pain syndrome group, and 0.22 for the osteoarthritis group.

The literature search found only these three studies on reliability of motion palpation of the extremity joints. The results are somewhat mixed, indicating the need for further research in this area. Motion palpation lacks proven reproducibility and repeated intra- and inter-examiner agreement of findings. In order to demonstrate that knee joint dysfunction can be reliably palpated through motion of the joint, it is necessary to study and compare the restrictions noted in asymptomatic and symptomatic knees (Russell, 1983). This study undertook to investigate and compare the reliability of motion palpation of symptomatic and asymptomatic knee joints.

2.4 Anatomy and biomechanics

2.4.1. Introduction

The knee, the largest joint in the body, is primarily a compound type of synovial joint, connecting the femur and tibia, which allows flexion and extension (Oloff, 1994).

The normal biomechanics of the knee are frequently altered by fixations that may be the cause or the effect of pathologic changes (Schafer and Faye, 1990). Familiarity with the anatomy and biomechanics of the knee joint is important in understanding how these fixations occur and the role that motion palpation plays in identifying them.

Any of the three joints of the knee complex may be involved (Schafer and Faye, 1990), these are:

- The lateral and medial articulations between the femoral and the tibial condyles, known as the tibiofemoral joint (Moore and Dalley, 1999).
- The articulation between the patella and femur, known as the patellofemoral joint (Moore and Dalley, 1999).
- The articulation of the head of the fibula with the lateral condyle of the tibia, known as the proximal tibiofibular joint (Moore and Dalley, 1999).

2.4.2 The tibiofemoral joint

The tibiofemoral joint is formed by the distal end of the femur (the femoral condyles) and the proximal end of the tibia (Cailliet, 1992).
The lateral and medial femoral condyles (Moore and Dalley, 1999) are convex, asymmetrical surfaces, covered by hyaline cartilage and separated by the intercondylar fossa (Cailliet, 1992). The lateral condylar articular surface is almost circular, whereas the medial surface is more elongated anterior to posterior (Oloff, 1994). This shape produces a posterior glide of the tibia on the femur during the first 20 degrees of flexion. The tibial articular surfaces correspond to the femoral condyles. The lateral and medial condylar surfaces of the tibia are concave, they are separated by the inter condylar eminances, and project into the fossa of the femur (Cailliet, 1992).

Knee joint flexion is a combination of a translatory gliding motion and rotation about the femoral condyles (Cailliet, 1992). The range of motion for knee flexion and extension is from 5-10 degrees of hyperextension to 120-140 degrees of flexion (Oloff, 1994). During the first 20 degrees of flexion, the tibia glides across the articular surface of the femur in a posterior direction. When it reaches the axis of rotation of the femoral condyles, it rotates about this axis until it reaches 90 degrees of flexion. Along with these motions, the tibia internally rotates about its own axis in the first 30 degrees of flexion, this is due to the differing lengths of the medial and lateral femoral condyles (Cailliet, 1992). Motion of the tibiofemoral joint therefore includes flexion, extension, internal and external rotation (Oloff, 1994).

The closed-packed position of the knee is at full extension. In this position, maximal compression, surface contact and congruency between the joint surfaces of the tibia and femur is achieved, as well as the most taught position of the supporting ligaments. Knee flexion results in the opposite of these forces (Oloff, 1994).
The knee is in the loose packed position in flexion and this puts the ligaments and joint capsule in the position of the most laxity (Redwood and Cleveland, 2003), thus anteroposterior glide and rotational movements of the tibiofemoral joint are motion palpated in this position. Medial, lateral and long axis accessory movements are assessed with the knee in passive extension. This is the neutral position on the knee in which joint play is best assessed (Bergmann *et al.* 1993).

2.4.3 The patellofemoral joint

The patella is a sesamoid bone, located in the quadriceps tendon, just proximal to its insertion (Cailliet, 1992). The outside edges form a vague triangle, which is slightly wider than high, with the apex pointing distally. The thickness of the patella is quite variable, ranging from 20 to 30 mm (Fulkerson, 1997).
The anterior surface is slightly convex and provides an attachment area to the patella tendon (Scuderi, 1995). Thick hyaline cartilage covers the posterior side, which articulates with the distal condyles of the femur (Fulkerson, 1997). The articular surface is divided into lateral and medial facets by a vertical ridge, with the lateral facet usually being slightly larger (Fulkerson, 1997). On the medial side of the articular surface there is a non-articular odd facet (Scuderi, 1995).

The portion of the femur that articulates with the patella, the trochlea, is found on the anterior surface of the distal femur. The trochlea surface has a medial and a lateral facet which are separated by a shallow groove. This groove deepens distally and posteriorly, becoming the intercondylar notch (Fulkerson, 1997).

The function of the patella is to improve the efficiency of the of the quadriceps by increasing the lever arm of the extensor mechanism (Reid, 1992 and Scuderi, 1995). To effectively perform this function, the patella must be aligned to remain in the intercondylar notch. Any deviations of this alignment will predispose the individual to developing patellofemoral pain and possibly articular cartilage breakdown (McConnell, 1986). Vaghmaria (2006) assumes that in the above conditions, patella mobility will be effected.

Other functions of the patella include concentrating the forces from the four heads of the quadriceps to the patella tendon, forming a bony shield for the trochlea and femoral condyles and providing a frictionless surface that glides over the femoral condyles and is able to bear highly compressive loads (Scuderi, 1995).

The patella is subject to two forces during knee movement (Hungerford and Lennox, 1983). One is a tensile force produced by the quadriceps muscle group, the other is the patella compressive force.

The quadriceps are the anterior muscles of the thigh, which function as extensors of the knee joint. The quadriceps muscle group is made up of (Moore and Dalley, 1999):

- The rectus femoris

- The vastus lateralis
- The vastus medialis
- The vastus intermedialis

The rectus femoris originates from the anterior superior iliac spine, while all the vasti originate from the anterior surface of the femur. These muscles join in a trilaminar way to form the patellar tendon, which inserts onto the tibial tubercle (Scuderi, 1995). They act to extend the knee joint and externally rotate the tibia during the last 20 degrees of extension (Cailliet, 1992). Due to their attachments, the quadriceps have a direct mechanical action on the collateral ligaments of the knee, maintaining their taughtness (Cailiet, 1992). The vector of pull of the quadriceps muscles is known as the Q angle and is at a slightly lateral angle (Oloff, 1994). This causes a predisposition in the patella to drift laterally (Reid, 1992). It is the function of the vastus medialis to overcome this tendency and maintain the appropriate orientation of the patella (Reid, 1992).

The patellofemoral compressive force depends on the angle of knee flexion, increasing with knee flexion and decreasing with extension (Hungerford and Lennox, 1983).

- In full extension with the quadriceps tightened, the patellar articulates with the supratrochlea fat pad and is subjected to little or no load (Fulkerson, 1997).
- During the first 20 degrees of flexion, the tibia internally rotates, allowing the patella to move into the trochlea groove (Reid, 1992). This is the first point of contact between the patella and the femur (Oloff, 1994).
- Between 30 and 45 degrees of flexion, the patella centralises in the deepening trochlea groove (Oloff, 1994). Before this point the patella is relatively unstable, as it has been held in place predominantly by muscle tension (Reid, 1992).
- Further flexion causes compression of the patella against the femur, increasing the stability of the joint (Oloff, 1994).
- At 90 degrees of flexion, the patella moves slightly laterally, leaving some of the medial femoral condyle uncovered (Reid, 1992).
- As flexion continues, the lateral movement continues, so that at 135 degrees the medial patella facet lies free in the intercondylar notch, and the odd facet contacts the lateral part of the medial femoral condyle (Reid, 1992).
- As the load that the knee is required to bear increases from extension to flexion, so too does the area of surface contact between the patella and the femur. The area increase does not completely counteract the increase in load, and thus the load per

unit area increases as the knee flexes (Oloff, 1994).

- Between 0 and 90 degrees of flexion, the patellar is the only part of the extensor mechanism that makes contact with the femoral condyles, but between 90 and 135 degrees of flexion the posterior surface of the quadriceps tendon contacts the trochlear surface (Scuderi, 1995).

With the quadriceps relaxed and the knee extended, the patella demonstrates free movement superiorly, inferiorly, medially, laterally, diagonally and in circumfusion (Schafer and Faye, 1990) although there is a greater amount of passive movement medially than laterally (Skalley, Terry and Teitge, 1993). Only superior motion of the patella is under voluntary control and if any of these movements are restricted, knee function is impaired (Schafer and Faye, 1990).

2.4.4 The proximal tibiofibular joint

The proximal tibiofibular joint is a plane type of synovial joint, between the head of the fibular and the lateral condyle of the tibia (Moore and Dalley, 1999).
The flat facet on the head of the fibula articulates with the posterolateral and inferior aspects of the lateral tibial condyle. The joint is enclosed in its own capsule and does not communicate with the tibiofemoral joint (Reid, 1992). The major stabilising function of the joint is played by the fibular collateral ligament, with the muscles that attach to the fibula, the peroneal and biceps femoris muscles performing a secondary role (Ogden, 1974).

Functions of the tibiofibular joint include, slight movement of the joint to accommodate for lateral tibial bending movements and rotational stress at the ankle. It also assists the dispersion of tensile loading during weight-bearing activities, rather than compressive forces (Ogden, 1976).

Although the proximal tibiofibular joint is mechanically linked to the ankle, dysfunction here may present clinically as pain in and around the knee. Thus the inclusion of the proximal tibiofibular joint in assessment of the knee is clinically relevant (Bergmann *et al.* 1993). To allow for movement generated by ankle motion, the superior tibiofibular joint allows anteroposterior (Mennell,1964 and Reid, 1992), superoinferior and rotary motion (Reid, 1992). When the foot is inverted the joint opens slightly, and when the foot is actively dorsiflexed, the head of the fibula shifts marginally in a superior

direction (Schafer and Faye, 1990).
Mennell (1964) and Ogden (1974) state that movement of this joint is maximal with the knee flexed past 80 degrees and Gillet (1981) reports that proximal tibiofibular joint fixation is quite common.

2.5 Patellofemoral pain syndrome

2.5.1 Introduction

Patellofemoral pain syndrome can be defined as retropatellar or peripatellar pain resulting from physical and biochemical changes in the patellofemoral joint (Juhn, 1999).

2.5.2 Incidence and prevalence

Disorders of the patellofemoral joint represent one of the most common athletic injuries (Oloff, 1994) with patellofemoral pain syndrome being one of the most prevalent among these (DeHaven and Lintner, 1986). Reported incidence ranges from 21 to 40% in the clinical setting (Hutchinson and Ireland, 1995) and this may be even higher in athletic adolescents and young adults (Davidson, 1993 and Potter and Sequeira, 2009).

The disorder occurs twice as often in females as in males (Boucher and Hodgdon, 1993; Davidson, 1993; Hutchinson and Ireland, 1995 and Thomee, Renstrom, Karlsson and Grimby, 1995) with De Haven and Lintner (1986) finding an incidence of 19.6% among female college athletes and 7.4% among male college athletes. They also noted that incidence increased with overuse and was related to the patients' activity.

2.5.3 Aetiology

The cause of patellofemoral pain syndrome is unknown, although many intrinsic and extrinsic factors have been suggested (Nakagawa, Muniz, de Marche Baldon, de Menzes Reiff and Serrao, 2008), these include overuse/overload, biomechanical problems, muscular dysfunction and acute trauma. Literature and clinical experience indicate that the aetiology of patellofemoral pain syndrome is multifactoral (Juhn, 1999).

2.5.3.1 Overuse

Bending of the knee causes an increase in pressure between the patella and its points of contact with the femur, this can be described as overload (Milgrom, Finestone, Shlamkovitch, Giladi and Radin, 1996). In athletes, especially in runners, the repeated contact between these points, combined with the impact of weight-bearing knee flexion amplifies this overload (Reid, 1992). This, at times accompanied by maltracking of the patella, leads to the retropatellar and peripatellar pain, of patellofemoral pain syndrome. Climbing steps, running up or down hills and running on uneven surfaces exacerbates this pain (Juhn, 1999).

2.5.3.2 Biomechanical

No single primary biomechanical cause for patellofemoral pain syndrome has been found, but there are numerous biomechanical and alignment factors which contribute to this syndrome (Oloff, 1994).

Pes planus

Pes planus is a combination of eversion, dorsiflexion and abduction of the foot, often due to lack of support of the medial arch (Juhn, 1999). Prolonged sub-talar joint pronation during midstance, causes continued internal rotation of the tibia and femur (Oloff, 1994). External rotation of the tibia is necessary for normal knee joint extention, a delay in this could adversely effect patellofemoral tracking. In this way, excessive pronation may lead to patellofemoral pain syndrome (Reid, 1992).

Pes cavus

This is a high arched foot, which provides inferior cushioning when the foot strikes the ground (Juhn, 1999). This places the patellofemoral mechanism under excess stress, especially during running (Reid, 1992).

Q Angle

The Q angle is measured by two lines transecting the middle of the patella, one from the anterior superior iliac spine, and the other from the tibial tubercle (Oloff, 1994). It represents the effect of the lateral pull of the vastus lateralis and the corrective medial pull of the vastus medialis (Reid, 1992). An increased Q angle has been related to increased risk of developing patellofemoral pain syndrome (Noakes, 1992 and Reid, 1992). The validity of this claim has been questioned (Oloff, 1994 and Juhn, 1999) because there are discrepancies between measurements of Q angle taken with the quadriceps relaxed and contracted (Reid, 1992). There is also difficulty in locating the exact anatomical landmarks and the Q angle is measured statically, whereas it is meant to portray a dynamic situation (Oloff, 1994 and Reid, 1992).

2.5.3.3 Muscular

The potential muscular causes of patellofemoral pain can be divided into weakness and inflexibility (Reid, 1992).

Insufficient pull of the vastus medialis is known to cause poor tracking of the patella. Factors which bring about vastus medialis insufficiency are congenitally atrophic or dystrophic vastus medialis muscle mass, reflex inhibition due to pain and atrophy due to disuse (Reid, 1992).

