AN INVESTIGATION INTO THE INTER-EXAMINER RELIABILITY OF MOTION PALPATION OF THE PATELLA IN PATELLOFEMORAL PAIN SYNDROME AND OSTEOARTHRITIS.

By

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Dissertation submitted in partial compliance with the requirements for the Master's Degree in Technology: Chiropractic, in the Faculty of Health at the Durban Institute of Technology, South Africa.

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

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DEDICATION

I would like to dedicate this work to my parents, Jaysukh and Usha Vaghmaria. Thank you for all your unconditional love and support throughout the years. Without your selfless sacrifices, I would not have had the opportunity to achieve my dreams and goals.

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ABSTRACT

Objectives: The aim of this study was to assess the inter-examiner reliability of motion palpation of the patella, in both pathological (osteoarthritis) as well as functional (patellofemoral pain syndrome) conditions, in order to assess the validity of this assessment tool, which is commonly used as a method in identifying restricted patella motion.

Methods: This was a quantitative, non-intervention, single-blinded, clinical reliability study. Sixty suitable participants were divided into two groups, Group A consisted of30 participants suffering from osteoarthritis and Group B consisted of 30 participants suffering from patellofemoral pain syndrome. Both groups were screened by student examiners, using Bergmann's Technique for motion palpation of the patella. Subjective data was obtained from both groups using the Numerical Pain Rating Scale. Objective data was obtained from both groups using the goniometer, Objective Pain Rating Scale for patellofemoral pain syndrome and the motion palpation recordings. For descriptive analysis frequency tabulations and graphs were used to display distributions. Intra-group (within group A and B) inter-rater reliability was assessed using Cohen's Kappa statistic. Demographics were compared between groups using Fisher's exact tests or chi square tests where appropriate for categorical variables, and t-tests were used to compare age. Finally associations between type of restriction and symptoms were assessed using one way ANOVA on each group separately, with Bonferroni post hoc tests. All statistical analysis was completed at the 95 % ($p<0.05$) level of confidence.

Results: Overall, examiners were able to reliably detect patella restrictions in a symptomatic population as opposed to normal patella motion in both groups. Specific agreement amongst examiners was noted for the direction of patella restriction as well as the grading of patella restriction between the two conditions.

In Group A there was agreement in the direction of lateral to medial (LM) whereas in Group B there was agreement in the superior to inferior (SI) direction. Similarly, the most common grade of patella restrictions agreed upon by the examiners was 2 (mild to moderate restrictions) both groups A and B.

Conclusion: Inter-rater reliability is dependant on the construct by which the comparison of examiner reliability is measured against. With reference to this study, inter-examiner reliability of motion palpation of the patella was found to be equally reliable in both the pathological (OA) and functional (PFPS) conditions in terms of direction and grade of patella restrictions as related to the clinical presentation of the syndromes. This therefore indicates that even though motion palpation is lacking conclusive research defining it as an integral assessment tool, these findings suggest that motion palpation has a level of ***reliability*** that is able to distinguish between the different constructs (i.e. direction and grade) utilized, which are not bound to the clinical condition present.

GLOSSARY

- **Patellofemoral pain syndrome (PFPS)**

PFPS is defined as anterior knee pain arising from the dysfunction of the patellofemoral articulation, including its connective as well as contractile tissues (Puniello 1993). According to Wood (1998), PFPS refers to a syndrome that comprises of the following signs and symptoms: anterior knee pain, inflammation, imbalance, instability, or any combination thereof.

- **Osteoarthritis (OA)**

Knee OA is a commonly encountered pathological joint affliction that leads to chronic disability, reduced mobility and functional limitation (Gordon et al. 1998). OA is also referred to as osteoarthrosis, degenerative arthritis, degenerative arthrosis and degenerative joint disease (Yochum and Rowe 1996:802).

- **Motion palpation**

Motion palpation is the palpatory procedure that assesses the quality of movement between adjacent articular structures, by challenging the segment, while feeling for the absence or presence of "end-feel" at the endpoints of several ranges of motion (Mootz et al. 1989).

- **Inter-examiner reliability**

Inter-examiner reliability consists of one assessment of all subjects by each of two or more examiners, blinded to each others observations and this is used to assess rater agreement amongst different examiners (Haas 1995).

- **Grade of patella restrictions**

A grading for general patella restrictions was utilized (Appendix K) which recorded normal mobility, mild to moderate restriction of mobility and severe restriction of mobility (Scott 2005). The grading of patella motion was recorded by the examiners as normal mobility (A), mild/ moderate restricted

(B) and severely restricted (C). For purposes of analysis, grade A was recorded as 1, grade B was recorded as 2 and grade C was recorded as 3.

- **Arthrogenic Muscle Inhibition (AMI)**

AMI is defined as the inability of a muscle to recruit all motor units of a muscle group to their full extent during a maximal effort voluntary muscle contraction and is a natural response designed to protect the joint from further damage (Suter et al. 2000).

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CHAPTER ONE

INTRODUCTION

1.1 The problem and it's settings:

Patellofemoral joint motion is of clinical interest, because of the large number of cases of patellofemoral disorders that are related to abnormal motion of the patella relative to the femur (Bull et al. 2002). Thus, it follows that if patella range of motion is restricted in any of its axes, then knee function may be impaired.

In this respect, motion palpation (MP) is a procedure used to assess the functional status of a joint, thus it is important to assess patella mobility prior to any form of treatment (Schafer and Faye 1989), in order to apply the correct form of treatment. This is supported by Panzer (1992) who stated that "it appears inherently logical to identify a joint which is lacking motion before administering a therapy which has enhanced mobility as an effect".

Motion palpation is defined as a palpatory procedure used to assess the quality of movement between articular structures (Bergmann et al. 1993:89). Therefore MP is able to detect any restriction present, due to the freedom and resiliency the articular components display when stressed beyond their physiological barrier to their anatomical barrier (Russell, 1983). Hence, the presence of normal passive motion in one direction of a motion plane and decreased motion in the other may be considered, as MP has been proposed, as a dynamic indicator of joint fixation or subluxation (Russell, 1983). Thus according to Bergmann et al. (1993), loss of normal elastic end-feel, or springiness, within the joint indicates disorders within the joint, its capsule or periarticular tissue.

In addition, aberrant patella motion could impair the efficient function of the quadriceps mechanism and thus result in knee disorders (Davidson, 1993), as abnormal motion within a joint may indicate decreased ability to meet the functional demands placed upon that particular joint. If such a condition is not normalized, either by homeostatic mechanisms, manipulative therapy or other therapeutic interventions, it is possible that early pathological changes might occur in the involved joint (Russell, 1983).

In order for a diagnostic tool to be useful, it should also be dependable (reliable), meaningful (valid) and be able to measure differences (discriminability and responsiveness) (Yeomans, 2000:9). However, Yeomans (2000:9) stated that measurements are rarely perfectly reliable and that some degree of discrepancy in measurements within and between patients is expected at a clinical level.

In addition and according to Russell (1983), a critical omission in the development of MP as a diagnostic technique, is the lack of proven reproducibility and repeated intra- or inter-examiner agreement of findings, especially with respect to symptomatic populations (Bezuidenhout, 2002). This is even more important in view of that fact that Lewit and Liebenson (1993) have stated that MP is subjective and not a reliable enough assessment tool. Thus only with the establishment of statistical reliability, can MP as a diagnostic or evaluation procedure be applied in a reasonable manner (Russell, 1983).

Therefore, in order to provide basic scientific credibility to manipulative techniques, further research in motion palpation is needed (Lewit and Liebenson, 1993) with particular reference to reliability, which is defined by Haas (1995) as: “the extent to which a repeated test will produce the same result when evaluating an unchanged characteristic”.

This concept is further divided into “inter-examiner reliability” which consists of one assessment of all subjects by each of two or more examiners, blinded to each others observations, in order to establish the degree of commonality or similarity of finding achieved by all examiners (Haas, 1995). Hence, agreement between observers is a more compelling gauge of performance of an entire examiner population than self-consistency or "intra-examiner reliability". With respect to these two definitions Russell (1983) states that motion palpation lacks proven reproducibility and repeated inter- and intra agreement of findings (and thus reliability) and only when the establishment of such statistical reliability is made, can a practitioner apply a procedure with confidence.

In addition to MP being used as an indicator of treatment and as a diagnostic tool, it is also a commonly used as an indicator of success with respect to the effects of manipulative therapy. Thus MP of the patella plays an integral part in the functional assessment and treatment of knee disorders. As a starting point reference can be made to the only study (Bezuidenhout, 2002), which investigated the inter- and intra-examiner reliability of motion palpation of the patella in an asymptomatic participant population. Bezuidenhout (2002) found that although motion palpation findings were consistent to some degree when using Pearson's Chi-Square ($p<0.05$) for inter-examiner reliability and McNemar's test for intra-examiner reliability ($p<0.05$), the kappa values (testing inter-examiner reliability beyond chance) were still found to be relatively low (K-ranged from 0.000 - 0.048). Bezuidenhout (2002) thus questioned whether decisions such as diagnosis, management and assessment of patella disorders should be made on motion palpation findings alone. This supports the assertions by Lewit and Liebenson (1993) and Russell (1983) that MP does not have a proven track record.

Thus as MP as a diagnostic and re-evaluation procedure, plays a crucial role in the chiropractic profession aimed at making vital treatment decisions (Watson et al. 2001), the reliability of this technique needs to be established in order for MP to continue to play a significant role in the future (Bezuidenhout, 2002). Furthermore, Bezuidenhout (2002) suggested that the sample group in further studies should include symptomatic patients, due to the lack of proven reproducibility of motion palpation findings amongst the asymptomatic population in his study.

Therefore with the literature as a basis, this study aimed to assess the inter-examiner reliability of MP of the patella, in order to assess the validity of this assessment tool, which is commonly used as a method in identifying restricted patella motion in both functional (PFPS) as well as pathological (OA) knee conditions.

PFPS and related functional conditions such as plicae syndrome, retinacular type pain, bursitis and even tendonitis causes a mechanical aberration of the knee joint and hence affects the functional ability of an individual. The most common symptoms experienced by patients include tenderness, painful clicking, giving way (Johnson et al. 1993) and inflammation of surrounding tissues (Wood, 1998). The most commonly experienced symptom is that of anterior knee pain. In terms of the functional ability of patients suffering from PFPS, the following functions appear to be primarily affected: squatting, kneeling, and climbing stairs (Sandow and Goodfellow, 1985; Puniello, 1993). With a functional condition such as PFPS, one of the requirements in order for normal movement to occur at the patella is a normally functioning knee extensor mechanism (Davidson, 1993). A dysfunction in this knee extensor mechanism is a causative factor in the development of PFPS (Post, 1998) and as a result, the pain and symptoms experienced often occurs during activity. OA, along with other pathological conditions is commonly associated with limited range of motion, swelling, crepitus and stiffness (Golding, 1989:148). Other pathological conditions include Osteochondritis Dessicans, patellofemoral dysplasia and subluxation of the patella. OA in particular causes degeneration of the entire knee joint affecting the integrity of the joint arrangement and could result in chronic disability (Dieppe, 1994: 4.1-4.5). With a pathological condition such as OA, the pain and symptoms experienced occurs continuously, and does not alter irrespective of movement or functional ability.