Muscle tightness usually involves the iliotibial band, the rectus femoris and the other flexors of the hip. Tightness in these muscles unfavourably effects landing from jumping, and thus the motion of the patella in its femoral groove. A tight iliotibial band will pull the patella laterally during knee flexion. Tight hamstrings may increase knee flexion during running, escalating the forces in the patellofemoral joint leading to joint overload (Reid, 1992).

2.5.3.4 Acute trauma

A blow to the patella may bring about surface changes, resulting in retropatellar pain. Moderate damage may take six to twelve weeks to recover, but severe damage may affect the full thickness of the cartilage and be irreversible (Reid, 1992).

2.5.4 Symptoms

The classic representation of patellofemoral pain syndrome, is that of a young active person who complains of retropatellar or peripetellar pain (Reid, 1992; Oloff, 1994; Juhn, 1999; Afra and Schepsis, 2008 and Potter and Sequeira, 2009). Pain is related to activity and is exacerbated by those requiring increased knee flexion, like cycling, running and skiing. Stiffness or tightness may be felt early on in activity, which decreases with continued use. Other actions that may aggravate the condition are descending stairs, squatting and sitting for prolonged periods of time (this is known as the “movie goers sign”) (Reid, 1992; Oloff, 1994; Juhn, 1999 and Potter and Sequiera, 2009).

2.5.5 Clinical features and physical findings

Provocative tests are performed to illicit and localise the pain (Oloff, 1994). Most of the physical findings are localized around the knee (Potter and Sequiera, 2009).

- Gait may demonstrate excessive foot pronation, excessive knee valgus, or an antalgic gait pattern (Potter and Sequiera, 2009).
- Crepitus may be present, but may be incidental if not accompanied by other signs and symptoms. Locking is absent (Reid, 1992).
- Repeated deep knee bends or squats may reproduce knee pain (Oloff, 1994).
- The bulk of the vastus medialis should be assessed as a possible cause of a malalignment syndrome. The vastus medialis is believed to be the most active muscle in the last 15° of resisted knee extension, this is thus the best arc of movement in which to determine its strength (Potter and Sequiera, 2009).
- There may be tenderness along the facets of the patella. These are best palpated with the knee fully extended and the quadriceps relaxed, while positioning the patella medially, laterally, superiorly and inferiorly to palpate the respective facets (Potter and Sequiera, 2009).
- Manually pressing the patella against the femur while asking the patient to contract their quadriceps may elicit pain and tenderness (Clark's sign) (Oloff, 1994).
- Genu recurvatum and hamstring weakness may contribute to the occurrence of patella femoral pain syndrome, identifying such areas of weakness may aid in the choice of management (Potter and Sequiera, 2009).

2.5.6 Diagnosis

Diagnosis is made chiefly on patient history (Blond and Hansen, 1998). The most important features being the presence of localized peri or retropatellar pain originating from the patellofemoral joint or peripatellar tissue (Davidson, 1993) with that pain being produced by at least two of the following (Powers et al. 1996):

- Descending or ascending stairs
- Squatting
- Isometrically contracting the quadriceps
- Prolonged sitting with the knee flexed
- Activity involving knee bending (for example running or cycling)

Diagnosis is confirmed if the examiner is able to elicit patella tenderness that corresponds to that of which the patient complains (Blond and Hansen, 1998).

Differential diagnosis includes meniscal and articular injuries, ligamentous disorders, and common overuse injuries effecting the medial lateral and posterior aspects of the knee (Oloff, 1994).

2.5.7 Treatment

Conservative treatment remains the best treatment for patellofemoral pain syndrome (Stakes, 2000) and due to the multifactoral nature of this condition, it must take into account the possible aetiologic factors so that the best possible outcome is achieved (Oloff, 1994).

As the patellofemoral joint is mainly a soft tissue joint, its position can be altered by mechanical means which means that defective joint motion can be effected by mechanical force, such as mobilization (McConnell, 1986).
A study by Stakes (2000) found significant improvement in subjective and objective pain ratings with the use of patella mobilisation for the treatment of patellofemoral pain syndrome and Rowlands and Brantingham (1999) found patella mobilisation to have a beneficial effect in the treatment of this condition. Patella mobilisation is recommended for the treatment of patellofemoral pain syndrome by Bergmann *et al.* (1993) and Oloff (1994).

Most conservative treatment protocols include:

- Activity modification and/or a period of rest, to avoid activities which aggrevate the condition (Juhn, 1999).
- Medication in the form of non-steroidal anti-inflammatories (NSAIDS) or intra-articular steroid injections, to reduce inflammation and assist pain control (Reid, 1992).
- Application of ice (Davidson, 1993).
- Mobilisation of the patella (Oloff, 1994).
- Exercise therapy, which focuses on correcting strength and flexibility of the quadriceps and other involved muscle groups (Oloff, 1994 and Reid, 1992).
- External support in the form of knee sleeves, braces and taping of the knee, to assist in controlling deviation of the patella and arch supports or orthotics, to control defective foot biomechanics (Juhn, 1999).

- Surgery is indicated only if conservative treatment has not produced satisfactory results The procedures considered are a lateral retinaculum release, arthroscopic shaving or open patella realignment (Oloff, 1994).

Consequently, to ensure correct diagnosis and administration of treatment it is important that the tool (motion palpation) used to detect altered or restricted joint motion is reliable.

Chapter 3: Methodology

3.1 Introduction

This chapter gives a description of the specific method followed in this research study.

3.2 Study design

This is a quantitative, inter-examiner, clinical reliability study, of motion palpation findings in knees with patellofemoral pain syndrome and in asymptomatic knees.

3.3 The Participants

The thirty participants consisted of volunteers suffering from patellofemoral pain syndrome, who lived in the greater Durban area, or were able to attend the Durban University of Technology Chiropractic Day Clinic for assessment.

3.3.1 Advertisement for participant recruitment

Advertisements, in the form of posters (Appendix 1) were placed on notice boards at the Durban University of Technology, as well as in local sports clubs, gyms and shopping centres. Pamphlets (reduced size posters) were distributed to the general public and handed out at sporting events. Patients were also obtained via word of mouth and referral by other patients. The patient group was not limited to a specific profile, with regards to ethnicity, occupation or gender.

3.3.2 Sampling

The sample group consisted of respondents to the advertisements, as a result of this the convenience sampling approach was adopted in this study. A convenience sample is a sample where the patients are selected, based on availability and ease of data collection

(Tashakkori and Teddlie, 1998). The sample consisted of a total of thirty patients, and therefore sixty knees. This sample size was advised in order for the study to be statistically relevant. Each patient was required to have one knee with the symptoms of patellofemoral pain syndrome, and one knee that was pain free- with no history of knee injury or pain.

3.3.3 Inclusion criteria

1. Only patients between 18-45 years of age were included, as patellofemoral pain syndrome occurs most commonly between the ages of 16-45 (Davidson, 1993).
2. Only patients whom had one knee that was symptomatic for patellofemoral pain syndrome (as described below) and one that was asymptomatic were included.
3. To be diagnosed with patellofemoral pain syndrome there must be:
    - Anterior knee pain (Puniello,1993) and localized peri or retropatella pain (Davidson, 1993 and Rowlands and Braningham, 1999).
    - Patients were required to answer yes to at least two of the following five questions (Powers et al. 1996).

      Do you experience pain:

      During and/or after activity?
      During and/or after sitting for prolonged periods of time?
      During walking up or down stairs?
      During squatting?
      When contracting the front thigh muscles, without moving the leg?
4. Asymptomatic knee:
    - Patients who had no history of knee pain or injury, in the previous six months.

3.3.4 Exclusion criteria

A patient presenting with any of the following, as defined by Maitland (1999), Wilson (1990) and Thomee *et al.* (1995) was excluded from the study.

1. A patient with any systemic arthritide that may affect the knee, such as gout or rheumatoid arthritis.

2. A patient who was pregnant or breast feeding, due to an increased laxity of ligaments during pregnancy.
3. A patient having undergone knee surgery in the last two years.
4. A patient with a history of recurrent patella subluxation or dislocation.
5. A patient with a history of intermittent or persistent knee joint swelling.
6. A patient with a history of knee joint injuries, such as meniscal tears, ligament or joint capsule injuries, articular cartilage damage or overuse syndromes such as bursitis, patella tendonitis and fat pad syndrome.
7. A patient with bilateral knee pain.

3.4 Study protocol

3.4.1 Clinical procedure

Respondents to the advertisement had a telephonic interview (Appendix 2) with the researcher, to exclude patients that did not meet the inclusion criteria. If the patient was eligible for the study an appointment was made.

At the appointment the patient was given a Letter of Information and Consent (Appendix 3), which informed them of the study details, and enabled them to ask any questions pertaining to the study. Once any relevant questions were answered and the patient knew what was expected of him/her, he/she was asked to sign this letter.

The patient then underwent a detailed case history (Appendix 4), physical examination (Appendix 5) and regional examination of the knee (Appendix 6) conducted by the researcher, which eliminated any contra-indications to their participation in this study.
If the patient was not eligible for the study, they were thanked for their participation and allowed to leave. If the patient was eligible and willing to participate, they were forwarded to the next part of the study. Patients who were motion palpated in this study were entitled to one free treatment by the researcher for their patellofemoral pain syndrome at a later date or directly after the consultation.

3.4.2 Motion palpation

The motion palpation was done by three independent examiners, blinded to which was the symptomatic and asymptomatic knee. The independent examiners were chiropractic interns at the Durban University of Technology and were paid a set fee for their role in the research. Bergman's technique (Bergmann *et al*. 1993) (Appendix 7) for motion palpation of the knee joint was used, and eight practice sessions took place prior to the study commencing. This ensured that the time taken, pressure applied, patient and doctor positioning and finger placement of the examiners were the same, as Mootz *et al.* (1989) recommended that the same palpatory techniques should be used by all examiners.

The joints which were examined are the following:

Tibiofemoral joint in:

- anterior to posterior glide
- posterior to anterior glide
- internal rotation
- external rotation
- medial to lateral glide
- lateral to medial glide
- long axis distraction

Patellofemoral joint in:

- superior to inferior glide
- inferior to superior glide
- medial to lateral glide
- lateral to medial glide

Proximal tibiofibular joint in:

- anterior to posterior glide
- posterior to anterior glide
- superior to inferior glide
- inferior to superior glide

The patient was motion palpated in private, at the initial consultation by all three student examiners. A screen was placed in front of the patient during the motion palpation so that the examiners were not influenced by the patients facial expression during the procedure. The patient was motion palpated by the first student examiner and the results of this were recorded on a special examination sheet (Appendix 8). Once the first examiner had motion palpated both knees, she left the room and the second examiner was called. The second examiner then motion palpated both knees and recorded her findings on a new examination sheet. This was repeated by the third examiner. During the change over in examiners no communication between them occurred. The examination sheets were kept by the researcher until all data was gathered.

The order in which the student examiners motion palpated the knees was alternated. The examiner who palpated first, was second to palpate the next patient, and third to palpate the one after, this system continued until all 30 patients were motion palpated. The examiners were blinded to the symptomatic knee. The right knee joint complex was motion palpated first in each patient to increase the blinding of the examiners. The examiners were not allowed to enter into conversation regarding the patient’s knees. The researcher ensured this by being present at all consultations.

The researcher kept all data confidential until such time that it was needed for statistical analysis. It was then handed to the statistician for statistical analysis. All the information was kept at the Durban University of Technology Chiropractic Day Clinic in the respective patient’s files, where confidentiality was maintained.

3.5 Measurement and observation

The study incorporated both primary and secondary data

3.5.1 Primary data

The primary data included the following:

- A case history (Appendix 4)
- A physical examination (Appendix 5)

- A regional examination of the knee (Appendix 6)
- A motion palpation record sheet (Appendix 8)

3.5.2 Secondary data

The secondary data was obtained from textbooks, journals and the internet.

3.6 Statistical analysis

The data was captured in MS Excel and imported into SPSS version 15.0 (SPSS Inc., Chicago, Illinois) for summary statistics and analysis.

Fleiss Kappa statistics, standard errors of the estimates and 95% confidence intervals were calculated in the symptomatic and the asymptomatic knees separately. The Kappa co-efficient for each direction of motion palpation was determined, this served to evaluate the inter-examiner reliability for the symptomatic and the asymptomatic knees.

The Kappa statistic is a measurement of agreement, beyond that which would be expected by chance. Cohen's Kappa, measures agreement between two raters. Fleiss's Kappa, measures the overall agreement between all the raters. As three examiners were involved in this study, Fleiss's Kappa was used. Kappa co-efficients range from 0-1, the closer it is to 1, the stronger the agreement is considered and the greater the reliability. The following scale was used to interpret the Kappa co-efficient:

<0.00	not better than chance
0.00-0.2	poor
0.21-0.4	fair
0.41-0.6	moderate
0.61-0.8	strong
0.81-1.00	near complete/perfect agreement

The reliability of motion palpation between the symptomatic and asymptomatic knees was compared with the Wilcoxin signed ranks test. Since the symptomatic and asymptomatic knees were paired, paired Wilcoxon signed ranks tests were used, and as the Kappa values were non normally distributed, non parametric testing was used. A 5 % level of significance was utilized and a p value <0.05 was considered as statistically significant (Esterhuizen, 2009).

Chapter 4: The Results

4.1 Introduction

This chapter contains the results of the data collected during the research process. The sample size for the study was 30 patients, each with one symptomatic and one asymptomatic knee, making a sample of sixty knees (n=60 knees) altogether. Data was gathered only from patients that met the research criteria.

4.1.1 Demographics

The first part of the results contains data regarding the demographics of the patients involved in the study. This includes information on gender, age, ethnicity and the symptomatic knee, and also the order in which the examiners motion palpated the knee joint for each patient.

4.1.2 Symptomatic knee joint

The second part of the results relate to the inter-examiner reliability of motion palpation of the symptomatic knee joint. The tables containing the relative data can be found in the appendix, from 9.1.1-9.1.15.