Hence with the resultant loss in functional ability as in a condition such as PFPS and joint structure as in a condition such as OA, it might be reasonable to assume that these two conditions will have some kind of effect on general mobility of the knee joint, causing some degree of restricted patella motion.

The rationale therefore, behind the inclusion of PFPS and OA both of which seem to have some kind of effect on mobility of the knee joint, is as follows: With a functional condition such as PFPS, the patella is directly involved, and is most often associated with restricted patella motion. Whereas OA, being a pathological condition, is characterized by degenerative changes within the articular cartilage (Yochum and Rowe, 1996), hence may not have direct patella implications.

Thus with the use of a common functional (PFPS) condition affecting functional ability and a common pathological (OA) condition affecting the joint integrity, it was considered possible to assess and compare whether MP is more reliable in a group that has direct patella implications as compared to the other that has a degenerative effect on the articular cartilage rather than involving the patella directly; and whether the procedure of MP overall was reliable in terms of detecting more patella restrictions as opposed to detecting more normal patella movement in these participants considering that MP was performed on symptomatic knees only.

1.2 Rationale:

Motion palpation is a common diagnostic tool used by chiropractors in assessing disorders of the knee (Russell, 1983; Schafer and Faye 1989). However, Lewit and Liebenson (1993) suggested that motion palpation is subjective, and that further studies are needed to establish the reliability of this commonly used tool. In order to prevent further injury or degeneration within the knee joint, resolution of this issue is important with regard to the treatment and rehabilitation of patients suffering from OA and PFPS.

1.3 Aims and Objectives:

The aim of this study was to assess the inter-examiner reliability of motion palpation of the patella, in order to assess the reliability of this assessment tool, which is commonly used as a method in identifying restricted patella motion in both pathological (OA) as well as functional (PFPS) conditions.

The first objective:

To assess the inter-examiner reliability of motion palpation of the patella, using Bergmann's Technique in subjects with OA and PFPS.

Hypothesis One

It was hypothesized that there would be inter-examiner reliability of the patella, using Bergmann's Technique in subjects with OA and PFPS, despite the variance introduced by the respective conditions.

The second objective:

To compare the reliability of Bergmann's Technique for motion palpation of the patella in a pathological (OA) compared to a functional (PFPS) condition.

Hypothesis Two

It was hypothesized that motion palpation of the patella was equally reliable in a pathological (OA) as well as a functional (PFPS) condition, as both groups were symptomatic.

Hypothesis Three

It was further hypothesized that there would be more patella restrictions noted as opposed to no restrictions/ normal patella mobility detected, irrespective of the direction or the severity of the grade of restriction, due the involvement of symptomatic subjects.

Hypothesis Four

It was further hypothesized that restrictions in movement in the pathological (OA) group would indicate that generalized movement (glide in all of the 4 cardinal directions) would be restricted.

Hypothesis Five

It was further hypothesized that restrictions in movement in the functional (PFPS) group would indicate that medial (lateral to medial movement) glide would be the most commonly restricted direction.

The third objective:

To determine whether any significant association exists between restricted patella motion and the symptomatology of OA and PFPS.

Hypothesis Six

It was hypothesized that there would be an association between restricted patella motion and the symptomatology of OA and PFPS in each respective group.

1.4 Limitations of the study:

These limitations of the study are those that could either not be controlled for in the study or were inherent limitations based on the study design and therefore cognizance of these limitations need to be taken.

- The results of this study may not necessarily be applicable to all patients suffering from OA (through the various stages of the disease process), and therefore generalizations to the condition of OA would be limited. This is due to the fact that this study only used subjects with mild OA, which was clinically indistinguishable by the examiners from PFPS when using only motion palpation as a tool. The researcher however was able to distinguish between the two conditions examined based on the history, physical examination and knee regional. This information was not at any time divulged to the examiners.
- It was expected that there would be no communication amongst examiners and between examiners and patients, so as to maintain blinding in order to achieve a more accurate result. However, even in light of all precautions taken, this cannot be guaranteed and therefore poses as one of the limitations of this study.
- Another potential limitation of this study was that the examiners were expected to truthfully reflect the findings that they obtained during the research process and not reflect what they thought was required or expected (Hawthorne effect) (Mouton, 1996). As a result, this could inadvertently influence the outcomes obtained from this study as the recorded readings may not have reflected the true reality at the time of the readings.

1.5 Conclusion:

This chapter has sketched the problem and its setting in order to provide a basis for an overview of the aims, objectives and rationale of this study. Chapter two goes further to highlight the literature surrounding the problem and its setting with particular interest in motion palpation, OA and PFPS and how these conditions are expected to modify the performance of the examiners. Chapter three then describes the materials and methods used in this study, whereas here chapter four presents the results obtained and provides for a discussion of the results. Chapter five then concludes the study with its conclusions and recommendations based on the outcome of the study.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction:

This chapter gives a review of the available literature concerning the clinical, aetiological and diagnostic aspects of both osteoarthritis and patellofemoral pain syndrome, with particular reference to MP in the respective contexts. In addition, Bergmann's Technique for MP of the patella and its reliability, as well as other reliability studies performed on the knee are also discussed.

2.1 Palpation:

2.1.1 Introduction

Palpatory procedures are divided into static palpation and MP:

- *Static palpation* involves the practitioner feeling for asymmetric tissue texture, subdermal prominences, edema and tenderness (Mootz et al. 1989).
- *Motion palpation* (MP) assesses the quality of movement between adjacent articular structures, by challenging the segment, while feeling for the absence or presence of "end-feel" at the endpoints of several ranges of motion (Mootz et al. 1989).

Static palpation is utilized in all assessment procedures and is a broad based assessment, defined as the palpatory diagnosis of somatic structures (Bergmann 1993:762), and hence, is not joint specific as opposed to motion palpation which assesses the physiological range of motion specifically directed at joints of the spine (Ames, 1987:14). Therefore, static palpation will not be assessed as part of the assessment procedure in this study.

2.1.2 Motion Palpation:

MP in contrast to static palpation is more specifically directed at joint movement and addresses several aspects of this joint motion:

Accessory joint movements, which are involuntary movements that represent the small "give or play" within a joint that is necessary for normal function, and it is the joint capsule that is responsible for the smooth give felt, as it allows for enough play and articular surface separation to avoid abnormal joint function (Bergmann et al. 1993:89). Thus MP is used to assess this accessory joint movement by means of joint play and end-feel. These terms refer to the springy quality normally present in a joint taken beyond its active motion limits. End-feel is the resistance felt at the end range of motion, whereas joint play is the resistance felt in the neutral position (Bergmann et al. 1993:89-90).

Joint play should not cause pain and it should yield to pressure applied by the palpator, but slight resistance to movement is normal. If this resistance is increased, articular soft tissue contracture could be suspected (Bergmann et al. 1993:94).

End-feel assessment is sometimes more useful in those cases where individual joint movement is limited, than when measuring their total passive range of motion. Disorders within the joint, the capsule and articular soft tissue, result in a decrease in end-play elasticity or "springiness". This loss of elasticity or increased resistance is instrumental in the diagnosis of joint dysfunction, as well as determining the vector of adjustive therapy, as adjustive therapy is normally applied along the planes of encountered resistance. In addition the pressure of normal passive motion in one plane, and decreased range of motion in the other, is considered a dynamic indicator of a joint fixation (Bergmann et al. 1993:90-92).

Therefore, it stands to reason that, in order to gain the most accurate information from motion palpation and to ensure correct diagnosis, it is necessary that this procedure is reliable (Bezuidenhout, 2002).

2.1.3 Motion Palpation of the Patella:

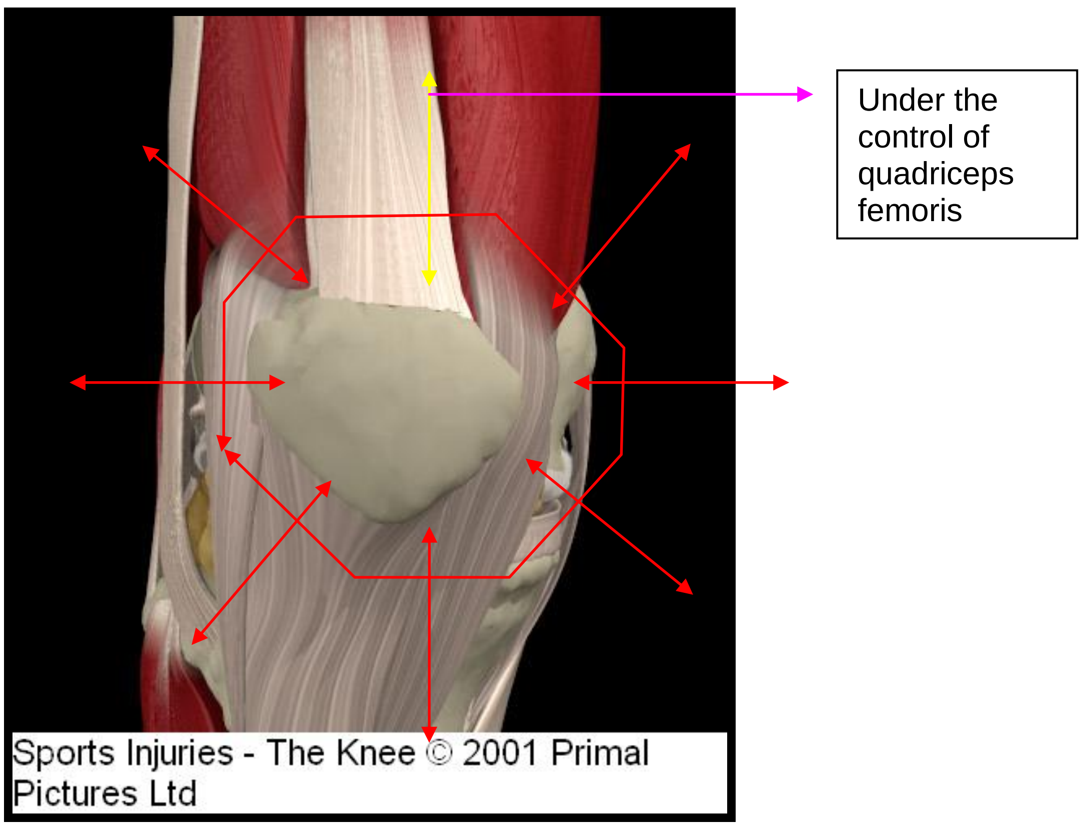

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Figure 2.1 Patella movements

The patella exhibits free excursion superiorly, medially, inferiorly, laterally, diagonally and in circumduction with only superior movement under voluntary control (quadriceps femoris muscle contraction). If any of these movements are restricted, then knee function is impaired (Schafer and Faye, 1989:396). It was further stated that patella mobility must be assured prior to any attempt to release a knee fixation (Schafer and Faye, 1989:396).

Maitland (1991:251) refined the statements of Schafer and Faye (1989), stating that there are four main movements of the patella: longitudinal movement (cephalad (1) and caudad (2)) and transverse movement (medially (3) and laterally (4)).

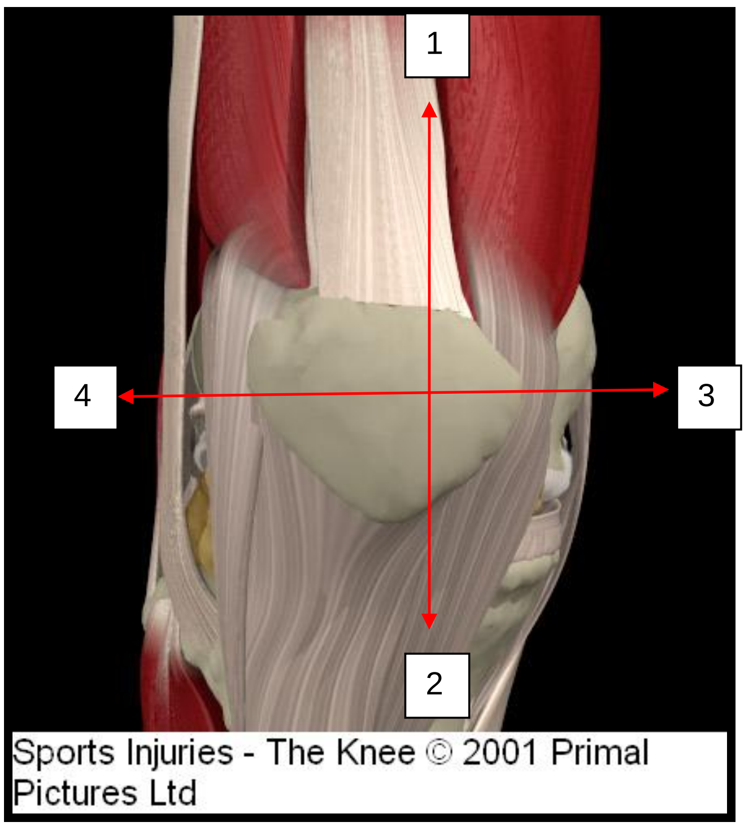

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Figure 2.2 Patella movements refined

Based on the refinements made by Maitland (1991:251), Skalley et al. (1993) conducted a study into the quantitative measurement of normal passive medial and lateral patella motion limits, in 67 high school athletes who participated. A patella pusher (hand-held force gauge) and a manual technique were used to measure patella displacement at knee flexion angles of 0º and 35º and the results were compared.

With the knee at 0º flexion, the patella movement was as follows:

- medial (average: 9.6mm) and
- lateral (average: 5.4mm).

With the knee at 35 º flexion, the patella movement was as follows:

- medial (average: 9.4mm) and
- lateral (average: 10mm).

The manually produced displacement was found to be more reproducible than the displacement by the patella pusher ($p < 0.05$) which demonstrated a greater range of standard deviation than the results obtained using the manual technique at 35º of flexion. This occurred as a result of the practical problems encountered using the device, which abnormally affected the patellar displacement. This study showed that the medial patella motion is greater than lateral patella motion, when the knee is at 0º, in addition to which it would appear that manual assessment of patella displacement is more reliable than that of instrument assisted measurements (Skalley et al. 1993).

In a similar manner Fithian et al. (1995) conducted a study into the instrumented measurement of patella mobility. They looked at 94 uninjured athletic subjects and 22 subjects with unilateral patellar dislocation. An instrument (patella pusher) was used to measure the compliance of the medial and lateral patella restraints with the subjects in a supine position. Subtracting the medial displacement from the lateral displacement at a given force level, allowed the tester to assess the peripatella soft tissue “balance”. Paired comparisons differentiated the three groups, with significant differences between the control and affected ($P=0.0001$), control and contralateral ($P=0.0036$) and affected and contralateral ($P=0.0157$) knees. In this test, medial displacement was found to exceed lateral displacement, in 81% of the control subjects. Thus, according to literature, it must be noted that the patella exhibits more motion medially than laterally. The reason for this difference in motion could be because of the raised lateral femoral condyle (Bose et al. 1980), which restricts motion laterally, as can be seen in figure 2.3 (B) below.

Without the comparison to manual assessment, the study by Fithian et al. (1995) could only drawn conclusions about the comparisons between instrument generated findings, therefore no further support of Skalley et al. (1993) findings were made.

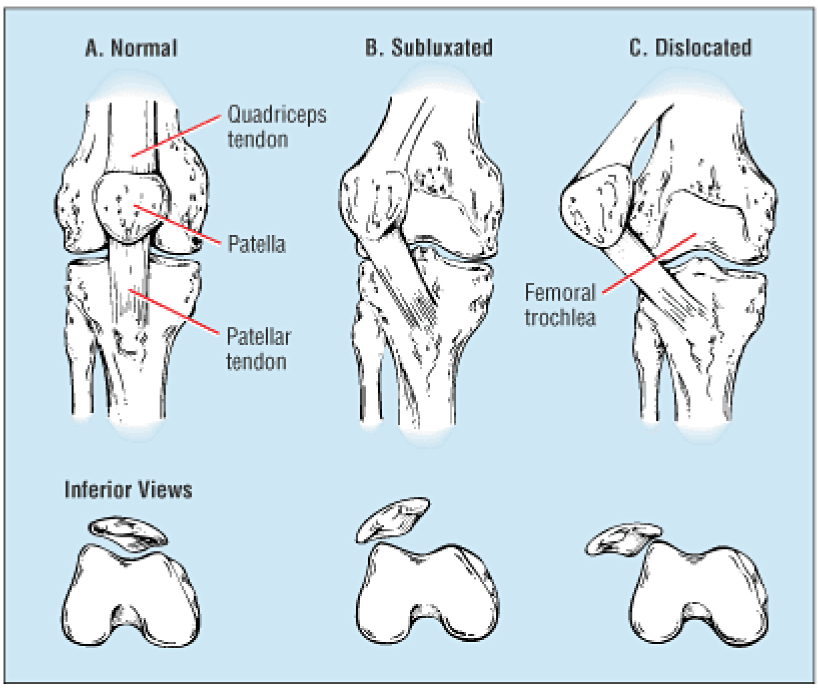


FIGURE 1. The bony and soft-tissue restraints provide stability in the normal patellofemoral joint (A). Subluxation (B) and dislocation (C) occur when the patella is torn from its normal position in the trochlear sulcus.

Figure 2.3 Patella movement restrictions

2.2 Reliability:

Irrespective of the type of technique (manual or instrument) utilized in measuring patella motion as found in the studies by Fithian et al. (1995) and Skalley et al. (1993), each of these techniques, especially with respect to motion palpation, is required to be reproducible in the clinical setting (Lakhani, 1999; Bezuidenhout, 2002), in order for practitioners to use the assessment to obtain reliable information on which to base a diagnosis, or to re-evaluate treatment and monitor patient progress (Panzer, 1992). Thus Haas (1995) states that the reliability of a procedure can be defined as: “the extent to which a repeated test will produce the same result when evaluating an unchanged characteristic”.

In this respect *inter-examiner reliability* consists of one assessment of all subjects by each of two or more examiners, blinded to each others observations (Haas, 1995) and this is used to assess examiner agreement amongst different examiners. Hence, agreement between examiners is a more compelling gauge of performance of an entire examiner population than self consistency (Haas, 1995). The reason for this is that it may be difficult to blind the examiners to their previous findings, resulting in high self consistency and even if blinding is achieved, repeated measures by individuals may still suffer from consistency of error (correlated error), which will also produce a positive bias or overestimation of reliability (Haas, 1995 and Mouton, 1996).

Thus Boline et al. (1993) studied the inter-examiner reliability of palpation for paraspinal soft tissue pain and osseous pain (pain over the spinous process) as well as including other assessment tools (visual observation, dermothermography and surface electromyography) for joint dysfunction in the lumbar spine. The study involved 28 subjects and the examiners were blinded to the findings of the other examiners. Palpation for osseous pain and paraspinal soft tissue pain was found to have good to excellent inter-examiner reliability ($K=0.48 – 0.90$ and $p< 0.01$ for osseous pain; $K=0.40 – 0.79$ and $p<0.05$ for paraspinal soft tissue pain). The results of the palpation for osseous and soft tissue pain and the findings from the visual observation (K=0.34 – 0.84) were combined to determine their inter-examiner reliability used together. The results ranged from no inter-examiner reliability beyond chance (K= -0.30) to good inter-examiner reliability beyond chance (K= 0.50) for the combined assessment. These scores were all lower than those obtained in the individual analysis of each assessment tool. These findings question the reliability between the signs and symptoms under investigation and highlights the need for the individual and combined analysis of each assessment tool (Boline et al. 1993). However, the inadequate sample size reduced the significance of the results obtained in this study.

In a similar manner, another study by Keating et al. (1990) examined the inter-examiner reliability of eight evaluative dimensions of lumbar segmental abnormality. The study involved eight methods of clinical examination of the lumbar spine of 46 patients by three experienced chiropractic physicians in symptomatic and asymptomatic subjects in order to assess for misalignment of vertebrae in relation to the one below, osseous pain, soft tissue pain and muscle tension. Active and passive motion palpation was used to assess for movement restriction and hard end-feel. Static palpation for osseous pain revealed results of marginal to good and significant inter-examiner reliability (K= 0.19 – 0.66, mean K= 0.48 and $p<0.05$), for soft tissue pain, results of marginal to good and significant inter-examiner reliability were noted (K= 0.10 – 0.59, mean K= 0.30 and $p<0.05$) at most levels. Palpation for misalignment, muscle tension and temperature changes each produced results of 0 to marginal inter-examiner reliability beyond chance (mean K= 0.00, mean K= 0.07 and mean K= 0.25 respectively), where visual observation produced results of marginal reliability (mean K= 0.29). Active and passive motion palpation was found to have marginal inter-examiner reliability beyond chance (mean K= 0.09 and K= 0.07 respectively). The results of the individual assessment tools were combined to determine overall results of inter-examiner reliability using Pearson's r and intraclass correlation coefficient (ICC). The scores obtained from the combination of the more reliable tools produced results of greater reliability (mean r= 0.48 and mean ICC= 0.46 and $p<0.05$) than the scores obtained from the combination of all the assessment tools used together (mean r= 0.36 and mean ICC=0.37 and $p<0.05$). This study concluded that subjective findings (i.e. pain over the osseous or soft tissue structures) were more reliable than active or passive motion palpation, including end-feel. This study therefore supports the fact that by identifying and combining the most reliable examination methods or assessment tools, one can establish the most reliable examination procedures for validation (Keating et al. 1990).

These findings (Keating et al., 1990 and Boline et al., 1993) support Haas (1991(a)) statement that it may be more realistic to investigate the inter-examiner reliability of an entire adjustment decision-making process as opposed to its constituent parts. This process was defined by Haas (1991(a)), as there are a number of positive indicators from a regimen implicating a particular vertebral segment for adjustment. Each procedure was therefore assumed to possess only one of two possible outcomes: adjustment indicated or adjustment not indicated. In addition the technique recommended for analysis (Haas (1991(a)), Kappa analysis of simple MTS (multi-test score), may serve to enhance inter-examiner reliability. Haas (1991(a)) however cautioned the interpretation of the results based on the limitation of the kappa statistic where he explained that kappa could become unstable under conditions of limited variation[1], as this limited variation can make the difference between a study demonstrating poor reliability and excellent reliability.