4.1.3 Asymptomatic knee joint

The third part of the results relate to the inter-examiner reliability of motion palpation of the asymptomatic knee joint. The tables containing the relative data can be found in the appendix, from 9.2.1-9.2.15.

In Tables 4-18 and Tables 20-34, which correspond to 4.3.1 - 4.3.15 and 4.4.1 - 4.4.15 respectively, the first column represents the number of the patient whom the data regards, column two indicates the number of examiners who found the joint motion to be normal, column three indicates the number of examiners who found the joint motion to be restricted, and column four indicates the number of examiners who found the joint to be hypermobile.

4.1.4 The effectiveness of motion palpation in identifying a knee joint with patellofemoral pain syndrome

The fourth part of the results are relevant to the ability of motion palpation to identify a knee joint with patellofemoral pain syndrome, as opposed to an asymptomatic knee joint. Fleiss Kappa co-efficient was used to compare the examiners findings (Table 36).

4.1.5 Symptomatic and asymptomatic knees

The fifth part of the results regards the inter-examiner reliability of motion palpation of symptomatic and asymptomatic knees (Tables 37 and 38) using the Wilcoxin signed ranks test.

4.2 Demographic Data

4.2.1 Gender

The sample of patients who participated in the study consisted of 17 males (56.7%) and 13 females (43.3%).

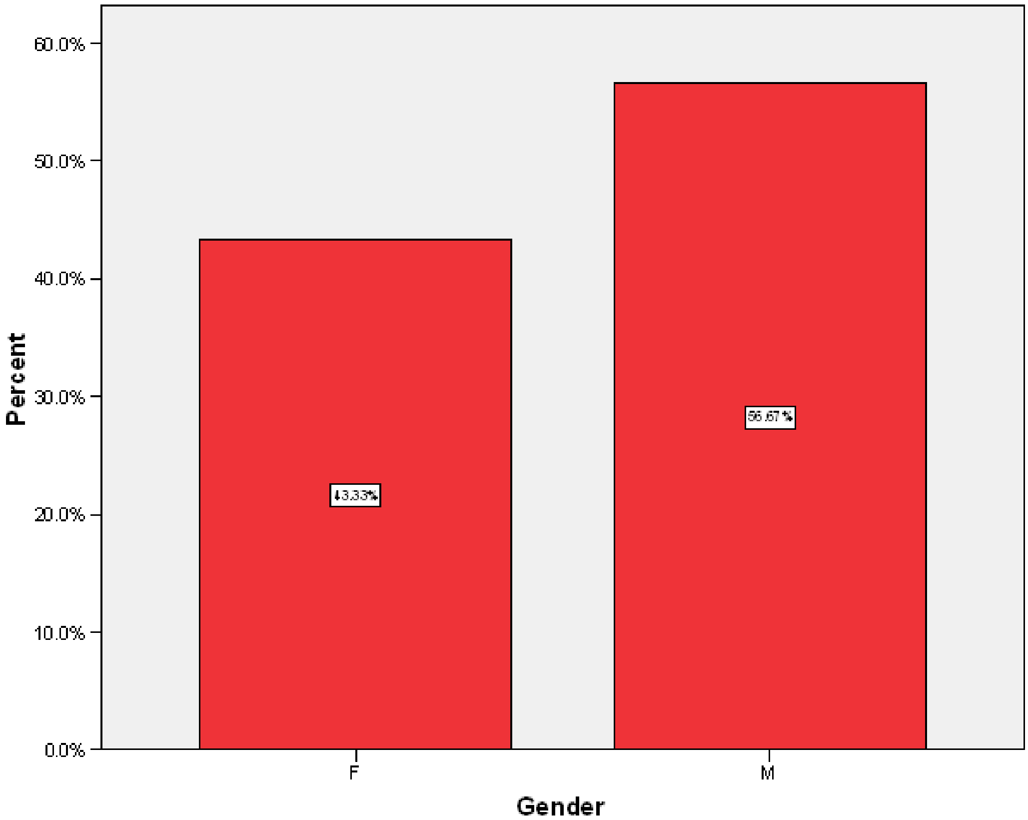

Figure 1 showing the gender of the patients

4.2.2 Age

The mean age of participants in the study was 31.57 years, with standard deviation being 6.8 years. The age range was from 21-44 years of age.

Table 1 showing the age of the patients who participated in the study

N	**Valid**	30
	Missing	0
Mean	31.57	
Standard Deviation	6.771	
Minimum	21	
Maximun	44	

4.2.3 Ethnicity

Of the participants in the study, 77% were White, 10% were Black, 10% were Indian and 3% were Coloured.

Table 2 showing the ethnic distribution of the patients

	Frequency	**Percentage**
White	23	76.7
Black	3	10.0
Indian	3	10.0
Coloured	1	3.3
Total	30	100.0

4.2.4 Symptomatic knee

The left knee was symptomatic in 63.3% of the patients and the right knee was symptomatic in 36.7% of the patients.

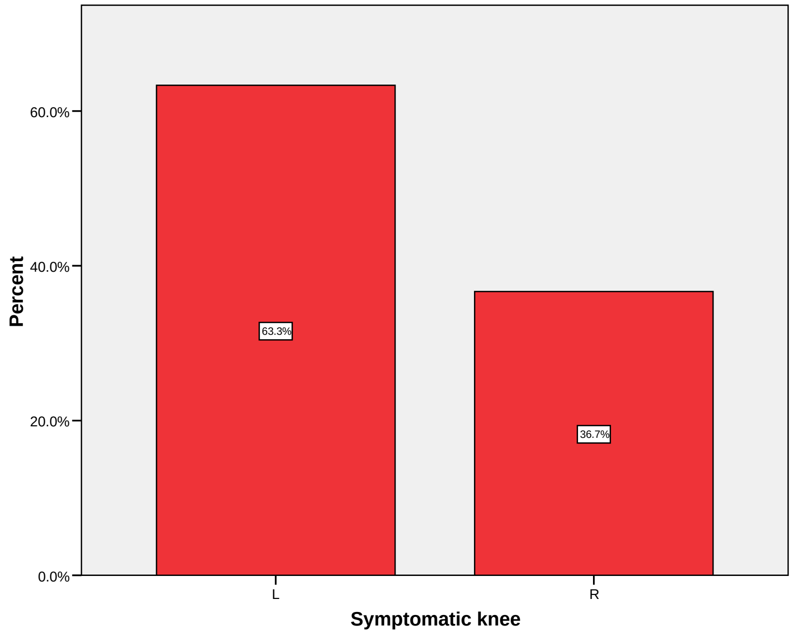

Figure 2 showing which knee was symptomatic with regards to patellofemoral pain syndrome

4.2.5 Order of Examiner

Examiner 1 went first 11 times, second 8 times and third 11 times.
Examiner 2 went first 7 times, second 12 times and third 11 times.
Examiner 3 went first 12 times, second 10 times and third 8 times.

Each examiner palpated in each order several times, therefore the order in which the patients were examined was varied and random.

Table 3 showing the frequency of each order combination in which the examiners motion palpated the knees.

	Frequency	Percentage
1,2,3	7	23.3
2,3,1	6	20.0
3,1,2	7	23.3
1,3,2	4	13.3
2,1,3	1	3.3
3,2,1	5	16.7
Total	30	100.0

4.3. To determine the inter-examiner reliability of motion palpation in symptomatic knees

Data was analyzed using Stat Tools freeware, and the Fleiss Kappa statistics, standard errors of the estimates and 95% confidence intervals were calculated for the symptomatic knees in each direction of motion palpation, these can be found in chapter 4.3.1 to chapter 4.3.15.

Tables 4-18 relating to chapter 4.3.1-4.3.15 can be found in the appendix.

4.3.1 Results for motion palpation of the knee joint in tibiofemoral anterior to posterior (For Table 4 please see appendix 9.1.1)

Overall Kappa = -0.0778
SE = 0.0929
95% CI = -0.2600 to 0.1043

The above data reveals that when assessing the symptomatic knee of each of the thirty patients for tibiofemoral anterior to posterior using motion palpation, overall Kappa was -0.0778, which was very poor agreement.

4.3.2 Results for motion palpation of the knee joint in tibiofemoral posterior to anterior

(For Table 5 please see appendix 9.1.2)

Overall Kappa = -0.0864

SE = 0.0992

95% CI = -0.2807 to 0.1080

The above data reveals that when assessing the symptomatic knee of each of the thirty patients for tibiofemoral posterior to anterior using motion palpation, overall Kappa was -0.0864, which was very poor agreement.

4.3.3 Results for motion palpation of the knee joint in tibiofemoral medial to lateral

(For Table 6 please see appendix 9.1.3)

Overall Kappa = 0.0648

SE = 0.0904

95% CI = -0.1125 to 0.2421

The above data reveals that when assessing the symptomatic knee of each of the thirty patients for tibiofemoral medial to lateral using motion palpation, overall Kappa was 0.0648, which was very poor agreement.

4.3.4 Results for motion palpation of the knee joint in tibiofemoral lateral to medial
(For Table 7 please see appendix 9.1.4)

Overall Kappa = 0.0476

SE = 0.1054

95% CI = -0.1590 to 0.2542

The above data reveals that when assessing the symptomatic knee of each of the thirty patients for tibiofemoral lateral to medial using motion palpation, overall Kappa was 0.0476, which was very poor agreement.

4.3.5 Results for motion palpation of the knee joint in tibiofemoral internal rotation
(For Table 8 please see appendix 9.1.5)

Overall Kappa = -0.0575

SE = 0.0905

95% CI = -0.2349 to 0.1199

The above data reveals that when assessing the symptomatic knee of each of the thirty patients for tibiofemoral internal rotation using motion palpation, overall Kappa was -0.0575, which was very poor agreement.

4.3.6 Results for motion palpation of the knee joint in tibiofemoral external rotation (For Table 9 please see appendix 9.1.6)

Overall Kappa = -0.0375

SE = 0.0889

95% CI = -0.2116 to 0.1367

The above data reveals that when assessing the symptomatic knee of each of the thirty patients for tibiofemoral external rotation using motion palpation, overall Kappa was -0.0375, which was very poor agreement.

4.3.7 Results for motion palpation of the knee joint in tibiofemoral long axis distraction (For Table 10 please see appendix 9.1.7)

Overall Kappa = -0.1308

SE = 0.0978

95% CI = -0.3225 to 0.0610

The above data reveals that when assessing the symptomatic knee of each of the thirty patients for tibiofemoral long axis distraction using motion palpation, overall Kappa was -0.1308, which was very poor agreement.

4.3.8 Results for motion palpation of the knee joint in anterior to posterior of the proximal tibiofibular joint (For Table 11 please see appendix 9.1.8)

Overall Kappa = 0.0707

SE = 0.1018

95% CI = -0.1289 to 0.2703

The above data reveals that when assessing the symptomatic knee of each of the thirty patients for anterior to posterior movement of the proximal tibiofibular joint using motion palpation, overall Kappa was 0.0707, which was very poor agreement.

4.3.9 Results for motion palpation of the knee joint in posterior to anterior of the proximal tibiofibular joint (For Table 12 please see appendix 9.1.9)

Overall Kappa = -0.2081

SE = 0.0980

95% CI = -0.4001 to -0.0160

The above data reveals that when assessing the symptomatic knee of each of the thirty patients for posterior to anterior movement of the proximal tibiofibular joint using motion palpation, overall Kappa was -0.2081, which was very poor agreement.

4.3.10 Results for motion palpation of the knee joint in superior to inferior of the proximal tibiofibular joint (For Table 13 please see appendix 9.1.10)

Overall Kappa = -0.1734

SE = 0.1006

95% CI = -0.3705 to 0.0238

The above data reveals that when assessing the symptomatic knee of each of the thirty patients for superior to inferior movement of the proximal tibiofibular joint using motion palpation, overall Kappa was -0.1734, which was very poor agreement.

4.3.11 Results for motion palpation of the knee joint in inferior to superior of the proximal tibiofibular joint (For Table 14 please see appendix 9.1.11)

Overall Kappa = -0.1899

SE = 0.1054

95% CI = -0.3965 to 0.0167

The above data reveals that when assessing the symptomatic knee of each of the thirty patients for inferior to superior movement of the proximal tibiofibular joint using motion palpation, overall Kappa was -0.1899, which was very poor agreement.

4.3.12 Results for motion palpation of the knee joint in superior to inferior glide of the patella

(For Table 15 please see appendix 9.1.12)

Overall Kappa = 0.1802

SE = 0.1054

95% CI = -0.0264 to 0.3868

The above data reveals that when assessing the symptomatic knee of each of the thirty patients for superior to inferior glide of the patella, using motion palpation, overall Kappa was 0.1802, which was very poor agreement.

4.3.13 Results for motion palpation of the knee joint in inferior to superior glide of the patella

(For Table 16 please see appendix 9.1.13)

Overall Kappa = 0.0435

SE = 0.1054

95% CI = -0.1631 to 0.2501

The above data reveals that when assessing the symptomatic knee of each of the thirty patients for inferior to superior glide of the patella, using motion palpation, overall Kappa was 0.0435, which was very poor agreement.

4.3.14 Results for motion palpation of the knee joint in medial to lateral glide of the patella (For Table 17 please see appendix 9.1.14)

Overall Kappa = -0.0687

SE = 0.1019

95% CI = -0.2685 to 0.1310

The above data reveals that when assessing the symptomatic knee of each of the thirty patients for medial to lateral glide of the patella, using motion palpation, overall Kappa was -0.0687, which was very poor agreement.

4.3.15 Results for motion palpation of the knee joint in lateral to medial glide of the patella (For Table 18 please see appendix 9.1.15)

Overall Kappa = 0.0500

SE = 0.1054

95% CI = -0.1566 to 0.2566

The above data reveals that when assessing the symptomatic knee of each of the thirty patients for lateral to medial glide of the patella, using motion palpation, overall Kappa was 0.0500, which was very poor agreement.