As a result of a literature survey documented by Haas et al. in 1995, 16 data studies and seven review articles were then published in the literature with respect to motion palpation assessing intra-examiner and / or inter-examiner reliability. It was found that inter-examiner reliability of active and passive motion palpation procedures was poor, whereas intra-examiner reliability was moderate with respect to motion palpation (Haas et al. 1995).

[1] Limited variation occurs when there is a large proportion of agreement and most of the agreement or distribution leans heavily to only one of the possible alternative categories (Haas et al. 1990)

2.2.1 Motion Palpation Reliability studies of Extremities:

In contrast to the outcome of results in the spinal inter-examiner and / or intra-examiner reliability studies mentioned above, studies on motion palpation of the extremities since then (Brantingham et al. 1997, Chesworth et al. 1998) appeared to have shown favorable results. However caution needs to be adopted as the results obtained were based on small sample sizes (Haas, 1991(a)). Furthermore with regard to published motion palpation reliability studies of the extremities, it was found that only three studies had been conducted. One involving the ankle (Brantingham et al. 1997), one involving the shoulder (Chesworth et al. 1998) and another involving the knee (Bezuidenhout, 2002).

Brantingham et al. (1997) conducted a study on the inter-examiner reliability of the circumduction test for general foot mobility and joint dysfunction. The study consisted of two chiropractic practitioners who evaluated each of the seventeen patients diagnosed with moderate to severe painful lower leg, ankle or foot disorder. Two chiropractic practitioners, one with 14 years experience and the other with 2 years experience, independently evaluated each patient. Inter-examiner agreement was assessed using Kappa coefficient and it was found that the agreement into whether there was decreased mobility in affected feet was 0.64 (substantial agreement), agreement as to whether there was decreased mobility in unaffected feet was 0.598 (moderate agreement), agreement of the exact grade of decreased movement in affected feet was 0.1785 (slight agreement) and agreement into the exact grade of decreased in unaffected feet was 0.453 (moderate agreement).

One of the two discrepancies noted with this study was that the examiners had a different amount of clinical experience (Brantingham et al. 1997). As a result, this could negatively impact the outcome of this study due to the level of variance amongst the examiners. This could create a level of inconsistency, by which the examiners work from a different frame of reference and will tend to have a different level of skill in motion palpation (Bezuidenhout, 2002).

The second inconsistency noted in this study was that the examiners were not blinded to the injured feet (Brantingham et al. 1997). This could inadvertently have influenced the outcome of this study by the examiners having preconceived ideas as to the type of joint restriction / dysfunction the participants presented with (Mouton, 1996:111-113).

Nevertheless, this study appeared to show that detecting forefoot dysfunction was relatively reliable when two examiners were used (inter-examiner reliability), however having had a larger sample size may have helped identify satisfactory agreement which would support Haas's (1991(a)) assertation above.

Secondly, ***Chesworth et al. (1998)*** conducted a study measuring passive lateral rotation of the shoulder in patients with shoulder pathology for the purpose of assessing end-feel reliability. The study consisted of two physical therapists that performed two assessments of passive lateral rotation of the shoulder in 34 patients. Intra-class correlation coefficients (ICC) were used to analyze the ratio (movement diagram) data and Kappa statistics (k) were used to analyze categorical end-feel data. The results showed that intra-examiner ICCs varied from 0.58 – 0.89 and the inter-examiner ICCs varied from 0.85 – 0.91. Intra-examiner kappa values for end-feel were moderate (k=0.48 – 0.59) and inter-examiner kappa values were substantial (k= 0.62 – 0.76). It was found that end-feel seemed to be more reliable, in terms of inter-examiner agreement, when assessing lateral rotation of the shoulder.

In congruence with Brantingham et al. (1997) and Chesworth et al. (1998), ***Bezuidenhout (2002)*** investigated the intra- and inter-examiner reliability of motion palpation of the patella using Bergmann's technique[2] for asymptomatic patients. The study consisted of 50 chiropractic students and four examiners who were senior chiropractic students trained in assessing motion palpation of the patella.

The results of this study revealed that there was an association between the examiners and their motion palpation findings, as demonstrated by Pearson's Chi-Square test ($p=0.05$). This meant that the motion palpation findings were consistent between the examiners (inter-examiner consistency). Furthermore, the consistency of the opinion (motion palpation findings) of the examiners between their first and second examination as demonstrated by McNemar's Test ($p< 0.05$) was significant (intra-examiner consistency). Nevertheless, even though Pearson's Chi-Square and McNemar tests showed association and consistency of results, kappa values for intra-examiner reliability (k ranged from 0.005 – 0.035) and inter-examiner reliability (k ranged from 0.000 – 0.48) were relatively low, allowing only for fair agreement.

Hence, according to Bezuidenhout (2002), there was an association between motion palpation findings of the different examiners, thus suggesting that there is consistency between different examiners and their motion palpation findings. However, Bezuidenhout (2002) stated that although the results have shown to be consistent, the results do not show us if their motion palpation findings are reliable. This could have possibly been due to the fact that examiners lacked adequate

[2] Bergmann's Technique (Bergmann et al. 1993:676) for motion palpation of the patella is particularly important in identifying patellofemoral joint dysfunction. With the lack of proven reproducibility, the reliability of this technique is still in question. In order to validate the use of Bergmann's Technique as a diagnostic tool in the assessment of patellofemoral joint function, it is important that the reliability be better established through further research (Watson et al. 2001, Bezuidenhout 2002).

experience, even though they were taught the same technique and examiners were not given enough time to practice their motion palpation skills (Bezuidenhout, 2002).

Hence, Bezuidenhout (2002) recommended further research using symptomatic patients, because motion palpation is a diagnostic procedure that looks for pathomechanics of a joint as well as for re-evaluation in treatment protocols, as opposed to the assessment of asymptomatic subjects as utilized in the study.

Thus with respect to motion palpation reliability studies involving the extremities, only these three studies were conducted. Although, the outcome of these studies has shown to be **consistent to a certain extent**, further research is needed into the inter-examiner and intra-examiner reliability of motion palpation of extremities (Bezuidenhout, 2002). Russell (1983) stated that motion palpation lacks proven reproducibility and repeated intra- and inter-examiner agreement of findings, and only when the establishment of such statistical reliability is made, can a practitioner apply a procedure with confidence.

2.2.2 Other Reliability studies involving the Patella on symptomatic patients (not involving motion palpation):

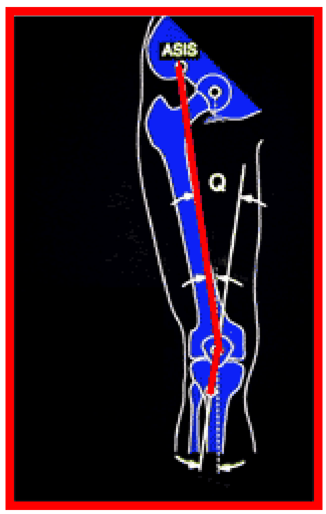
Ehrat et al. (1994) investigated the reliability of assessing the A-angle[3]. The study used three examiners that measured the A-angles of 36 subjects. Intra-rater A-angle ICCs were poor (0.20 – 0.32) and inter-rater A-angle ICC was poor (-0.01) The results revealed that the A-angle was not reproducible and that further investigations are needed before the A-angle could be used as a reliable tool.

Thereafter, Tomsich et al. (1996) investigated the reliability of patellofemoral alignment, paying particular attention to the Q-angle[4], A-angle[3] and patella

[3] The relationship between the patella and the tibial tuberosity (Arno 1990).

4 The angle formed by the intersection of the line of pull of the quadriceps and the patella tendon measured through the centre of the patella (McConnell, 1986)

orientation. The study used 27 participants and three examiners. The Kappa range between 0.80 and 1.00 were considered very reliable, 0.60 and 0.79 moderately reliable and 0.59 or lower questionable reliability. Intra-tester and inter-tester intraclass coefficients of measurements obtained ranged from 0.52 to 0.86 and 0.03 to 0.61, respectively. Intra-tester Kappa's of visually estimating patella orientation ranged from 0.40 to 0.57 and inter-tester Kappa's were between 0.03 and 0.30. The study revealed that both instrumented measurement and clinical estimation of patellofemoral alignment may be unreliable.



www.kneehippain.com/ patient/pain/anatomy.html

Figure 2.4 Q angle

Fitzgerald and Mcclure (1995) on the other hand, investigated the reliability of measurements obtained with four tests: medial to lateral displacement, medial to lateral tilt, medial to lateral rotation, and anterior tilt for patellofemoral alignment laxity. The study used 12 physical therapists as examiners and included 66 patients. The percentages of agreement ranged from 44% to 71%. The kappa coefficients ranged from 0.10 to 0.36 for the four tests. The results revealed that reliability ranged from poor to fair.

On a larger scale Fritz et al. (1998) looked at patients with unilateral knee dysfunction (due to inflamed knees or osteoarthrosis). The study involved 33 participating therapists examining 152 subjects. Passive range of motion (PROM) of the knee and the relationship between the onset of pain and resistant to PROM were measured. There appeared to be inter-examiner reliability in the detection of decreased range of motion from resistance due to pain and therefore this supports the concept of capsular pattern which results in a proportional motion restriction.

In a study by Watson et al. (2001) assessing the reliability of the lateral pull test and tilt test[4] to assess patellar alignment in subjects with symptomatic knees, the study consisted of 55 subjects providing 99 knees all of whom were assessed by the blinded student examiners. The kappa coefficients for inter-rater reliability were 0.31 for the lateral pull test and varied from 0.20 to 0.35 for the patella tilt test. The results showed that the two tests appeared to have poor inter-examiner reliability.

Thus with respect to the studies mentioned above, it appears that agreement amongst the examiners ranged from poor to fair. This could have been in part due to the inadequate sample sizes (Haas 1991(a)) and differences in the number of examiners (Bezuidenhout, 2002) assessing the patients that made up the various sample sizes. Furthermore, it has been shown that results are not reproducible when assessing the alignment of the patella (Bezuidenhout, 2002).

However the literature shows that instrument assisted assessment of patients seems to be less reliable than manual techniques, in addition to which it would seem that when looking at the whole patient, it is better to consider the Kappa values of a combination of tests (especially those previously identified individually as having high Kappa values), as opposed to individual tests. To attain these Kappa values however it is important to test each individual test first in order to assess the degree to which it contributes to a combined Kappa score for the group.

[5]The lateral pull test and tilt test are used to examine patella tracking and in the diagnosis of patellofemoral pain syndrome (PFPS) (Watson et al. 2001).

Therefore this study was structured in order to provide basic scientific credibility to a MP technique of the patella. In order to achieve this, two conditions were chosen for this study, namely Osteoarthritis (OA) and Patellofemoral pain syndrome (PFPS) in order to introduce variance into the study by virtue of the conditions, which allowed for the examiners not to be able to predict the possible outcomes expected (Mouton, 1996:110-113), thereby making the results stronger as well as assessing specificity and sensitivity (Yeomans 2000:9, 10, 19) of MP.

Therefore the next section in this chapter will discuss the anatomy of the knee followed by the individual syndromes (OA and PFPS) in order to contextualize the discussions of the results later in the study.