In summary, Kappa scores for the patellofemoral pain syndrome group are, per direction:

Table 19 summary of the Kappa scores for the patellofemoral pain syndrome group

Direction of MP	Kappa score
T/F AP	-0.0778
T/F PA	-0.0864
T/F ML	0.0648
T/F LM	0.0476
T/F int rot	-0.0575
T/F ext rot	-0.0375
T/F LAD	-0.1308
T/f AP	0.0707
T/f PA	-0.2081
T/f SI	-0.1734
T/f IS	-0.1899
P SI	0.1802
P IS	0.0435
P ML	-0.0687
P LM	0.0500

The results highlighted in Table 19 suggest overall poor agreement for motion palpation of the asymptomatic knee joint.

4.4 To determine the inter-examiner reliability of motion palpation in asymptomatic knees

Data was analyzed using Stat Tools freeware, and the Fleiss Kappa statistics, standard errors of the estimates and 95% confidence intervals were calculated for the asymptomatic knees in each direction of motion palpation, these can be found in chapter 4.4.1 to chapter 4.4.15.

Tables 20-34 relating to chapter 4.4.1-4.4.15 can be found in the appendices.

4.4.1 Results for motion palpation of the knee joint in tibiofemoral anterior to posterior
(For Table 20 please see appendix 9.2.1)

Overall Kappa = -0.0534
SE = 0.1004
95% CI = -0.2502 to 0.1434

The above data reveals that when assessing the asymptomatic knee of each of the thirty patients for tibiofemoral anterior to posterior using motion palpation, overall Kappa was -0.0534, which was very poor agreement.

4.4.2 Results for motion palpation of the knee joint in tibiofemoral posterior to anterior
(For Table 21 please see appendix 9.2.2)

Overall Kappa = -0.0272
SE = 0.0995
95% CI = -0.2222 to 0.1678

The above data reveals that when assessing the asymptomatic knee of each of the thirty patients for tibiofemoral posterior to anterior using motion palpation, overall Kappa was -0.0272, which was very poor agreement.

4.4.3 Results for motion palpation of the knee joint in tibiofemoral medial to lateral
(For Table 22 please see appendix 9.2.3)

Overall Kappa = -0.1213

SE = 0.0809

95% CI = -0.2798 to 0.0373

The above data reveals that when assessing the asymptomatic knee of each of the thirty patients for tibiofemoral medial to lateral using motion palpation, overall Kappa was -0.1213, which was very poor agreement.

4.4.4 Results for motion palpation of the knee joint in tibiofemoral lateral to medial
(For Table 23 please see appendix 9.2.4)

Overall Kappa = -0.0753

SE = 0.0899

95% CI = -0.2515 to 0.1008

The above data reveals that when assessing the asymptomatic knee of each of the thirty patients for tibiofemoral lateral to medial using motion palpation, overall Kappa was -0.0753, which was very poor agreement.

4.4.5 Results for motion palpation of the knee joint in tibiofemoral internal rotation (For Table 24 please see appendix 9.2.5)

Overall Kappa = -0.0843

SE = 0.0848

95% CI = -0.2506 to 0.0819

The above data reveals that when assessing the asymptomatic knee of each of the thirty patients for tibiofemoral internal rotation using motion palpation, overall Kappa was -0.0843, which was very poor agreement.

4.4.6 Results for motion palpation of the knee joint in tibiofemoral external rotation (For Table 25 please see appendix 9.2.6)

Overall Kappa = -0.0582

SE = 0.0869

95% CI = -0.2285 to 0.1120

The above data reveals that when assessing the asymptomatic knee of each of the thirty patients for tibiofemoral external rotation using motion palpation, overall Kappa was -0.0582, which was very poor agreement.

4.4.7 Results for motion palpation of the knee joint in tibiofemoral long axis distraction (For Table 26 please see appendix 9.2.7)

Overall Kappa = -0.2836

SE = 0.0981

95% CI = -0.4759 to -0.0913

The above data reveals that when assessing the asymptomatic knee of each of the thirty patients for tibiofemoral long-axis distraction using motion palpation, overall Kappa was -0.2836, which was very poor agreement.

4.4.8 Results for motion palpation of the knee joint in anterior to posterior of the proximal tibiofibular joint (For Table 27 please see appendix 9.2.8)

Overall Kappa = -0.0688

SE = 0.0958

95% CI = -0.2565 to 0.1189

The above data reveals that when assessing the asymptomatic knee of each of the thirty patients for anterior to posterior motion of the proximal tibiofibular joint using motion palpation, overall Kappa was -0.0688, which was very poor agreement.

4.4.9 Results for motion palpation of the knee joint in posterior to anterior of the proximal tibiofibular joint (For Table 28 please see appendix 9.2.9)

Overall Kappa = -0.1267

SE = 0.0957

95% CI = -0.3142 to 0.0608

The above data reveals that when assessing the asymptomatic knee of each of the thirty patients for posterior to anterior motion of the proximal tibiofibular joint using motion palpation, overall Kappa was -0.1267, which was very poor agreement.

4.4.10 Results for motion palpation of the knee joint in superior to inferior of the proximal tibiofibular joint (For Table 29 please see appendix 9.2.10)

Overall Kappa = -0.0081

SE = 0.1011

95% CI = -0.2063 to 0.1901

The above data reveals that when assessing the asymptomatic knee of each of the thirty patients for superior to inferior motion of the proximal tibiofibular joint using motion palpation, overall Kappa was -0.0081, which was very poor agreement.

4.4.11 Results for motion palpation of the knee joint in inferior to superior of the proximal tibiofibular joint (For Table 30 please see appendix 9.2.11)

Overall Kappa = -0.0829

SE = 0.1054

95% CI = -0.2895 to 0.1237

The above data reveals that when assessing the asymptomatic knee of each of the thirty patients for inferior to superior motion of the proximal tibiofibular joint using motion palpation, overall Kappa was -0.0829, which was very poor agreement.

4.4.12 Results for motion palpation of the knee joint in superior to inferior glide of the patella (For Table 31 please see appendix 9.2.12)

Overall Kappa = 0.0081

SE = 0.0990

95% CI = -0.1858 to 0.2021

The above data reveals that when assessing the asymptomatic knee of each of the thirty patients for superior to inferior glide of the patella, using motion palpation, overall Kappa was 0.0081, which was very poor agreement.

4.4.13 Results for motion palpation of the knee joint in inferior to superior glide of the patella (For Table 32 please see appendix 9.2.13)

Overall Kappa = 0.0339

SE = 0.0990

95% CI = -0.1602 to 0.2279

The above data reveals that when assessing the asymptomatic knee of each of the thirty patients for inferior to superior glide of the patella, using motion palpation, overall Kappa was 0.0339, which was very poor agreement.

4.4.14 Results for motion palpation of the knee joint in medial to lateral glide of the patella (For Table 33 please see appendix 9.2.14)

Overall Kappa = -0.0405

SE = 0.0989

95% CI = -0.2344 to 0.1535

The above data reveals that when assessing the asymptomatic knee of each of the thirty patients for medial to lateral glide of the patella, using motion palpation, overall Kappa was -0.0405, which was very poor agreement.

4.4.15 Results for motion palpation of the knee joint in lateral to medial glide of the patella

(For Table 34 please see appendix 9.2.15)

Overall Kappa = 0.1187

SE = 0.1054

95% CI = -0.0879 to 0.3253

The above data reveals that when assessing the asymptomatic knee of each of the thirty patients for lateral to medial glide of the patella, using motion palpation, overall Kappa was 0.1187, which was very poor agreement.

In summary, Kappa scores for the asymptomatic knee are, per direction:

Table 35 Summary of the Kappa scores for the asymptomatic knee

Direction of MP	Kappa score
T/F AP	-0.0534
T/F PA	-0.0272
T/F ML	-0.1213
T/F LM	-0.0753
T/F int rot	-0.0843
T/F ext rot	-0.0582
T/F LAD	-0.2836
T/f AP	-0.0688
T/f PA	-0.1267
T/f SI	-0.0081
T/f IS	-0.0829
P SI	0.0081
P IS	0.0339
P ML	-0.0405
P LM	-0.1187

The results highlighted in Table 35 suggest overall poor agreement for motion palpation of the asymptomatic knee joint.

4.5 To determine the effectiveness of motion palpation in identifying a knee joint with patellofemoral pain syndrome, when compared to an asymptomatic knee joint

Table 36 depicts the findings of the examiners with regard to which knee was symptomatic. Column one indicates the patient number and column two, the number of examiners who motion palpated the knee joints. Column three shows the number of examiners who correctly identified the symptomatic knee and column four shows the number of examiners who incorrectly identified the symptomatic knee.

Table 36 showing examiner data for detecting the symptomatic knee

Patient number	Number of examiners	Number of examiners identifying the symptomatic knee	Number of examiners misidentifying the symptomatic knee
1	3	1	2
2	3	2	1
3	3	1	2
4	3	1	2
5	3	2	1
6	3	1	2
7	3	1	2
8	3	2	1
9	3	2	1
10	3	1	2
11	3	2	1
12	3	3	0
13	3	1	2
14	3	1	2
15	3	1	2
16	3	1	2
17	3	1	2
18	3	0	3
19	3	1	2
20	3	1	2
21	3	2	1
22	3	3	0
23	3	2	1
24	3	0	3
25	3	2	1
26	3	0	3
27	3	3	0
29	3	1	2
29	3	1	2
30	3	2	1

Overall Kappa = -0.0714

SE = 0.1054

95% CI = -0.2780 to 0.1352

The results of Table 36 reveal that using motion palpation in isolation, to identify the symptomatic knee of each of the thirty patients, produced a Kappa score of -0.0714. This shows poor effectiveness of motion palpation in identifying a knee joint with patellofemoral pain syndrome.

4.6 To compare the inter-examiner reliability of motion palpation of symptomatic and asymptomatic knees

Data was analyzed using Stat Tools freeware, and the Wilcoxin signed ranks test was used to compare the reliability of motion palpation between the symptomatic and asymptomatic knees. A Boxplot graph was used to present findings.

Kappa values were extracted from objectives 1 and 2, and compared between the symptomatic and asymptomatic knees in the sample of 15 tests. Non parametric testing was used since the Kappa values were not normally distributed. Paired Wilcoxon signed ranks test were used since the symptomatic and asymptomatic knees were paired.

Table 37 shows that in 7 of the directions of motion palpation (a), the Kappa value was greater for the asymptomatic than the symptomatic knee. While in 8 of the directions of motion palpation (b), the Kappa value was greater for the symptomatic than the asymptomatic knees.
There were no directions of motion palpation in which the Kappa values were tied for the symptomatic and the asymptomatic knees.

Table 37 showing results of the Wilcoxin signed ranks test

	N	Mean Rank	Sum of Ranks
Negative Ranks	7(a)	7.29	51.00
Positive Ranks	8(b)	8.63	69.00
Ties	0(c)		
Total	15		

a symptomatic < asymptomatic
b symptomatic > asymptomatic
c symptomatic = asymptomatic

Table 38 shows that there was a non significant difference in Kappa values between the two groups (p=0.609). The numbers of positive and negative ranks were similar.

Table 38 showing test statistics(b) for the Wilcoxin signed ranks test

	symptomatic - asymptomatic
Z	-.511(a)
Asymp. Sig. (2-tailed)	.609

a Based on negative ranks.

b Wilcoxon Signed Ranks Test

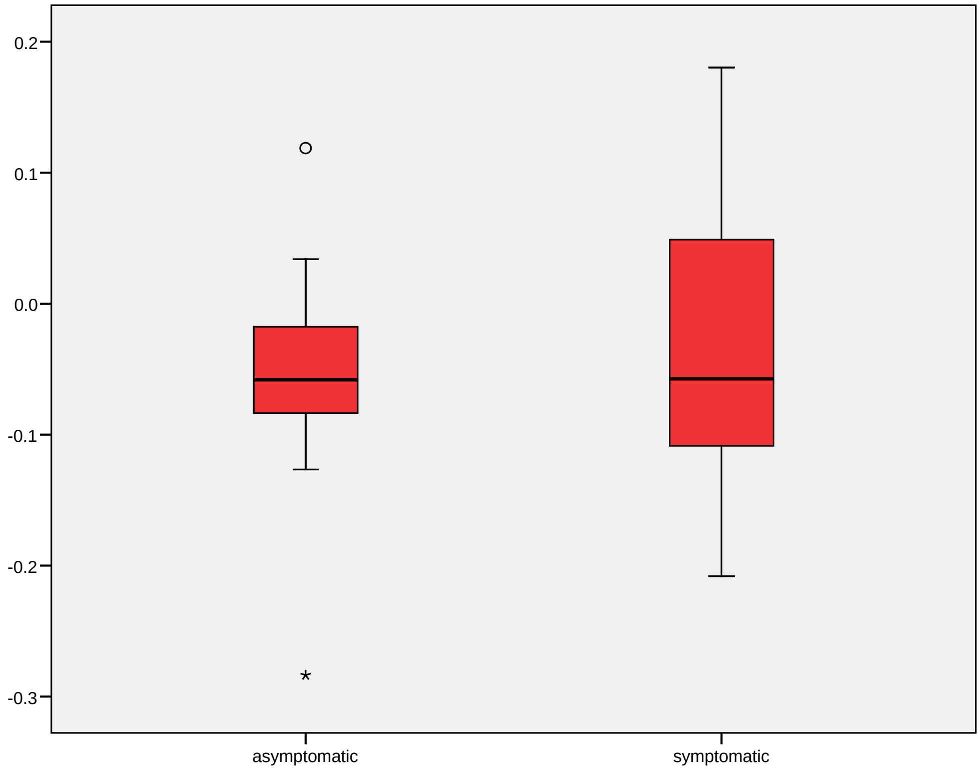

Figure 3 Boxplot of the distribution of Kappa values between the asymptomatic and symptomatic knees

Figure 3 illustrates the range of Kappa values for the asymptomatic and symptomatic knees. The red box represents the 50% median of the Kappa values, with the darkened horizontal black line being the actual/exact median. The vertical lines on either side represent the outside 25% of Kappa values and the dot represents values that were far outside the range, and so were discarded.
The general distribution of Kappa values was less spread out in the asymptomatic group but the median values were similar in both groups.