2.3 Patellofemoral Joint:

2.3.1 Anatomy:

The knee, as a whole, is probably the most complicated joint in the human body. It is an intricate structure because it is comprised of two structurally different, yet interrelated joints: the tibiofemoral and patellofemoral joints (Calliet, 1992:1).

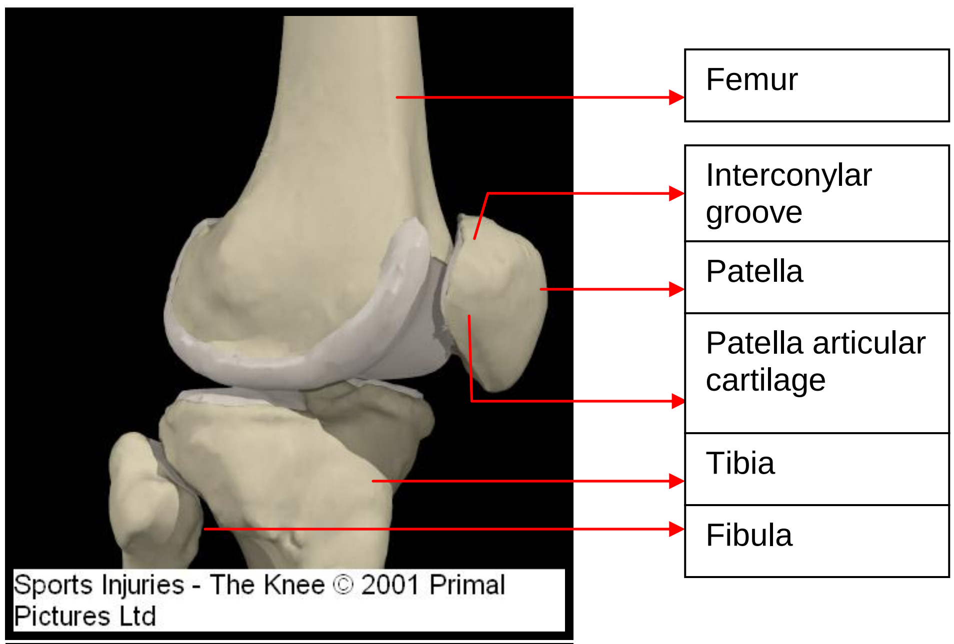


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Figure 2.5 Patella

The patella is a triangular sesamoid bone with its apex pointing inferiorly. The patella is embedded within the quadriceps femoris tendon proximally and within the patella tendon distally (Davidson, 1993). Therefore this bone is subcutaneous and easily palpable, where it lies anterior to the distal femur articulating with the femoral condyles.

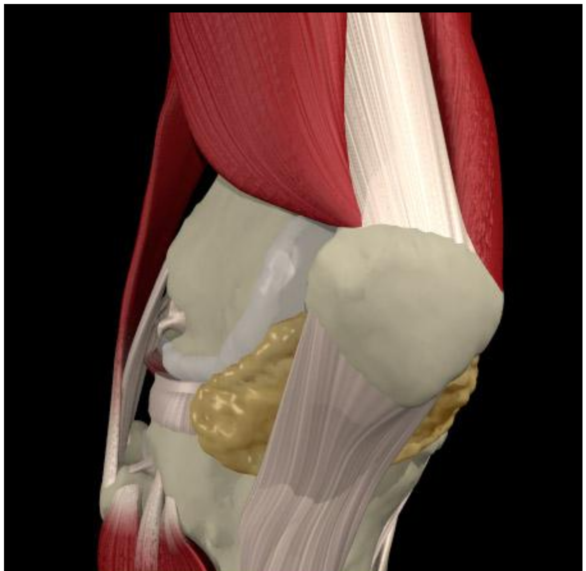

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Figure 2.6 Patella position

The patellofemoral articulation consists of the facets of the patella in contact with the sulcus of the anterior femur (Moore and Dalley, 1999:617). The uncovered undersurface of the patella is coated with cartilage and glides on the cartilage of the femoral condylar notch (Calliet, 1992:31-33; Reid, 1992:347-349). The patella surface can include up to seven facets, with three on the medial surface, three on the lateral surface and an extra ("odd") facet on the medial side (Tria et al. 1992). These facets make contact with the femoral condyles differently at various degrees of flexion. Thus, as a result of the facet arrangement and the angles associated with these facets, there is a possibility that the joint surfaces can be incongruous, resulting in varied contact between the asymmetric infrapatella surfaces and the femoral condyles as the knee flexes and extends (Reid, 1992: 347-349; Fulkerson, 1997:27-31), which may result in aberrant motion or biomechanics.

Motion is principally imparted by the quadriceps femoris muscle, whose anatomical origin and insertion are divided into four components as described by Moore and Dalley (1999:534) as:-

- Rectus femoris: From the anterior inferior iliac spine and groove superiorly to the acetabulum.
- Vastus Lateralis: Stems from the greater trochanter and lateral lip of the linea aspera of the femur
- Vastus Medialis: Stems from the inter-trochanteric line and medial lip of the linea aspera of the femur
- Vastus Intermedius: Stems from the anterior and lateral surface of the body of the femur.

The distal attachment is to the base of the patella via the quadriceps tendon. The four components of the quadriceps muscle are thus attached to the upper border and sides of the patella forming a single musculotendinous expansion. From the apex of the patella, a strong tendon, the patella ligament, descends and is attached to the tibial tubercle. On each side of the patella ligament, the capsule of the joint is formed largely by downward fibrous expansions of the quadriceps femoris muscle through which the muscles gain attachment to the tibial condyles (Moore and Dalley, 1999:532-534).

Thus, patella stability is afforded on the lateral aspect by the lateral retinaculum, iliotibial band (ITB) and the Vastus Lateralis muscle (VL). On the medial aspect stability is provided by the Vastus Medialis Oblique (VMO) and the medial retinaculum (Bose et al. 1980).

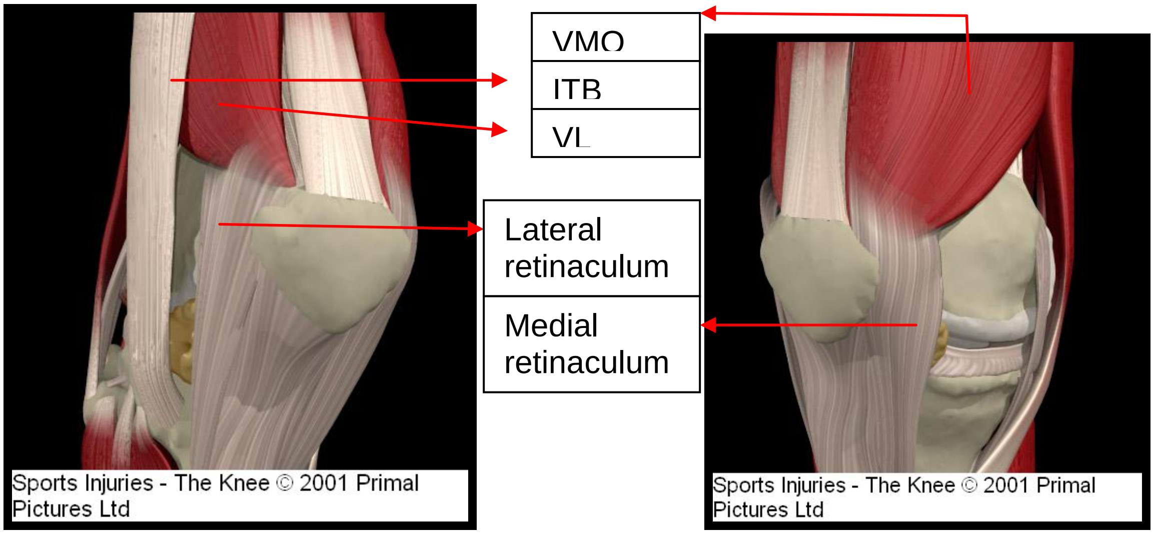

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Figure 2.7 and 2.8 supporting structures

As a result the patella is thought to increase the power of the quadriceps femoris muscle in extending the knee (Davidson, 1993), with the main biomechanical function of the patella being to increase the effective lever arm of the quadriceps femoris muscle in affecting knee extension or resisting knee flexion (Hungerford and Barry, 1979).

The patella articular cartilage:

The uncovered undersurface of the patella is coated with hyaline cartilage and glides on the cartilage of the femoral condylar notch (Calliet, 1992:31-33; Reid, 1992:347-349). Hyaline cartilage is the smooth coating overlying bone in all of the synovial joints in the body, and functions to distribute and transmit loads to the underlying bone, protecting the underlying bone and permitting the synovial joints to have a wide range of movement. Cells called chondrocytes are responsible for the synthesis of proteoglycans and collagen fibres that comprise the cartilage matrix. In a healthy joint, there is a dynamic equilibrium between cartilage production and cartilage breakdown. In OA there is a mismatch in this equilibrium resulting in a gradual loss of cartilaginous mass (Harris and Genovese, 2000:334).

With gradual progression of this disease process (OA), the cartilage surface thins and the concentration of proteoglycans decreases. This results in the cartilage becoming susceptible to mechanical damage. Such mechanical trauma causes softening of the cartilaginous surface and a resultant loss of its integrity. As the cartilaginous surface is gradually denuded, there is an aberration of both gliding and shock absorbing functions of the cartilage, which can in turn give rise to localized changes in the affected bones (Brandt et al. 1999). In addition at the joint margins growth of bone leads to osteophyte formation, which in turn may alter the contour of the joint and may also impair mobility (Brandt et al. 1999). Therefore one could clinically expect that with progression of OA, a gradual reduction in all ranges of motion would be seen.

However, having pointed out that a reduction in all ranges of motion is expected with the progression of OA, it is important to mention here that there is also some literature suggesting that the degenerative changes most commonly affect the medial compartment of the knee in patients suffering from OA (Lewek et al. 2004). As a result, it has been found that retinacular laxity appears on the medial aspect of the knee (Lewek et al. 2004). Consequently, due to this hypermobility in the medial compartment via the medial retinaculum, a corresponding hypomobility in the lateral retinaculum (Reid, 1992:354-355) can be expected. Hence, it may be possible that movement in the lateral aspect of the knee may be restricted in the *early to middle stages* of OA development, with *late stage osteophytosis* leading to general mobility decrease (Brandt et al. 1999).

With respect to this study conducted, a positive and important finding would constitute inter-examiner agreement that a restriction in patella mobility was found in that patient as opposed to no restrictions/ normal mobility detected, irrespective of the direction, and the severity of the grade of restriction. This outcome is expected due to the fact that the participants in the study are all symptomatic (i.e. they are all suffering with either OA or PFPS).

2.3.2 Biomechanics:

The patella has the primary function of increasing the efficiency of the quadriceps muscle by increasing its lever arm (McConnell, 1986; Tria et al. 1992; Davidson, 1993). For this function to be efficient, the patella must be aligned and remain in the trochlea notch of the femur, and any misalignment of the patella from altered mechanics will predispose an individual to patellofemoral pain and possibly articular cartilage breakdown (McConnell, 1986). The patella may articulate abnormally such that it is transiently or permanently medial or lateral to its normal tracking course (Fulkerson, 1997:175). This may result in the patella deviating from the normal patella course as a result of a functional imbalance between the articular surfaces of the patella and femoral trochlea (Fulkerson, 1997:175). Hence, one can assume that patella mobility may become altered.

This can be seen in the work of Fulkerson (1997:44), where he stated that if the patella is malaligned as a result of a deficient VMO, the articular surfaces may become somewhat incongruent. Deficiency of the VMO because of developmental abnormality or acquired atrophy may lead to a lateral subluxation of the patella

(Scuderi, 1995:277). Furthermore, Fulkerson (1997) has shown that tenderness in the lateral retinaculum is common in patients with patellofemoral pain and that malalignment is frequently associated with such pain. As an example the literature suggests that PFPS is associated with restricted patella motion, especially medial (lateral to medial) glide, resulting from a tight iliotibial band and / or tight lateral retinaculum (Post, 1998). Thus, malalignment of the patella could possibly lead to lateral mobility restrictions in this syndrome.

However as PFPS is not associated with any one aetiology, and McConnell (1986) stated that there have been many causes of malalignment of the patella and hence pain. The following are suggestions for misalignment in accordance with McConnell (1986):

- The Q-angle, where an increase may be associated with increased femoral anteversion, excessive tibial torsion and lateral displacement of the tibial tubercle increasing the lateral pull of the patella.
- Prolonged pronation of the subtalar joint is accompanied by prolonged internal rotation of the leg resulting in malalignment of the patella and internal rotation of the femur.
- Muscle tightness which includes the rectus femoris, iliotibial band, hamstrings and gastrocnemius, all of which have reported to have an effect on patella alignment.
- Patella alta is present when the measurement of the length of the patella tendon is 20% more than the measurement of the height of the patella. The patella is late in engaging the femoral trochlea during flexion and the consequent high sitting of the patella predisposes the individual to patella subluxation.

In addition to this and due to the physiologic valgus of the knee and Q-angle of the quadriceps, there is a lateral pull on the patella. The patella is primarily stabilised against this pull by the raised bony contour of the lateral femoral condyle and the VMO (Bose et al. 1980). Secondarily the lateral femoral condyle on the patella articular surface helps to prevent subluxation and dislocation, increasing stability to the patella with knee flexion. During the first 30º of knee flexion, the patella moves medially into the trochlea groove of the femur. Most patella instability occurs in the first 30º because beyond this point, the patella has more bony support in the trochlea groove. Normally, the iliotibial band moves posteriorly over the lateral femoral condyle when the knee is flexed beyond 30º. This results in the lateral retinacular bands being drawn posteriorly along with the iliotibial band on knee flexion. This causes progressive tilting of the patella laterally, especially if the medial static stabilizers are stretched or the dynamic stabilisers (VMO) are weak (seen in Figure 2.9 (B), below). Thus balance of the medial and lateral static stabilizers is necessary for proper alignment of the patella for pain free function (Puniello, 1993); however, in the last 30º of knee extension, the patella sits above the patella articular surface allowing little stability then to be offered by these bony contours. Therefore, the VMO becomes the most important structure in providing stability for the patella in the last 30º of extension (Bose et al. 1980).

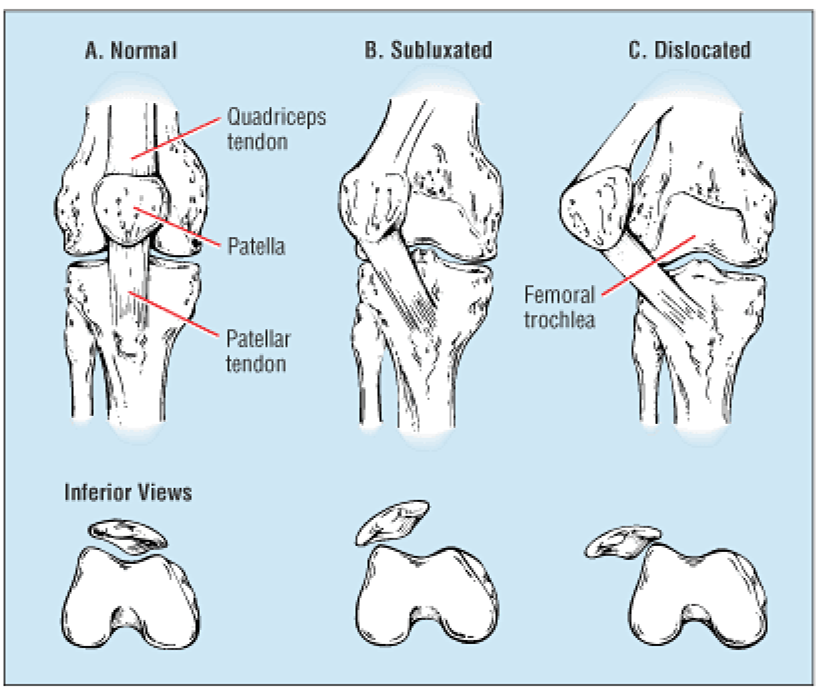

FIGURE 1. The bony and soft-tissue restraints provide stability in the normal patellofemoral joint (A). Subluxation (B) and dislocation (C) occur when the patella is torn from its normal position in the trochlear sulcus.

Figure 2.9 Patella tilt

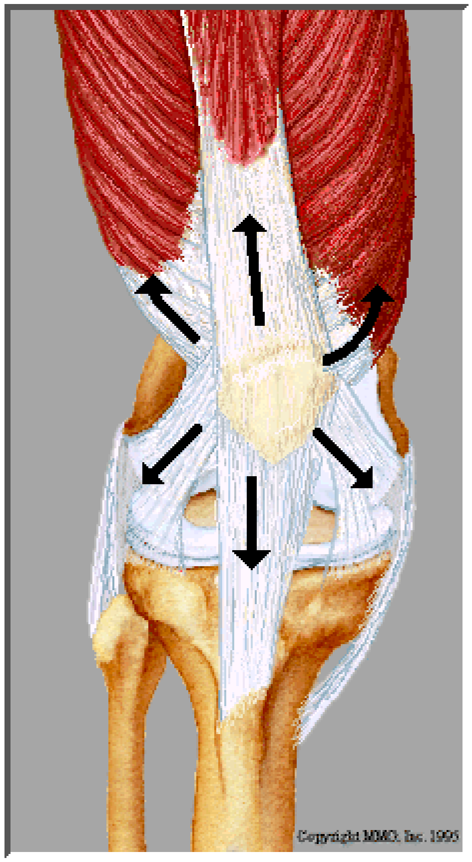

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Figure 2.10 Patella forces

With the medial and lateral static stabilizers, being responsible for maintaining the dynamic relationship of the patella to the femur, with respect to maintaining proper alignment of the extensor mechanism (Fulkerson, 1997:14), there are two forces that act on the patella during knee movement (Outerbridge and Dunlop, 1975) viz.:

- The patellofemoral compressive force is also known as the patellofemoral joint reaction force (PFJRF) and
- The quadriceps muscle tension force (Hungerford and Lennox, 1983).

In addition to the above principle forces, correct tracking of the patella during flexion and extension of the knee is influenced by the following interactions (Davidson, 1993):

- The height of the femoral condyles and hence the depth of the femoral groove, keeping the patella "seated" and tracking correctly.
- The shape of the facets on the undersurface of the patella determines the "fit" between the patella and the femoral groove.
- The medial and lateral retinaculae which keep the patella "centred" in the femoral sulcus.
- The composite angle of the pull of the quadriceps muscle group referred to as the Q-angle.
- The relative strength of the individual muscles comprising the quadriceps femoris muscle.

As much as these factors are present and control movement of the knee, any anatomic abnormalities of these structures can lead to abnormal tracking of the patella during knee movement as they affect the relationship of vectors present in the knee (Davidson, 1993) and hence may affect the ability of the patella to move within its ranges of motion and result in the presence of a decreased movement in a particular direction.

Examples of these abnormalities may include one or more of the following (Davidson, 1993):

- ***A shallow intercondylar sulcus***. According to literature a high lateral femoral condyle with a concomitant shallow sulcus, allows for more motion in the medial direction of the patella as opposed to the lateral direction. This in return restricts patella motion laterally. This is in accordance with Fithian et al. (1995) whose study concluded that the patella exhibits more medial displacement than lateral displacement.
- ***Deformed patella facets***. As the patella is drawn into a laterally tilted position due to a tight lateral retinaculum, compression of the lateral facet

results (Scuderi, 1995:77), causing a limitation in lateral to medial movement of the patella.

- ***Tightness of the medial or lateral retinaculum***. Scuderi (1995) states that pain and / or inflammation in one retinaculum is thought to affect both retinaculae simultaneously as hypermobility in one retinaculum is associated with hypomobility in the other retinaculum (Reid, 1992:354-355), causing a restriction in movement away from the hypomobile segment. This implies that there would be restricted movement related to the lateral retinaculum, thereby limiting lateral to medial movement.
- ***Weakness of the Vastus Medialis Oblique muscle***. Fulkerson (1997:44) stated that if the patella is malaligned as a result of a deficient VMO, the articular surfaces may become somewhat incongruent. Deficiency of the VMO because of developmental abnormality or acquired atrophy may lead to a lateral subluxation of the patella (Scuderi, 1995:277) as discussed above with respect to 2.3.2.

2.3.3 Function of the patella:

The functions of the patella have been denoted as follows in the literature (Reid, 1992; Fulkerson, 1997:23-24):

- The patella facilitates extension of the knee by increasing the distance of the extensor apparatus from the axis of flexion and extension of the knee.
- The patella acts as a guide for the quadriceps tendon in centralising the divergent input from the four muscles of the quadriceps femoris, transmitting these forces to the patella tendon.
- The patella protects the cartilage of the trochlea as well as the condyles by acting as a bony shield.
- The hyaline cartilage (which coats the undersurface of the patella) lacks nerve supply. This cartilage allows the transmission of forces to subchondral and cancellous bone in such a way that the pain threshold of the richly innervated bone is not surpassed.

- The tendons (infrapatellar tendon) are capable of withstanding high tensile loads, but not high friction or compression. The presence of the patella in the extensor apparatus protects the tendon from friction and permits the extensor apparatus to tolerate high compressive loads.

If any one of these functions is ***aberrant*** or there is a ***congruency deficit*** between the structures that constitute the patellofemoral joint, then pain and motion restriction is often present as well as limiting the patella in its ability to accommodate the forces that normal activity brings (Fulkerson, 1997:23).

Furthermore, there is a potential to develop clinical symptomatology, which could lead to arthrogenic muscle inhibition (AMI), due to joint effusion (Hopkins et al. 2002), immobilization (Reid, 1992:49), pain (Hopkins et al. 2002) and / or injury to joint structures (Hopkins et al. 2002). This could include OA (Arokoski et al. 2002) and PFPS (Arokoski et al. 2002), which are both clinical conditions related to joint injury. Thereafter, following joint injury, the patient experiences some deficits in range of motion and immobilization (Hopkins and Ingersoll, 2000) which could affect any one or more of the knee articulations, and perhaps could also affect motion in a particular direction or plane of movement. With AMI being defined as the inability to recruit all motor units of a particular muscle group during voluntary muscle contraction (Suter et al. 2000), the VMO is the first muscle to be affected (Hopkins and Ingersoll, 2000) by AMI. Thus, it is possible that due to this AMI, the VMO loses its ability to control the medial pull of the patella, thereby causing hypermobility along the medial aspect of the knee and hypomobility along the lateral aspect of the knee (Reid, 1992:354-355).