The above data reveals that there is no statistically significant difference when comparing the inter-examiner reliability findings for motion palpation of asymptomatic and symptomatic knees.

Chapter 5: Discussion

5.1 Introduction

This chapter is a discussion of the results of the statistical analysis represented by the figures and tables of the previous chapter.

Both knees of the 30 patients were motion palpated by the three examiners respectively, and their findings were recorded. These were then analyzed using the Fleiss Kappa coefficient to measure agreement between three or more examiners. The Kappa statistic for each direction of motion palpation was calculated for the symptomatic and for the asymptomatic knee. Overall Kappa values showed very poor agreement. This implies that the examiners were unable to successfully identify restrictions of motion of the knee joint.

5.2 Demographic Data

5.2.1 Gender

In total, 30 patients participated in this study. This included 17 (56,7%) males, and 13 (43,3%) females. The literature states that females have a greater predisposition to patellofemoral pain syndrome than males (Boucher and Hodgdon, 1993; Davidson, 1993; Hutchinson and Ireland, 1995 and Thomee *et al.* 1995).
Much of the patient recruitment was done at sports events and clubs where there is greater male participation, this may account for the increased number of male participants. In previous studies involving patellofemoral pain syndrome that have been carried out in South Africa, a higher percentage of males have participated (Stakes, 2000, Clifton, 2003 and Scott, 2005). This study correlates with these findings.

5.2.2 Age

The age of participants in the study ranged from 21 to 44 years, with the mean age being 31.57 years. Patellofemoral pain syndrome is a common knee problem, which occurs most often in adolescents, young adults and sports men and women (Boucher and Hodgdon, 1993, Davidson, 1993; and Potter and Sequeira, 2009). According to Kannus, Natri, Paakkala and Jarvinen (1999) it affects individuals between the ages of 10 and 20 years.

However, other studies on patellofemoral pain syndrome carried out at the Durban University of Technology (Clifton, 2002; Scott, 2005; Vaghmaria, 2006), found the mean age of participants to be from 29.6 years to 42.1, making 31.57 years well within the expected range.

5.2.3 Ethnicity

The majority of the participants in this study were White (77%). Other ethnic groups who took part were Black (10%), Indian (10%) and Coloured (3%). There was no correlation between the distribution of ethnicity in this study and the various ethnic groups in the Durban area.

The racial distribution could be accounted for in that this study relied on a response of the public to an advertisement, which was only available in English (Appendix 1), or on the self selection of patients who already attended the Durban University of Technology Chiropractic Day Clinic.

5.2.4 Symptomatic knee

Of the patients who took part in this study, 19 (63%) had symptomatic left knees, while 11 (37%) patients had symptomatic right knees. The exclusion criteria excluded patients who suffered from patellofemoral pain syndrome in both knees, therefore all patients included were those with only one symptomatic knee.

No biomechanical reason for the left knee being more susceptible to patellofemoral pain syndrome than the right knee was found. The predominance of this condition in the left knee may be due to type II statistical errors, which may be prevented by using a larger sample size.

5.2.5 Order of examiner

The order of examination by the three examiners was randomly determined,
with each examiner palpating in each order several times.
The order in which the patients were examined was therefore varied and random, giving no one examiner the advantage of repeatedly palpating the joint first.

5.3 The inter-examiner reliability of motion palpation in symptomatic knees

It was hypothesized that there would be inter-examiner reliability of motion palpation of knee joints with patellofemoral pain syndrome.

For Objective One, the motion palpation findings of the three examiners were analyzed using Fleiss Kappa coefficient. A Kappa score for each direction of motion palpation for the symptomatic knee was calculated to assess the reliability between examiners.

As seen from Tables 4-18 the Kappa scores for motion palpation of the symptomatic knee joint ranged from -0.2081 to 0.1802. A Kappa score of below 0.2 is considered poor agreement. As all the scores were below 0.2, the result for the reliability of motion palpation of symptomatic knee joints in this study was poor agreement. This implies that the examiners were unable to reliably identify restrictions of motion of the symptomatic knee joint when using motion palpation in isolation.

These findings correlate with the findings of other motion palpation studies on symptomatic patients. Brinkley *et al.* (1995) found poor inter-examiner reliability while assessing for lumbar accessory motion and Schneider *et al.* (2008) found results to be poor and in many cases worse than chance in the assessment of lumbar segmental mobility. A review of the literature on motion palpation reveals that reliability is generally poor to fair (Panzer, 1992, van Trijffel, Anderegg, Bossuyt and Lucas, 2005 and Stochkendahl *et al*. 2006).

The only existing motion palpation study on the knee, involving symptomatic patients was by Vaghmaria (2006). It involved motion palpation of the patellofemoral joint in patients with osteoarthritis and patients with patellofemoral pain syndrome. The results conflict with the results of this study, in that reliability was fair. Vaghmaria (2006) stated that the reason for the high rates of examiner agreement could have been due to chance. Also, examiners worked in a close environment and directly contacted the patient, therefore the possibility of communication between them could not be ruled out.

The results of this study, indicate poor agreement and thus poor reliability for the inter-examiner reliability of motion palpation of symptomatic knee joints. Thus the hypothesis is rejected.

5.4 The inter-examiner reliability of motion palpation in asymptomatic knees

It was hypothesized that there would be inter-examiner reliability of motion palpation of asymptomatic knee joints.

For Objective Two, the motion palpation findings of the three examiners were analysed using Fleiss Kappa coefficient. A Kappa score for each direction of motion palpation for the asymptomatic knee was calculated to assess the reliability between examiners.

The Kappa scores for motion palpation of the asymptomatic knee ranged from -0.2836 to 0.0339, as can be seen in Table 35. A Kappa score of below 0.2 is considered poor agreement. As all the scores are in this range, the result for the reliability of motion palpation of asymptomatic knee joints in this study was poor agreement. This implies that the examiners were unable to reliably identify restrictions of motion of the asymptomatic knee joint when using motion palpation in isolation.

In other motion palaption studies carried out on asymptomatic patients similar results have been found. Love and Brodeur (1987) found that inter-examiner reliability of the thoraco-lumbar spine was not statistically significant, and Hawk, Phonqphau, Bleecker, Swank, Lopez and Rubley (1999) found inter-examiner reliability for motion palpation of the lumbar spine to be poor to slight. A review of the literature on motion palpation reveals that reliability is generally poor to fair (Panzer, 1992, van Trijffel *et al*. 2005 and Stochkendahl *et al.* 2006).

In a study assessing the reliability of motion palpation of the patella on asymptomatic patients, Bezuidenhout (2002) found that reliability was fair, with Kappa ranging from 0.00-0.048. However, the Kappa rating scale used in Bezuidenhout's research was different from that of this study and of other research, in that a score of 0.00-0.20 would be viewed as poor agreement, and 0.20-0.40 fair agreement. Consequently, a direct comparison of research findings is not feasible.

The results of this study, indicate poor agreement and thus poor reliability for the inter-examiner reliability of motion palpation of asymptomatic knee joints. Thus the hypothesis is rejected.

5.5 The effectiveness of motion palpation in identifying a knee joint with patellofemoral pain syndrome

It was hypothesised that motion palpation would be effective in identifying a knee joint with patellofemoral pain syndrome, when compared to an asymptomatic knee joint.

For Objective Three, the Fleiss Kappa coefficient was calculated using the findings of the examiners, as to which knee was symptomatic. This resulted in a Kappa score that demonstrated how reliable motion palpation was at determining which knee was symptomatic. The Kappa score for the effectiveness of motion palpation, in isolation, in identifying a symptomatic knee joint, when compared to an asymptomatic knee joint was -0.0714.

A Kappa score of below 0.2 is considered poor agreement. As the score was below this number, the result was poor agreement. Thus, the examiners were unable to effectively identify which of the two knees was symptomatic, by using motion palpation in isolation, as there was no palpable difference between the symptomatic and asymptomatic knees.

In an unblinded study by Brantingham *et al.* (1997), motion palpators strongly agreed that movement was restricted in the symptomatic feet of the patients examined, as opposed to the asymptomatic feet. Therefore, a symptomatic foot may be distinguished from an asymptomatic foot by motion palpation alone. The results of Brantingham's study conflict with the results of this study, but may serve to highlight the difficulty in identifying a symptomatic joint when an examiner is blinded.

Because the process of motion palpation requires movement and stressing of the joint in various directions, it can contribute to restoring mobility to a joint with restricted motion. As each of the patients was motion palpated three times, the joint was in a different state on the first and third examination. This may have lead to an initially restricted joint gaining mobility by the third examination, and thus being recorded as unrestricted.

Many of the patients who participated in this study were long distance runners, who were covering large distances at the time. Although the asymptomatic knee was pain and injury free, it was still subjected to loads far above normal use. This overload, may have created muscle tightness and imbalance, as well as repetitive microtrauma, imperceptible to the patient, but which could have lead to abnormal joint motion/restrictions. In these instances it may be more difficult to distinguish between the symptomatic and asymptomatic knee.

The examiners in this study were final year students, with limited experience in clinical diagnosis and motion palpation. Although studies have shown that clinical experience does not affect the reliability of manual examinations (Stochkendahl, Christensen, Hartvigsen, Vach, Haas, Hestbaek, Adams and Bronfort, 2006 and Seffinger, Najm. Mishra, Adams, Dickerson, Murphy and Reinsch, 2004), motion palpation is a subjective tool and experience may enable the motion palpator to discern more subtle differences in joint motion.

Motion palpation is subjective as it relies on the senses of the examiner, and is dependent on their individual perception. An examiner is constantly subjected to changing psychological and physical factors, which may influence their ability to motion palpate and the reliability of that motion palpation.

In line with the findings of this study, the application of motion palpation as a diagnostic tool used in isolation appears to be unreliable. Motion palpation was not effective in identifying a knee joint with patellofemoral pain syndrome, therefore, the hypothesis is rejected.

5.6 The inter-examiner reliability of motion palpation of symptomatic and asymptomatic knees

It was hypothesized that there would be no difference when comparing the inter-examiner findings for motion palpation of symptomatic and asymptomatic knees.

To test this hypothesis, the Kappa scores from Objectives One and Two were extracted for all of the 15 different directions of motion palpation. This data was analysed using a paired Wilcoxin signed ranks test to compare the reliability of motion palpation between the symptomatic and asymptomatic knees.

For the Wilcoxin signed ranks test, there was no significant difference in Kappa values ($p = 0.609$) for the two groups and the number of positive and negative ranks were similar. This indicates that the reliability of motion palpation in both groups was similar.

The Boxplot graph represents the distribution of Kappa values for the symptomatic and the asymptomatic knees. The general distribution of Kappa values was less spread out in the asymptomatic group, but the median values were similar in both. Less variance in the Kappa values for the asymptomatic group suggests more reliability. However, the difference is not statistically significant.

There was no literature available which compared the inter-examiner reliability between symptomatic and asymptomatic patients. However, a review of the literature on spinal palpation for the diagnosis of back and neck pain by Seffinger *et al.* (2004) found that the use of symptomatic patients in inter-examiner reliability studies did not improve the reliability of motion palpation overall. These findings draw a parallel to the result of this study.

Motion palpation is a tool for assessing joint motion (Bergmann *et al.* 1993). Motion of the symptomatic joint is compared to that of the asymptomatic joint to determine whether joint motion is restricted or not. Thus it is intended to discern both normal and restricted joint motion, and should be equally reliable at assessing symptomatic and asymptomatic joints.

According to the findings of this study, there is no statistically significant difference when comparing the inter-examiner reliability findings for motion palpation of symptomatic and asymptomatic knees. Thus motion palpation was show to be an equally reliable tool when assessing a symptomatic and an asymptomatic knee joint.
Consequently the hypothesis is accepted.

Chapter 6: Conclusions and Recommendations

6.1 Conclusion

The first objective of this study was to determine the inter-examiner reliability of motion palpation of knee joints with patellofemoral pain syndrome. The motion palpation findings of the three examiners were analyzed to form a Kappa score for each direction of motion palpation. For the symptomatic knee joints, the Kappa scores ranged from -0.2081 to 0.1802. This indicates poor reliability of motion palpation, when used in isolation for assessing the symptomatic knee joint.

The second objective was to determine the inter-examiner reliability of motion palpation of knee joints that are asymptomatic. For this objective, the motion palpation findings of the three examiners were also analyzed to form a Kappa score for each direction of motion palpation. For the asymptomatic knee joints, the Kappa scores ranged from -0.2836 to 0.0339. This also indicates poor reliability of motion palpation, when used in isolation for assessing the asymptomatic knee joint.

The overall findings of this research with regards to the reliability of motion palpation of the knee joint are that it demonstrates poor reliability in both the symptomatic and the asymptomatic knee joint when used in isolation as an assessment tool.

The third objective was to assess effectiveness of motion palpation in identifying a knee joint with patellofemoral pain syndrome, when compared to an asymptomatic knee joint. The Kappa coefficient was calculated using the findings of the examiners, as to which knee was symptomatic. This resulted in a Kappa score of -0.0714. This indicates poor agreement between the examiners and implies that they were unable to effectively identify which of the two knees was symptomatic, by using motion palpation in isolation.

The fourth objective of this study was to compare the inter-examiner reliability of motion palpation of knee joints in patellofemoral pain syndrome and asymptomatic knees. Here the Kappa scores from objectives 1 and 2 were extracted for all of the 15 directions of motion palpation. This data was analyzed using the paired Wilcoxin signed ranks test. There was no significant difference in the Kappa values for the symptomatic and the asymptomatic group and the number of positive and negative ranks were similar.

This indicates that there is no difference when comparing the inter-examiner findings and that the use of symptomatic patients does not improve the reliability of motion palpation in the knee joint.

6.2 Recommendations

Methodological recommendations:

- In studies to date, emphasis has been place on using a homogenous patient group. As a motion palpation study is not intended to evaluate the patient, but rather the examiner's use of the specific technique of motion palpation, the focus should be placed on greater standardization of examiners and the technique used. Practice sessions should be continued throughout the data collection phase to maintain exact technique, this is especially important if data collection occurs over an extended period of time. Examiners should have a time of focus before each examination session commences, to eliminate psychological and physical influences that differ from day to day.
- Grading of mobility in this study was of normal, restricted or hypermobile joint motion. By using only two gradings (normal or restricted) the Kappa values for reliability could be improved.
- The demographics of the patient group in this study were not reflective of the population of the study area. In future such studies, advertisements could be made in other languages to help attract patients of different ethnic groups, making the sample a reflection of the population of the research area.
- Due to time constraints a sample of thirty patients was used in this study. A larger sample size will help to prevent statistical errors and it will also be more representative of the population of the study area.
- Although studies have shown that clinical experience does not affect the reliability of manual examinations, motion palpation is a subjective tool and experience may enable the motion palpator to discern more subtle differences in joint motion. Future studies may be improved by using examiners with more clinical and motion palpation experience.

Recommendations for further research in this field of study:

- Motion palpation in isolation has been shown to have relatively poor reliability. In the future motion palpation research should focus on diagnostic testing using a combination of tests, in order to more closely mimic the clinical setting in which it is used.
- To improve the reliability of motion palpation there needs to be standardization of the technique that is used in both the extremity and spinal joints. Motion palpation research has thus far focused on the reliability of the procedure overall. Future research could compare motion palpation techniques and methods of instruction, with the aim of developing a standardized technique.
- There is limited literature available on the reliability of motion palpation of the extremity joints. Further research in this area will help to identify the role that motion palpation plays in the diagnosis and treatment of extremity conditions, leading to more effective patient management.
- Studies to assess the validity of motion palpation are important in promoting the credibility of manipulative therapy of the extremity joints. Although its reliability has not yet been established, validity may be investigated through correlating results with patient symptoms, other diagnostic test results and treatment outcome.

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Appendix 1

Are you between the ages of

18-45 years

and suffer from

KNEE PAIN

in one knee,
with one pain free knee?

Research is currently being carried out at the

Durban University
Of Technology
Chiropractic Day Clinic

One free treatment

is available after the study to those who qualify to take part

For more information
contact

Claire

On

031 2042205/2512

Appendix 2

Telephonic Interview

Date:____

Patient name:_________________________________

Contact number:______________________________

Questions to be asked during the telephonic interview:

1. Age ______________

2. Do you have anterior/front knee pain, or knee pain around your knee cap in one knee, with the other knee pain free Y N

3. Have you ever had : Knee surgery Y N

   Knee injury Y N

   Description if yes ____
   ____
   ____

4. Have you been diagnosed with gout or arthritis? Y N

5. Are you pregnant or breastfeeding? Y N

6. Are you suffering from the following, in one of your knees? (Patients must answer yes to at least 2 of the following 4 questions)

   Do you experience pain:

   During and/or after activity? Y N

   During and or after sitting? Y N

   During walking up/down stairs? Y N

   During squatting? Y N

Appendix 3

Letter of Information and consent

Dear Patient,

Title of the study:

The inter-examiner reliability and a comparison of motion palpation findings of the knee joint in patella-femoral pain syndrome and asymptomatic knees.

Researcher: Claire Farrimond Supervisor: Dr H. Kretzmann
M Dip Chiropractic
031 3732512 031 2055520

Welcome to this research study on the reliability of motion palpation findings of the knee joint in PFPS (anterior/front knee pain) and asymptomatic (pain free) patients. I am investigating the reliability of different examiners being able to find the same characteristic when they assess the movement of your knee joint.

You will be required to undergo a brief medical history, physical examination and a thorough knee examination, and if there are no contra-indications to motion palpation and you fit the inclusion criteria, you will be included in the study. You will then be required to have both of your knee joints examined by three different examiners in order to assess for movement or lack thereof.

You are assured that your confidentiality will be maintained and the results will be used for research purposes only. The researcher, research supervisor and/or research ethics representative may inspect the records.

Your full cooperation in this study will enable the chiropractic profession to get a better understanding about the procedures we use to assess if there are any problems with movement of a joint.

There is no risk to participating in this study. Participation is free and will be performed under the supervision of a qualified chiropractor and you are free to leave the research at anytime with no consequences. On completion of the study you will be entitled to one free treatment at Durban University of Technology Chiropractic Day Clinic for any knee pain, valid for one month from the day of your participation.

If you need to discuss any further matters, feel free to contact myself or my supervisor and if you have any complaints you may contact the Durban University of Technology Faculty of Health Research Ethics Committee (Mr. V. Singh 031 3732701).

Thank you

Yours sincerely
Claire Farrimond
Senior Chiropractic Intern

Statement of agreement to participate in the research study

I…………………….(full name)……………………(ID number), have read this document in its entirety and understand its contents. Where I have had any questions or queries, these have been explained to me by Claire Farrimond to my satisfaction. Furthermore, I fully understand that I may withdraw from this study at any stage without any adverse consequences and my future health care will not be compromised. I therefore voluntarily agree to participate in this study.

Subjects name (print)……………Subjects signature……………..……Date…………..

Researchers name (print)……………Researchers signature………...Date…………..

Witness name (print)…………..…Witness signature…………………..Date………….

Appendix 4

DURBAN UNIVERSITY OF TECHNOLOGY
CHIROPRACTIC DAY CLINIC
CASE HISTORY

Patient: ______________________________ Date: __________

File # __________ Age: __________

Sex : __________ Occupation: ______________________________

Intern : ____________________ Signature: ____________________

FOR CLINICIANS USE ONLY:
Initial visit
Clinician: Signature :

Case History:

Examination:
Previous: Current:

X-Ray Studies:
Previous: Current:

Clinical Path. lab:
Previous: Current:

CASE STATUS:

PTT:	Signature:	Date:

CONDITIONAL: Reason for Conditional:
Signature: Date:

Conditions met in Visit No:	Signed into PTT:	Date:

Case Summary signed off:	Date:

Intern's Case History:

1. **Source of History:**

2. **Chief Complaint : (patient's own words):**

3. **Present Illness:**

	Complaint 1	**Complaint 2**
< Location		
< Onset : Initial:		
Recent:		
< Cause:		
< Duration		
< Frequency		
< Pain (Character)		
< Progression		
< Aggravating Factors		
< Relieving Factors		
< Associated S & S		
< Previous Occurrences		
< Past Treatment		
< Outcome:		

4. **Other Complaints:**

5. **Past Medical History:**

< General Health Status

< Childhood Illnesses

< Adult Illnesses

< Psychiatric Illnesses

< Accidents/Injuries

< Surgery

< Hospitalizations

6. Current health status and life-style:

< Allergies

< Immunizations

< Screening Tests incl. x-rays

< Environmental Hazards (Home, School, Work)

< Exercise and Leisure

< Sleep Patterns

< Diet

< Current Medication
Analgesics/week:
< Tobacco

< Alcohol

< Social Drugs

7. Immediate Family Medical History:

< Age
< Health
< Cause of Death
< DM
< Heart Disease
< TB
< Stroke
< Kidney Disease
< CA
< Arthritis
< Anaemia
< Headaches
< Thyroid Disease
< Epilepsy
< Mental Illness
< Alcoholism
< Drug Addiction
< Other

8. Psychosocial history:

< Home Situation and daily life
< Important experiences
< Religious Beliefs

9. Review of Systems:

< General

< Skin

< Head

< Eyes

< Ears

< Nose/Sinuses

< Mouth/Throat

< Neck

< Breasts

< Respiratory

< Cardiac

< Gastro-intestinal

< Urinary

< Genital

< Vascular

< Musculoskeletal

< Neurologic

< Haematologic

< Endocrine

< Psychiatric

Appendix 5

Durban University of Technology PHYSICAL EXAMINATION: SENIOR

Patient Name : ________________________________ **File no :** ____ **Date :**
Student : **Signature :**

VITALS:					
Pulse rate:			Respiratory rate:		
Blood pressure:	R	L	Medication if hypertensive:		
Temperature:			Height:		
Weight:	Any recent change? Y / N		If Yes: How much gain/loss	Over what period	

GENERAL EXAMINATION:		
General Impression		
Skin		
Jaundice		
Pallor		
Clubbing		
Cyanosis (Central/Peripheral)		
Oedema		
Lymph nodes	Head and neck	
	Axillary	
	Epitrochlear	
	Inguinal	
Pulses		
Urinalysis		

SYSTEM SPECIFIC EXAMINATION:
CARDIOVASCULAR EXAMINATION
RESPIRATORY EXAMINATION
ABDOMINAL EXAMINATION
NEUROLOGICAL EXAMINATION
COMMENTS

Clinician: **Signature :**

DURBAN UNIVERSITY of TECHNOLOGY

Appendix 6

DURBAN UNIVERSITY OF TECHNOLOGY
KNEE REGIONAL EXAMINATION

Patient:______________________________ File:__________ Date:________
Intern:________________________ Signature:________________________
Clinician:________________________ Signature:________________________

! **OBSERVATION (**Standing, Seated and during gait cycle).

A. Anterior view

Genu Varum:____________________
Genu Valgum:____________________
Patellar position:____________________
Tibial Torsion:____________________
Skin:____________________
Swelling:____________________

B. Lateral view

Genu Recurvatum:____________________
Patella Alta:____________________
Patella Baja:____________________
Skin:__

C. Posterior view

Swelling:____________________
Skin:____________________

D. General

Movement symmetry:____________________
Structures symmetry:____________________

! **ACTIVE MOVEMENTS**

Flexion (0 - 135E)____________________
Extension (0 - 15E)____________________
Medial Rotation (20 - 30E)____________________
Lateral rotation (30 - 40E)____________________

! **PASSIVE MOVEMENTS**

Tissue approx____________________
Bone-bone____________________
Tissue stretch____________________
Tissue stretch____________________
Patellar movement____________________

! **RESISTED ISOMETRIC MOVEMENTS**

Knee: Flexion:____________________
Extension:____________________
Internal rotation:____________________
External rotation:____________________

Ankle: Plantarflexion____________________
Dorsiflexion____________________

! **LIGAMENTOUS ASSESSMENT**

One-Plane Medial Instability

Valgus stress (abduction)

Extended____________________
Resting Position____________________

One-Plane Lateral Instability

Varus stress (adduction)

Extended____________________
Resting Position____________________

One-Plane Anterior Instability

Lachman Test (0-30°)____________
Anterior Drawer Sign ____________

One-Plane Posterior Instability

Posterior "sag" Sign____________________
Posterior Drawer Test____________________

Anterolateral Rotatory Instability

Slocum Test____________________
Macintosh Test____________________

Anteromedial Rotatory Instability

Slocum Test____________________

Posterolateral Rotatory Instability

Jacob ____________________
Hughston's Drawer Sign____________________
Reverse pivot shift test____________________

Posteromedial Rotatory Instability

Hughston's Drawer Sign____________________

TESTS FOR MENISCUS INJURY

McMurray__________________________ Anderson med-lat grind__________________________

"Bounce Home"______________________ Apley=s__________________________________

! PLICA TESTS

Mediopatellar Plica ____________________ Hughston's Plica______________________________

Plica "Stutter"________________________

! TESTS FOR SWELLING

Brush/Stroke Test ____________________ Patellar Tap Test_____________________________

! TESTS FOR PATELLA FEMORAL PAIN SYNDROME

Clarke's Sign __________________ Passive patella tilt test_______________________________

Waldron test_________________________

! OTHER TESTS

Wilson's____________________________ Quadriceps Contusion Test______________________

Fairbank's___________________________ Leg Length Discrepancy_________________________

Noble Compression___________________

! JOINT PLAY

Movement of the tibia on the femur P | A:_ A | P:___________________

Translation of the tibia on the femur M | L:______________ L M:__

Long axis distraction of the tibiofemoral joint ____

Inf, sup, lat, + med glide of the patella ____

Movement of the inf. tibiofibular joint A | P:______________ P | A:____________________

Movement of the sup. tibiofibular joint A | P:______________ P | A:____________________

Movement of the sup. tibiofibular joint S | I :__________________ I | S___________________

! PALPATION

Tenderness_______________________________ Swelling______________________________

Joint line________________________________ Nodules/exostoses_______________________

Ligaments_______________________________ Muscles: thigh:_________________________

Patella:_________________________________ Leg :_________________________

Patella tendon:___________________________ Popliteal artery:_________________________

Bursae:__________________________________

! REFLEXES AND CUTANEOUS DISTRIBUTION

	R	L
Patellar Reflex (L3,L4)		
Medial Hamstring Reflex (L5,S1)		

! DERMATOMES

	R	L		R	L
L2			S1		
L3			S2		
L4			S3		
L5					

Appendix 7

Technique for motion palpation of the knee joint

(Bergman *et al*., 1993).

Tiboifemoral joint

Long axis distraction

Patient position: Supine with the involved leg slightly abducted.
Examiner position: Standing facing the patient and straddles the leg so that his/her knees can grasp the distal leg, just proximal to the malleoli.
The examiners knees are used to apply long axis distraction while the hands palpate both the medial and lateral aspects of the knee joint for a springy end feel.

Anterior to posterior and posterior to anterior glide

Patient position: Supine with the involved leg flexed to 90 degrees and the foot flat on the table.
Examiner position: Sitting on the patients foot to stabilize the leg, while grasping the tibia in both hands.
The proximal tibia is then stressed in an anterior to posterior and posterior to anterior direction, feeling for a springy end feel.

Internal and external rotation

Patient position: Supine with the involved leg flexed to 90 degrees and the foot flat on the table.
Examiner position: Sitting on the patients foot to stabilize the leg, while grasping the tibia in both hands.
The proximal tibia is then stressed in rotation, internally and externally to feel for a springy end feel.

Medial to lateral and lateral to medial glide

Patient position: Supine with the involved leg abducted beyond the edge of the table.
Examiner position: Straddling the patients leg, just proximal to the ankle, while grasping the proximal tibia with both hands.
A medial to lateral and lateral to medial stress is applied to the knee joint to identify a springy end feel.

Patellofemoral joint

Medial to lateral, lateral to medial, superior to inferior and inferior to superior

Patient position: Supine, with the involved leg passively extended.