2.4 Knee Pain-

2.4.1 Introduction:

In the past, knee pain was the focal point of many studies and the patellofemoral joint in particular, has been documented in the literature for almost two centuries (Kolowich et al. 1990). The patellofemoral joint is a major source of pain and dysfunction in both males and females, in the young and old, and in the sedentary and athletic population alike (Walsh and Helzzer- Julin, 1992).

As a result of the wide population groups that are affected by knee pain, there are almost as many causes including (Reid, 1992:311-319):

- Articular dysfunction, including tears or strains from the ligaments; meniscal injuries; tendonosus/tendonitis or bursitis.
- Meniscal injury due to overuse or trauma. Patients often suffer from joint line pain or retropatella pain. There is an associated “open/closed locking of the knee”. This must be differentiated from plica syndrome (Calliet, 1992:76-84; Reid, 1992:311-319; Fulkerson, 1997:146). Pain on full flexion of the knee with rotation and tenderness at the medial and lateral joint line is more suggestive of a meniscal tear.
- Plica syndrome involves anterior knee pain, particularly in the medial infrapatella region, which may be caused by a plical fold. Pain particularly associated with a palpable tender band in the medial peripatella area, may indicate a symptomatic plica causing anterior pain (Fulkerson, 1997:143).
- Retinacular pain occurs when patients with patellofemoral malalignment frequently complain of nondescript aching or pain in the anterior knee. The association of this pain with softened articular cartilage has led to the assumption that this pain is caused by soft cartilage or chondromalacia patella.
- Bursitis of the infrapatella, anserine bursae that can lead to knee pain (Calliet, 1992:209-211; Reid, 1992:419-422).

- Tendonosus / tendonitis of the infrapatella tendon. Pin point pain at the apex of the patella and there may be associated swelling (Reid, 1992:78-80)
- Ligamentous pain including the cruciate ligament (Fulkerson, 1997:147).
- Rheumatoid arthritis which affects joint function and can cause joint derangement (Davidson, 1993:891).
- Gout causing swelling, redness, decreased function and pain of the joint (Calliet, 1992:207; Davidson, 1993:885-886).

However for purposes of this study, only one common functional (biomechanical) and one common pathological (degenerative) condition were chosen, namely OA (pathological) and PFPS (functional) respectively were used and thus will be discussed hereafter in more detail.

The knee, being associated with weight bearing function and susceptibility to injury (Brandt et al. 1999), is a common site of osteoarthritic involvement. OA is also known by the terms osteoarthrosis, degenerative arthritis, degenerative arthrosis and degenerative joint disease (Yochum and Rowe, 1996:802). In this respect, OA appears to commonly affect the older age group, majority of who are older than 65 years (Dowdy et al. 1998). Where knee OA is a common pathology, it leads to chronic disability, reduced mobility and functional limitation (Gordon et al. 1998).

On the other hand, Rowlands and Brantingham (1999) revealed that the prevalence of PFPS in the general population may be as high as 40%, where PFPS is defined as anterior knee pain arising from the dysfunction of the patellofemoral articulation, including its connective as well as contractile tissues (Puniello, 1993). Some of the other terms used to describe PFPS are summarized by Davidson (1993) as retropatella pain syndrome, lateral patella compression syndrome, patellofemoral arhralgia, patellofemoral dysfunction and extensor mechanism disorder.

2.4.2 Incidence and Prevalence:-

A] OA:-

An estimated 25 to 30% of people between the ages of 45 and 64 years and 60% of people older than 65 years have radiographically detectable OA (Dowdy et al. 1998) with a slightly higher female predominance in both groups. Lane and Thompson (1997) suggested that 70% of the U.S. population older than 65 years demonstrate some radiographic evidence of OA.

Felson et al. (1995:1500) performed the Framingham Osteoarthritis study, aimed at determining the incidence of radiographic knee OA and symptomatic knee OA, as well as determining the rate of progression of pre-existing radiographic OA, in a population sample of elderly persons. The rate of incident disease was 1.7 times higher in females than in men. Among females, approximately 2% per year developed symptomatic knee OA and 4% per year experienced progressive knee OA. They stated that OA was more common in females than in males and the new onset of OA occurred more often in elderly people.

B] PFPS:-

PFPS is one of the most common musculoskeletal disorders of the knee (Sandow and Goodfellow 1985; Wilson, 1990; Boucher et al. 1992; Thomee et al. 1995). PFPS commonly occurs in association with misalignment of the extensor mechanism of the knee or as a result of repetitive microtrauma and is most common in adolescents and young adults (Davidson, 1993).

The incidence of PFPS in the general population may be as high as 25 to 40% (Meyer et al. 1990; Rowlands and Brantingham 1999; Watson et al. 2001) and is most often found amongst athletic individuals (Gelfound and Devore 1993; Watson et al. 2001). Females are also affected more by PFPS than males (Davidson, 1993; Walsh, 1994:1163). This may be due to their broader pelvis and greater tendency to valgus at the knees (Davidson, 1993; Walsh, 1994:1163).

2.4.3 Aetiology:

A] OA:

OA is classified into two groups: primary (idiopathic) and secondary OA. Yochum and Rowe (1996:802) state that a classification system based on aetiology is commonly encountered were:

- Primary (idiopathic) joint disease is where no proven factor or group of factors is directly attributable to the arthropathy, although numerous factors have been hypothesized and
- Secondary joint disease conversely, applied where a known factor or event has caused the resultant degenerative changes.

Several factors have been found to play a role in the initiation or perpetuation of OA. These include the following (Martin, 1994:1433):

- Ageing.
- Alteration in matrix structure of articular cartilage.
- Alteration in the activity of articular cartilage chondrocytes.
- Alteration in the chemical mediators in the synovial fluid.
- Trauma.
- Poorly understood immune response.

Causes of secondary OA include the following (Haslett et al. 1999:826):

- Developmental factors (Legg-Calve-Perthe's disease, slipped capital femoral epiphysis and hip dysplasia).
- Trauma (intra-articular fracture, meniscectomy, occupational).
- Metabolic (hypertension, hypercholestemia, high blood glucose levels) (Hart et al. 1995:1118).
- Endocrine (acromegaly).
- Inflammatory (rheumatoid arthritis, gout, septic arthritis).
- Aseptic necrosis (corticosteroids, sickle cell disease, SLE).

- Neuropathic factors (tabes dorsalis, syrinomyelia, diabetes mellitus)
- Miscellaneous (pagets disease, gauchers disease).

B] PFPS:

The exact aetiology of PFPS is controversial, difficult to identify and poorly understood (Kannus et al. 1999).

Watson et al. (2001) reported that excessive lateral tilt or displacement of the patella with an associated tight lateral retinaculum provokes symptomatology. Other aetiologies include a shallow intercondylar groove and overuse or overactivity of the patellofemoral joint, in addition to quadriceps weakness and lower extremity misalignment, which have also been implicated as causes of PFPS (Watson et al. 2001).

In a study on PFPS in athletes attending a sports clinic, Devereaux and Lachmann (1984) found that over a five year period, actual patella trauma only occurred in 29% of 137 athletes presenting to the clinic with PFPS. Hence, this study indicated that patella trauma does not appear to be a major contributing factor in PFPS.

During a five year period, 22% of 2519 injuries reviewed at a sports injury clinic were knee injuries, with 25% of the knee injuries being PFPS. In 32% of the cases, running was thought to be a major cause (Devereaux and Lachmann, 1984). Pinshaw et al. (1984) reported that of 196 consecutive injuries seen in a runner's clinic, the knee was the most common site of injury. These studies support the idea that chronic overloading during high intensity activity such as running, as in the cases mentioned above, may be a possible factor contributing to PFPS.

In addition Sandow and Goodfellow (1985) suggested that the pain is brought on by prolonged sitting with knees flexed, ascending and descending stairs and usually by vigorous athletic activity. Gelfound and Devore (1995) stated that knee pain commonly occurred amongst adolescents and young adults, the prevalence may be as high as 40% and may account for as many as one out of every four running injuries, with Zappala et al. (1992) stating that with the increased participation in athletic activities, there has been an increase in the number of complaints in patellofemoral pain.

However, many different diagnoses exist for anterior knee pain, such as meniscal and ligamentous involvement, plica syndromes, tumors, arthritis, bursitis and tendonitis (Calliet, 1992; Reid, 1992; Fulkerson, 1997), which need to be excluded prior to a diagnosis of PFPS.

2.4.4 Clinical Features:-

A] OA:

Patients suffering from OA complain of the following:-

- Pain

The most important symptom is pain, which can vary from mild to severe, often described as a deep, dull ache localized to the affected joint. Typically the pain is aggravated by activity or when bearing weight, and is relieved by rest. The pain in the initial stages of OA is intermittent and as the disease progresses, it can become constant and disabling. The pain may also be due to worn internal structures, tense popliteal cysts, medial ligament strain, trabecular fractures, tender fat pads, synovitis, capsular contraction, loose bodies and super added crystal deposition (Golding, 1989:148).

- Stiffness

Joint stiffness and “gelling” is also another common complaint, which is occasionally relieved after motion. The morning stiffness of OA typically occurs for less than 30 minutes duration. The exact pathogenesis is not known. However, it was thought to be as a result of thickening of the joint capsule and periarticular structures (Golding, 1989:148).

- Limitation of movement

The range of movement of the knee may be decreased by capsular fibrosis, osteophytes, irregularity of articular structures or impaction of loose bodies. Fine or course crepitus may also occur on motion (Golding, 1989:148).

- Crepitus

Also known as the sensation of cracking or popping with movement of the joint is another common symptom especially with OA of the knee. Crepitus is probably due to the roughening of the joint surface or outgrowths from the joint margin, which interfere with normal smooth movement between the joint surfaces (Dieppe, 1994: 4.1-4.5).

- Swelling

Synovial swelling or effusions occur in episodes of acute OA (Golding, 1989:148). The typical protective function of the body to injury, pathological insult and microbes is that of inflammation. The classic inflammatory process, as seen in wound repair, is characterized by redness, swelling, heat and pain (Walker and Helewa, 1996:30).

- Muscle wasting

According to Brandt et al. (1999:2431), weakness of the quadriceps muscle is common and is generally believed to be the result of disuse atrophy, due to a decrease in loading of the limb, because of pain.

B] PFPS:-

- Physical findings

Three physical findings have been found to be fairly specific for PFPS when the pain originates from the patellofemoral joint (Davidson, 1993):

1) Tenderness on palpation of the medial and lateral facets.
2) A characteristic discomfort upon compression of the patella onto the femoral condyles.
3) When both sides of the patella are grasped whilst the quadriceps muscle is actively contracted, the pressure of the patella against the femoral condyles may cause discomfort.

McConnell (1986) believes the majority of patients have some degree of restricted glide of the patella that needs correction. A tightened lateral retinaculum will result in a restricted medial glide of the patella (McConnell, 1986).