Examiner position: Contacting the borders of the patella with both thumbs and applies a stress from medial to lateral, lateral to medial, superior to inferior and inferior to superior, comparing, as well as feeling for a springing quality of movement.

Tibiofibular joint

Anterior to posterior and posterior to anterior glide

Patient position: Supine, with the involved knee flexed to 90 degrees and the foot flat on the table.

Examiner position: Sitting on the patients foot to stabilize the leg and grasping the proximal fibula with the outside hand, while stabilizing the proximal tibia with the inside hand.

A stress is then applied to the fibula in anterior to posterior and posterior to anterior, while feeling for a springy end feel.

Superior to inferior and inferior to superior glide

Patient position: Supine with the involved leg straight in passive extension.

Examiner position: The cephalic hand uses digital contact over the proximal fibula, while the caudal hand grasps the patients foot.

The ankle is inverted (with plantar flexion) and everted (with dorsiflexion) by the caudal hand, while the digits of the cephalic hand palpate for the fibula to move superiorly and inferiorly.

Appendix 8

Examination Sheet

Patient Name: ________________________________

File Number: _________________________________

Examiner: **A** **B** **C**

Which is the symptomatic knee? **R** **L**

<u>Tibiofemoral Joint</u>

	Right			Left		
Anterior to posterior	**n**	↑	↓	**n**	↑	↓
Posterior to anterior	**n**	↑	↓	**n**	↑	↓
Medial to lateral	**n**	↑	↓	**n**	↑	↓
Lateral to medial	**n**	↑	↓	**n**	↑	↓
Internal rotation	**n**	↑	↓	**n**	↑	↓
External rotation	**n**	↑	↓	**n**	↑	↓
Long axis distraction	**n**	↑	↓	**n**	↑	↓

<u>Proximal Tibia-fibula Joint</u>

	Right			Left		
Anterior to posterior	**n**	↑	↓	**n**	↑	↓
Posterior to anterior	**n**	↑	↓	**n**	↑	↓
Superior to inferior	**n**	↑	↓	**n**	↑	↓
Inferior to superior	**n**	↑	↓	**n**	↑	↓

<u>Patella Femoral Joint</u>

	Right			Left		
Superior to inferior	**n**	↑	↓	**n**	↑	↓
Inferior to superior	**n**	↑	↓	**n**	↑	↓
Medial to lateral	**n**	↑	↓	**n**	↑	↓
Lateral to medial	**n**	↑	↓	**n**	↑	↓

n = normal movement, ↑ = increased mobility, ↓ = decreased mobility

DURBAN UNIVERSITY of TECHNOLOGY

Faculty of Health Sciences

ETHICS CLEARANCE CERTIFICATE

Student Name	Claire Farrimond	Student No	20400621
Ethics Reference Number	FHSEC · 035/09	Date of FRC Approval	17/08/2009
Qualification	M.Tech: Chiropractic		
Research Title:	The inter-examiner reliability and comparison of motion palpation findings of the knee joint in patellofemoral pain syndrome and asymptomatic knee joints.		

In terms of the ethical considerations for the conduct of research in the Faculty of Health Sciences, Durban University of Technology, this proposal meets with institutional requirements and confirms the following ethical obligations:

1. The researcher has read and understood the research ethics policy and procedures as endorsed by the Durban University of Technology, has sufficiently answered all questions pertaining to ethics in the DUT 186 and agrees to comply with them.
2. The researcher will report any serious adverse events pertaining to the research to the Faculty of Health Sciences Research Ethics Committee.
3. The researcher will submit any major additions or changes to the research proposal after approval has been granted to the Faculty of Health Sciences Research Committee for consideration.
4. The researcher, with the supervisor and co-researchers will take full responsibility in ensuring that the protocol is adhered to.
5. ***The following section must be completed if the research involves human participants:***

	YES	NO	N/A
❖ Provision has been made to obtain informed consent of the participants	✓		
❖ Potential psychological and physical risks have been considered and minimised	✓		
❖ Provision has been made to avoid undue intrusion with regard to participants and community	✓		
❖ Rights of participants will be safe-guarded in relation to: - Measures for the protection of anonymity and the maintenance of Confidentiality.	✓		
- Access to research information and findings.	✓		
- Termination of involvement without compromise	✓		
- Misleading promises regarding benefits of the research	✓		

Appendix 9.1

In each of the tables (4-15) in appendix 9.1.1 to 9.1.15, the first column represents the number of the patient whom the data regards, column two indicates the number of examiners who found the joint motion to be normal, column three indicates the number of examiners who found the joint motion to be restricted, and column four indicates the number of examiners who found the joint to be hypermobile.

Appendix 9.1.1

Table 4 showing examiner data for motion palpation of the symptomatic knee joint in tibiofemoral anterior to posterior

Patient number	Normal	Restricted	Hypermobile
1	2	1	0
2	3	0	0
3	3	0	0
4	1	1	1
5	1	1	1
6	2	1	0
7	3	0	0
8	3	0	0
9	1	2	0
10	3	0	0
11	2	1	0
12	2	1	0
13	1	2	0
14	2	1	0
15	2	1	0
16	2	1	0
17	3	0	0
18	3	0	0
19	2	1	0
20	2	1	0
21	2	1	0
22	3	0	0
23	3	0	0
24	3	0	0
25	2	0	1
26	3	0	0
27	2	1	0
28	2	1	0
29	3	0	0
30	3	0	0

Appendix 9.1.2

Table 5 showing examiner data for motion palpation of the symptomatic knee joint in tibiofemoral posterior to anterior

Patient number	Normal	Restricted	Hypermoblie
1	3	0	0
2	2	0	1
3	3	0	0
4	3	0	0
5	3	0	0
6	1	2	0
7	2	1	0
8	3	0	0
9	2	1	0
10	3	0	0
11	3	0	0
12	2	1	0
13	3	0	0
14	2	1	0
15	2	1	0
16	2	1	0
17	3	0	0
18	3	0	0
19	2	1	0
20	3	0	0
21	2	1	0
22	2	1	0
23	3	0	0
24	3	0	0
25	2	1	0
26	3	0	0
27	3	0	0
28	3	0	0
29	3	0	0
30	2	1	0

Appendix 9.1.3

Table 6 showing examiner data for motion palpation of the symptomatic knee joint in tibiofemoral medial to lateral

Patient number	Normal	Restricted	Hypermobile
1	2	1	0
2	3	0	0
3	3	0	0
4	3	0	0
5	3	0	0
6	2	1	0
7	0	3	0
8	0	3	0
9	1	2	0
10	0	2	1
11	2	1	0
12	2	1	0
13	3	0	0
14	2	1	0
15	2	1	0
16	2	0	1
17	1	1	1
18	3	0	0
19	2	1	0
20	2	1	0
21	1	1	1
22	1	2	0
23	2	1	0
24	1	2	0
25	2	1	0
26	3	0	0
27	3	0	0
28	2	1	0
29	2	0	1
30	2	1	0

Appendix 9.1.4

Table 7 showing examiner data for motion palpation of the symptomatic knee joint in tibiofemoral lateral to medial

Patient number	Normal	Restricted	Hypermobile
1	1	2	0
2	3	0	0
3	2	1	0
4	3	0	0
5	2	1	0
6	1	2	0
7	2	1	0
8	2	1	0
9	2	1	0
10	3	0	0
11	3	0	0
12	1	2	0
13	3	0	0
14	3	0	0
15	2	1	0
16	3	0	0
17	2	1	0
18	3	0	0
19	3	0	0
20	3	0	0
21	2	1	0
22	1	2	0
23	1	2	0
24	2	1	0
25	1	2	0
26	3	0	0
27	2	1	0
28	0	3	0
29	2	1	0
30	2	1	0

Appendix 9.1.5

Table 8 showing examiner data for motion palpation of the symptomatic knee joint in tibiofemoral internal rotation

Patient number	Normal	Restricted	Hypermobile
1	2	0	1
2	3	0	0
3	2	1	0
4	2	1	0
5	3	0	0
6	3	0	0
7	2	1	0
8	3	0	0
9	2	0	1
10	2	0	1
11	1	2	0
12	1	2	0
13	1	2	0
14	3	0	0
15	1	2	0
16	3	0	0
17	3	0	0
18	3	0	0
19	2	1	0
20	2	1	0
21	2	1	0
22	2	1	0
23	2	1	0
24	2	1	0
25	3	0	0
26	3	0	0
27	2	1	0
28	2	0	1
29	2	1	0
30	3	0	0

Appendix 9.1.6

Table 9 showing examiner data for motion palpation of the symptomatic knee joint in tibiofemoral external rotation

Patient number	Normal	Restricted	Hypermobile
1	3	0	0
2	3	0	0
3	3	0	0
4	2	0	1
5	3	0	0
6	3	0	0
7	3	0	0
8	3	0	0
9	3	0	0
10	3	0	0
11	3	0	0
12	3	0	0
13	3	0	0
14	3	0	0
15	3	0	0
16	3	0	0
17	3	0	0
18	2	1	0
19	3	0	0
20	3	0	0
21	2	1	0
22	3	0	0
23	3	0	0
24	3	0	0
25	3	0	0
26	3	0	0
27	3	0	0
28	3	0	0
29	2	1	0
30	3	0	0

Appendix 9.1.7

Table 10 showing examiner data for motion palpation of the symptomatic knee joint in tibiofemoral long axis distraction

Patient number	Normal	Restricted	Hypermobile
1	2	1	0
2	2	1	0
3	3	0	0
4	3	0	0
5	2	1	0
6	2	1	0
7	2	0	1
8	2	1	0
9	2	1	0
10	2	1	0
11	3	0	0
12	2	1	0
13	1	2	0
14	2	0	1
15	3	0	0
16	3	0	0
17	1	2	0
18	3	0	0
19	2	1	0
20	2	1	0
21	2	1	0
22	2	1	0
23	2	1	0
24	3	0	0
25	2	1	0
26	2	1	0
27	2	1	0
28	2	1	0
29	2	1	0
30	0	3	0

Appendix 9.1.8

Table 11 showing examiner data for motion palpation of the symptomatic knee joint in anterior to posterior of the proximal tibiofibular joint

Patient number	Normal	Restricted	Hypermobile
1	2	1	0
2	3	0	0
3	3	0	0
4	3	0	0
5	3	0	0
6	3	0	0
7	2	0	1
8	3	0	0
9	1	2	0
10	2	1	0
11	0	3	0
12	2	1	0
13	2	1	0
14	2	1	0
15	2	1	0
16	0	3	0
17	3	0	0
18	2	1	0
19	1	2	0
20	2	1	0
21	1	2	0
22	1	2	0
23	2	1	0
24	2	1	0
25	1	2	0
26	1	2	0
27	1	2	0
28	1	2	0
29	2	1	0
30	3	0	0

Appendix 9.1.9

Table 12 showing examiner data for motion palpation of the symptomatic knee joint in posterior to anterior of the proximal tibiofibular joint

Patient number	Normal	Restricted	Hypermobile
1	3	0	0
2	1	1	1
3	2	1	0
4	3	0	0
5	3	0	0
6	3	0	0
7	2	1	0
8	2	1	0
9	2	1	0
10	2	1	0
11	2	1	0
12	3	0	0
13	3	0	0
14	2	1	0
15	3	0	0
16	2	1	0
17	2	1	0
18	2	1	0
19	2	1	0
20	2	1	0
21	2	1	0
22	2	1	0
23	1	2	0
24	2	1	0
25	1	2	0
26	2	1	0
27	1	2	0
28	2	1	0
29	2	1	0
30	1	1	1

Appendix 9.1.10

Table 13 showing examiner data for motion palpation of the symptomatic knee joint in superior to inferior of the proximal tibiofibular joint

Patient number	Normal	Restricted	Hypermobile
1	2	1	0
2	3	0	0
3	3	0	0
4	3	0	0
5	2	1	0
6	2	1	0
7	3	0	0
8	1	2	0
9	2	1	0
10	3	0	0
11	3	0	0
12	2	1	0
13	3	0	0
14	2	1	0
15	2	1	0
16	3	0	0
17	3	0	0
18	2	1	0
19	3	0	0
20	1	1	1
21	2	1	0
22	2	1	0
23	2	1	0
24	3	0	0
25	2	1	0
26	3	0	0
27	2	1	0
28	2	1	0
29	2	1	0
30	3	0	0

Appendix 9.1.11

Table 14 showing examiner data for motion palpation of the symptomatic knee joint in inferior to superior of the proximal tibiofibular joint

Patient number	Normal	Restricted	Hypermobile
1	2	1	0
2	2	1	0
3	3	0	0
4	3	0	0
5	2	1	0
6	3	0	0
7	1	2	0
8	2	1	0
9	2	1	0
10	3	0	0
11	2	1	0
12	1	2	0
13	2	1	0
14	2	1	0
15	2	1	0
16	2	1	0
17	1	2	0
18	3	0	0
19	3	0	0
20	3	0	0
21	2	1	0
22	1	2	0
23	2	1	0
24	2	1	0
25	2	1	0
26	3	0	0
27	2	1	0
28	2	1	0
29	2	1	0
30	2	1	0

Appendix 9.1.12

Table 15 showing examiner data for motion palpation of the symptomatic knee joint in superior to inferior glide of the patellar

Patient number	Normal	Restricted	Hypermobile
1	3	0	0
2	1	2	0
3	2	1	0
4	2	1	0
5	3	0	0
6	3	0	0
7	3	0	0
8	1	2	0
9	1	2	0
10	2	1	0
11	1	2	0
12	3	0	0
13	1	2	0
14	1	2	0
15	2	1	0
16	3	0	0
17	0	3	0
18	0	3	0
19	3	0	0
20	2	1	0
21	1	2	0
22	1	2	0
23	3	0	0
24	1	2	0
25	2	1	0
26	1	2	0
27	3	0	0
28	2	1	0
29	1	2	0
30	0	3	0

Appendix 9.1.13

Table 16 showing examiner data for motion palpation of the symptomatic knee joint in inferior to superior glide of the patellar

Patient number	Normal	Restricted	Hypermobile
1	3	0	0
2	2	1	0
3	2	1	0
4	2	1	0
5	1	2	0
6	2	1	0
7	3	0	0
8	2	1	0
9	2	1	0
10	2	1	0
11	1	2	0
12	3	0	0
13	1	2	0
14	3	0	0
15	1	2	0
16	1	2	0
17	0	3	0
18	1	2	0
19	1	2	0
20	2	1	0
21	1	2	0
22	1	2	0
23	2	1	0
24	3	0	0
25	3	0	0
26	2	1	0
27	1	2	0
28	3	0	0
29	1	2	0
30	0	3	0

Appendix 9.1.14

Table 17 showing examiner data for motion palpation of the symptomatic knee joint in medial to lateral glide of the patellar

Patient number	Normal	Restricted	Hypermobile
1	3	0	0
2	1	1	1
3	2	1	0
4	2	1	0
5	2	1	0
6	3	0	0
7	2	1	0
8	1	2	0
9	2	1	0
10	2	1	0
11	2	1	0
12	2	1	0
13	3	0	0
14	2	1	0
15	1	2	0
16	1	2	0
17	0	3	0
18	1	2	0
19	1	2	0
20	2	1	0
21	1	2	0
22	2	1	0
23	2	1	0
24	2	1	0
25	3	0	0
26	2	1	0
27	2	1	0
28	2	1	0
29	3	0	0
30	0	3	0

Appendix 9.1.15

Table 18 showing examiner data for motion palpation of the symptomatic knee joint in lateral to medial glide of the patellar

Patient number	Normal	Restricted	hypermobile
1	3	0	0
2	2	1	0
3	1	2	0
4	3	0	0
5	2	1	0
6	2	1	0
7	3	0	0
8	1	2	0
9	2	1	0
10	2	1	0
11	2	1	0
12	2	1	0
13	0	3	0
14	3	0	0
15	3	0	0
16	3	0	0
17	0	3	0
18	2	1	0
19	1	2	0
20	2	1	0
21	3	0	0
22	1	2	0
23	3	0	0
24	3	0	0
25	2	1	0
26	2	1	0
27	2	1	0
28	2	1	0
29	2	1	0
30	1	2	0

Appendix 9.2

In each of the tables (20-34) in appendix 9.2.1 to 9.2.15, the first column represents the number of the patient whom the data regards, column two indicates the number of examiners who found the joint motion to be normal, column three indicates the number of examiners who found the joint motion to be restricted, and column four indicates the number of examiners who found the joint to be hypermobile.

Appendix 9.2.1

Table 20 showing examiner data for motion palpation of the asymptomatic knee joint in tibiofemoral anterior to posterior

Patient number	Normal	Restricted	Hypermobile
1	3	0	0
2	3	0	0
3	2	1	0
4	3	0	0
5	2	1	0
6	2	1	0
7	2	1	0
8	2	1	0
9	3	0	0
10	2	1	0
11	2	1	0
12	3	0	0
13	2	0	1
14	1	2	0
15	1	2	0
16	3	0	0
17	2	1	0
18	3	0	0
19	3	0	0
20	3	0	0
21	3	0	0
22	2	1	0
23	3	0	0
24	2	1	0
25	3	0	0
26	1	2	0
27	3	0	0
28	2	1	0
29	2	1	0
30	3	0	0

Appendix 9.2.2

Table 21 showing examiner data for motion palpation of the asymptomatic knee joint in tibiofemoral posterior to anterior

Patient number	Normal	Restricted	Hypermobile
1	3	0	0
2	3	0	0
3	3	0	0
4	2	1	0
5	3	0	0
6	2	1	0
7	1	2	0
8	2	1	0
9	3	0	0
10	2	1	0
11	3	0	0
12	2	1	0
13	2	0	1
14	1	2	0
15	3	0	0
16	3	0	0
17	2	1	0
18	3	0	0
19	2	1	0
20	3	0	0
21	3	0	0
22	3	0	0
23	2	1	0
24	3	0	0
25	3	0	0
26	3	0	0
27	3	0	0
28	2	1	0
29	3	0	0
30	2	1	0

Appendix 9.2.3

Table 22 showing examiner data for motion palpation of the asymptomatic knee joint in tibiofemoral medial to lateral

Patient number	Normal	Restricted	Hypermobile
1	1	0	2
2	1	0	2
3	1	2	0
4	2	1	0
5	2	1	0
6	2	1	0
7	2	1	0
8	2	1	0
9	1	2	0
10	1	2	0
11	1	2	0
12	1	2	0
13	2	0	1
14	2	1	0
15	2	1	0
16	1	1	1
17	1	1	1
18	0	2	1
19	1	2	0
20	2	1	0
21	3	0	0
22	2	1	0
23	2	1	0
24	2	1	0
25	0	1	2
26	1	2	0
27	2	0	1
28	2	1	0
29	2	0	1
30	2	1	0

Appendix 9.2.4

Table 23 showing examiner data for motion palpation of the asymptomatic knee joint in tibiofemoral lateral to medial

Patient number	Normal	Restricted	Hypermobile
1	1	0	2
2	2	0	1
3	3	0	0
4	3	0	0
5	2	1	0
6	3	0	0
7	2	1	0
8	3	0	0
9	2	1	0
10	3	0	0
11	2	1	0
12	3	0	0
13	2	0	1
14	2	1	0
15	2	1	0
16	2	0	1
17	1	2	0
18	3	0	0
19	2	1	0
20	1	2	0
21	1	2	0
22	2	1	0
23	1	2	0
24	1	2	0
25	2	1	0
26	1	2	0
27	2	1	0
28	2	1	0
29	2	1	0
30	2	1	0

Appendix 9.2.5

Table 24 showing examiner data for motion palpation of the asymptomatic knee joint in tibiofemoral internal rotation

Patient number	Normal	Restricted	Hypermobile
1	3	0	0
2	3	0	0
3	3	0	0
4	3	0	0
5	2	0	1
6	3	0	0
7	2	1	0
8	3	0	0
9	2	1	0
10	3	0	0
11	2	1	0
12	3	0	0
13	2	0	1
14	2	1	0
15	3	0	0
16	3	0	0
17	2	1	0
18	3	0	0
19	3	0	0
20	3	0	0
21	3	0	0
22	2	1	0
23	3	0	0
24	3	0	0
25	3	0	0
26	2	0	1
27	3	0	0
28	3	0	0
29	3	0	0
30	3	0	0

Appendix 9.2.6

Table 25 showing examiner data for motion palpation of the asymptomatic knee joint in tibiofemoral external rotation

Patient number	Normal	Restricted	Hypermobile
1	3	0	0
2	3	0	0
3	3	0	0
4	3	0	0
5	2	1	0
6	1	1	1
7	3	0	0
8	2	0	1
9	3	0	0
10	3	0	0
11	3	0	0
12	3	0	0
13	2	0	1
14	3	0	0
15	3	0	0
16	3	0	0
17	2	1	0
18	3	0	0
19	3	0	0
20	2	1	0
21	3	0	0
22	3	0	0
23	3	0	0
24	2	1	0
25	2	1	0
26	3	0	0
27	3	0	0
28	2	1	0
29	3	0	0
30	2	1	0

Appendix 9.2.7

Table 26 showing examiner data for motion palpation of the asymptomatic knee joint in tibiofemoral long axis distraction

Patient number	Normal	Restricted	Hypermobile
1	2	1	0
2	1	1	1
3	2	1	0
4	3	0	0
5	2	1	0
6	2	1	0
7	3	0	0
8	2	1	0
9	2	1	0
10	2	1	0
11	3	0	0
12	2	1	0
13	1	1	1
14	2	1	0
15	3	0	0
16	2	1	0
17	2	1	0
18	2	1	0
19	2	1	0
20	2	1	0
21	2	1	0
22	2	1	0
23	2	1	0
24	2	1	0
25	2	1	0
26	1	2	0
27	2	1	0
28	1	2	0
29	3	0	0
30	2	1	0

Appendix 9.2.8

Table 27 showing examiner data for motion palpation of the asymptomatic knee joint in anterior to posterior of the proximal tibiofibular joint

Patient number	Normal	Restricted	Hypermobile
1	3	0	0
2	2	1	0
3	2	1	0
4	2	1	0
5	3	0	0
6	1	2	0
7	2	1	0
8	1	2	0
9	3	0	0
10	2	1	0
11	2	1	0
12	1	2	0
13	2	0	1
14	2	1	0
15	2	0	1
16	2	1	0
17	3	0	0
18	2	1	0
19	1	2	0
20	0	2	1
21	1	2	0
22	1	2	0
23	3	0	0
24	2	1	0
25	1	2	0
26	1	2	0
27	3	0	0
28	1	2	0
29	2	1	0
30	2	1	0

Appendix 9.2.9

Table 28 showing examiner data for motion palpation of the asymptomatic knee joint in posterior to anterior of the proximal tibiofibular joint

Patient number	Normal	Restricted	Hypermobile
1	2	1	0
2	2	0	1
3	3	0	0
4	2	1	0
5	3	0	0
6	1	2	0
7	2	1	0
8	3	0	0
9	1	2	0
10	3	0	0
11	1	2	0
12	2	1	0
13	2	0	1
14	1	2	0
15	2	1	0
16	1	2	0
17	1	2	0
18	2	1	0
19	2	1	0
20	2	1	0
21	2	1	0
22	2	1	0
23	0	3	0
24	2	1	0
25	2	1	0
26	2	1	0
27	2	1	0
28	2	1	0
29	2	1	0
30	2	0	1

Appendix 9.2.10

Table 29 showing examiner data for motion palpation of the asymptomatic knee joint in superior to inferior of the proximal tibiofibular joint

Patient number	Normal	Restricted	Hypermobile
1	3	0	0
2	2	0	1
3	1	2	0
4	1	2	0
5	2	1	0
6	2	1	0
7	2	1	0
8	1	2	0
9	2	1	0
10	1	2	0
11	2	1	0
12	3	0	0
13	3	0	0
14	3	0	0
15	3	0	0
16	2	1	0
17	3	0	0
18	2	1	0
19	1	2	0
20	2	1	0
21	3	0	0
22	3	0	0
23	3	0	0
24	3	0	0
25	3	0	0
26	2	1	0
27	2	1	0
28	2	1	0
29	3	0	0
30	1	2	0

Appendix 9.2.11

Table 30 showing examiner data for motion palpation of the asymptomatic knee joint in inferior to superior of the proximal tibiofibular joint

Patient number	Normal	Restricted	Hypermobile
1	1	2	0
2	3	0	0
3	2	1	0
4	2	1	0
5	3	0	0
6	2	1	0
7	3	0	0
8	3	0	0
9	2	1	0
10	3	0	0
11	2	1	0
12	1	2	0
13	2	1	0
14	3	0	0
15	2	1	0
16	2	1	0
17	2	1	0
18	3	0	0
19	2	1	0
20	2	1	0
21	2	1	0
22	3	0	0
23	2	1	0
24	2	1	0
25	3	0	0
26	3	0	0
27	3	0	0
28	1	2	0
29	1	2	0
30	3	0	0

Appendix 9.2.12

Table 31 showing examiner data for motion palpation of the asymptomatic knee joint in superior to inferior glide of the patellar

Patient number	Normal	Restricted	hypremobile
1	2	1	0
2	3	0	0
3	0	3	0
4	1	1	1
5	1	2	0
6	3	0	0
7	1	2	0
8	2	1	0
9	2	1	0
10	0	3	0
11	1	2	0
12	2	1	0
13	1	1	1
14	3	0	0
15	2	1	0
16	3	0	0
17	1	2	0
18	0	3	0
19	1	2	0
20	2	1	0
21	2	1	0
22	2	1	0
23	2	1	0
24	2	1	0
25	3	0	0
26	1	2	0
27	1	2	0
28	2	1	0
29	2	1	0
30	1	2	0

Appendix 9.2.13

Table 32 showing examiner data for motion palpation of the asymptomatic knee joint in inferior to superior glide of the patellar

Patient number	Normal	Restricted	Hypermobile
1	2	1	0
2	2	1	0
3	1	2	0
4	1	2	0
5	0	3	0
6	1	1	1
7	2	1	0
8	2	1	0
9	2	1	0
10	2	1	0
11	2	1	0
12	2	1	0
13	0	2	1
14	1	2	0
15	3	0	0
16	1	2	0
17	0	3	0
18	0	3	0
19	0	3	0
20	1	2	0
21	1	2	0
22	2	1	0
23	1	2	0
24	1	2	0
25	3	0	0
26	1	2	0
27	3	0	0
28	1	2	0
29	2	1	0
30	0	3	0

Appendix 9.2.14

Table 33 showing examiner data for motion palpation of the asymptomatic knee joint in medial to lateral glide of the patellar

Patient number	Normal	Restricted	Hypermobile
1	2	1	0
2	3	0	0
3	1	2	0
4	1	1	1
5	3	0	0
6	2	1	0
7	2	1	0
8	1	2	0
9	2	1	0
10	1	2	0
11	2	1	0
12	1	2	0
13	2	1	0
14	1	2	0
15	1	1	1
16	1	2	0
17	0	3	0
18	1	2	0
19	2	1	0
20	3	0	0
21	2	1	0
22	2	1	0
23	3	0	0
24	1	2	0
25	2	1	0
26	2	1	0
27	3	0	0
28	1	2	0
29	2	1	0
30	0	3	0

Appendix 9.2.15

Table 34 showing examiner data for motion palpation of the asymptomatic knee joint in lateral to medial glide of the patellar

Patient number	Normal	Restricted	Hypermobile
1	3	0	0
2	3	0	0
3	1	2	0
4	3	0	0
5	3	0	0
6	2	1	0
7	2	1	0
8	2	1	0
9	2	1	0
10	2	1	0
11	1	2	0
12	3	0	0
13	3	0	0
14	3	0	0
15	1	2	0
16	3	0	0
17	0	3	0
18	1	2	0
19	3	0	0
20	2	1	0
21	3	0	0
22	1	2	0
23	2	1	0
24	1	2	0
25	3	0	0
26	2	1	0
27	3	0	0
28	1	2	0
29	2	1	0
30	1	2	0