According to literature, patients with PFPS commonly suffer with a tight iliotibial band, which may result in a patella restriction due to the iliotibial band's attachment to the patella through the lateral retinaculum (Post, 1998).

In patients with PFPS both step up and step down movements may lack muscular control which in turn could produce pain (Walsh, 1994:1171).

- Signs and Symptoms

The symptoms of PFPS are persistent in nature, affecting one or both knees (Sandow and Goodfellow, 1985), in a syndrome comprising the following signs and symptoms (Wood, 1998):-

- Anterior knee pain.
- Imbalance of the extensor mechanism.
- Instability of the patellofemoral joint.
- Inflammation of the surrounding tissues,
- Or any combination thereof.

These signs and symptoms may be caused by biomechanical factors, traumatic injury, or congenital abnormalities.

The most common presenting symptom in patients diagnosed with PFPS is anterior knee pain which may include pain in the subpatella, peripatella, or retropatella regions of the knee, as well as pain in the patella tendon area (Puniello, 1993). The pain is usually dull and aching in nature, becoming sharp with compressive activities, namely ascending or descending stairs, squatting, deep knee bends or sitting for prolonged periods with the knees flexed (Davidson, 1993).

Puniello (1993) found that other complaints included grinding, locking and buckling, as well as difficulty supporting weight on the affected knee are common. Zappala et al. (1992), however contradict this stating that locking of the knee, is not true locking as in the case of meniscal injuries, but rather, a catching of the patella when the knee is extended.

2.4.5 Diagnosis and Radiographic Evidence

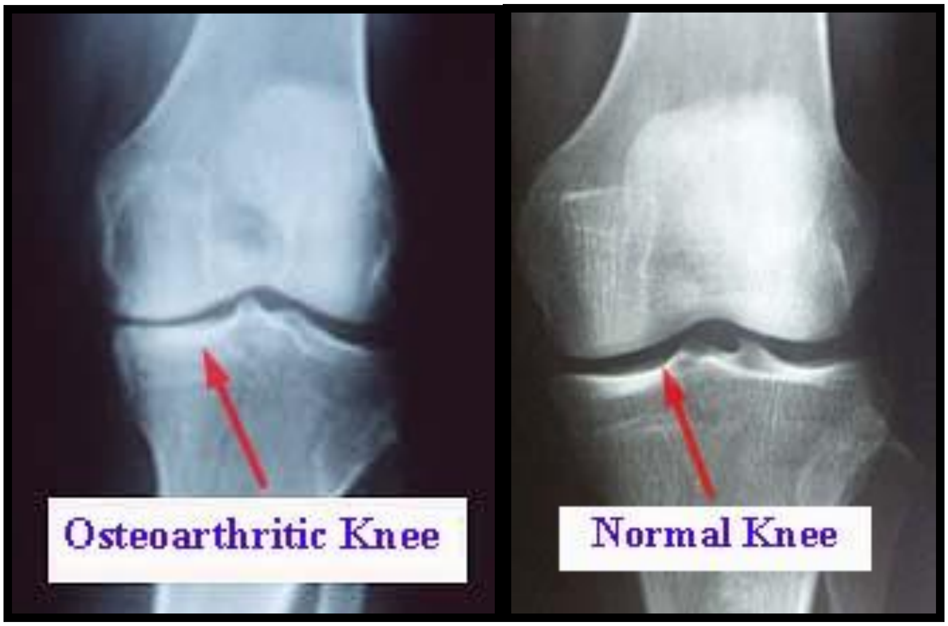
A] OA

The clinical diagnosis of OA was based on the classification criteria according to the American College of Rheumatology (ACR), which are as follows (Hart and Spector, 1995:424):-

1. knee pain (on most days of the prior month)
2. crepitus
3. morning stiffness (under 30 minutes)
4. age 38 years and older
5. bony enlargements

According to the ACR, the classification criteria will be fulfilled if any of the following combinations are met:-

- 1; 2; 3 and 4
- 1; 2; and 4
- 1; 4 and 5



http://www.emedx.com
Figure 2.11 Patella tilt

However, for purposes of this study, a homogenous sample of PFPS and OA participants were included into the study if they suffered from any of points, 1 (knee pain, on most days of the month); 3 (morning stiffness, under 30 minutes) or 4 (age 38 years and older).

There are 8 essential signs of degenerative joint disease according to Yochum and Rowe (1996:803):-

1. Asymmetric distribution
2. Non-uniform loss of joint space
3. Osteophytes
4. Subchondral sclerosis
5. Subchondral cysts
6. Intra-articular loose bodies
7. Intra- articular deformity
8. Joint subluxation

In keeping with early OA, as opposed to well-developed degenerative changes within the joint, not all of the above signs were necessary to make a diagnosis (Yochum and Rowe, 1996:803) as this study only used participants with mild OA.

B] PFPS

In assessing the patellofemoral joint, one must be aware of its dynamic function. Static evaluation of this joint may not properly reveal the causative factors related to the dysfunction. Due to the many causes of anterior knee pain, a careful evaluation is necessary to diagnose patellofemoral joint dysfunction and a complete history of the problem is pertinent (Zappala et al.1992).

The clinical diagnosis of PFPS was based on the criteria according to Powers et al. (1996):

Participants must present with at least two of the following:

- Pain with prolonged sitting (movie-goers knee)
- Pain on deep knee bends or squatting
- Pain on kneeling
- Pain on ascending or descending stairs
- Pain on isometric quadriceps femoris contraction

With emphasis being place on the history and physical examination (Zappala et al. 1992; Daly, 2005), Fulkerson (1997:73) noted significant limitations of standard radiographs with respect to patellofemoral disorders. The combined use “skyline” projections and measurements derived are important in evaluating contributing causes of PFPS. However, none of these measurements have been used to show a conclusive relationship with regards to the diagnosis or severity of PFPS (Hillerman, 2003). The use of lateral projections is valuable in assessing patella alta or baja and patella tendon lengths (Yochum and Rowe, 1996:181). For purposes of this study and due to the limitations mentioned by Fulkerson (1997:73), radiographs were not taken for participants diagnosed with PFPS.

Instead, as mentioned above, emphasis was placed on a thorough case history, physical examination and a knee regional examination to diagnose PFPS and rule out any other pathology. Furthermore, the knee regional examination consisted of multiple orthopaedic tests in order to confirm the diagnosis of PFPS and was used in combination as opposed to being used in isolation to one another. Hence this ensured a more accurate diagnosis of PFPS.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Introduction:

The aim of this research study was to determine the inter-examiner reliability of motion palpation of the patella in OA and PFPS, in order to assess the validity of this commonly used assessment tool as a reliable method in identifying restricted patella motion.

3.2 Study design:

The design was that of a quantitative, non-intervention, single-blinded, clinical reliability study.

3.3 The subjects:

The subjects consisted of volunteers suffering from OA and PFPS residing in the Kwazulu-Natal province.

3.3.1 Advertising for subject recruitment:

The public was informed of the study by advertisements placed on local community notice boards, sports clubs, gyms, in local newspapers and on the Durban Institute of Technology campus advertising for free participation in a research program being conducted on knee pain (Appendix A). Upon reply, all participants were required to undergo a cursory telephonic discussion with the examiner to exclude subjects that did not fulfill the criteria for the study (Appendix B).

3.3.2 Sampling:

The sample consisted of 60 volunteers between the ages of 35 and 50 years, 30 of which were suffering from OA, allocated to group A, and 30 of which were suffering from PFPS, allocated to group B.

3.3.3 Clinical assessment procedure:

Those volunteers that fulfilled the criteria based on the telephonic discussion came in for an ***initial consultation*** during which a case history (Appendix C), physical examination (Appendix D) and a knee regional examination (Appendix E) were conducted by the researcher.

Weight-bearing antero-posterior (A.P.), lateral and skyline radiographs were taken in order to confirm the diagnosis of OA, if OA was suspected from the initial consultation. There are 8 essential signs of degenerative joint disease according to Yochum and Rowe (1986:803):-

1. Asymmetric distribution
2. Non-uniform loss of joint space
3. Osteophytes
4. Subchondral sclerosis
5. Subchondral cysts
6. Intra-articular loose bodies
7. Intra- articular deformity
8. Joint subluxation

In keeping with early OA, as opposed to well-developed degenerative changes within the joint, not all of the above signs were necessary to make a diagnosis (Yochum and Rowe, 1996:803), as this study only included participants with mild OA. Hence, in order to ensure a more homogenous sample group, so that the examiners remained blinded as to the condition the patient presented with, the presence of certain radiological signs in the participants caused them to be excluded from the study. These were intra-articular deformity, joint subluxation, and any overt clinical deformity. Thus, the participants with mild OA presented with a knee that had no external signs indicative of OA, and as a result, had the same outer appearance as participants with PFPS. Participants therefore, were required not to present with all eight radiological signs, as this study only used participants with mild OA. Infact, participants who presented with all eight radiological signs, were automatically excluded from the study. However, it must be stated that the possibility exists where having all eight radiological signs does not necessarily indicate that participants have a different clinical appearance as opposed to participants with mild OA, but it is more likely so.

Inclusion criteria:

OA:-

A] Participants were between the ages of 35 and 50 years (Dowdy et al. 1998; Fish, 2002). The commonality of both conditions in this age group would automatically ensure blinding of the examiners by avoiding any association between the conditions and the age groups.

B] The clinical classification criteria of OA of the knee, according to the American College of Rheumatology (ACR) are (Hart and Spector, 1995):-

1. Knee pain (on most days of prior month).
2. Crepitus.
3. Morning stiffness (under 30 minutes).
4. Age 38 years and older.
5. Bony enlargements.

According to the ACR (Hart and Spector, 1995), the criteria would be fulfilled if any of the following combinations of points are met:

- 1, 2, 3, and 4
- 1, 2 and 4
- 1, 4 and 5

In diagnosing OA for the group of 30 participants, emphasis was placed on the case history, physical findings as well as the ACR criteria and confirmed via radiographs of both knees. If there were signs of both PFPS and OA found in some patients during the initial consultation, radiographs were taken. If the radiographs had shown signs of mild OA, patients automatically fell into the OA group (group A). However, if radiographic signs were severe, participants were excluded from the study. If there were no radiological signs of OA, patients fell into the PFPS group (group B).

This was done as this study required a homogenous sample of PFPS and OA participants to be included in the study if they suffered from any of points 1 (knee pain on most days of prior month), 3 (morning stiffness under 30 minutes), or 4 (age 38 years and older). This attempted to create a relative uncertainty amongst the examiners in order to maintain blinding. Therefore, participants were excluded from the study if they presented with any of points, 2 (crepitus) or 5 (bony enlargements), as these were more obvious signs indicative of OA.

PFPS:-

A] Participants were between the ages of 35 and 50 years (Devereaux and Lachman 1984; Sandow and Goodfellow 1985; Meyer et al. 1990; Wilson, 1990; Boucher et al. 1992; Davidson, 1993; Thomee et al. 1995; Heng and Haw 1996). PFPS occurs commonly amongst the younger population (16 to 45 years). The commonality of the age groups between OA and PFPS would automatically ensure blinding of the examiners by avoiding any association between the conditions and the age groups.

B] Subjects were required to present with anterior knee pain (Puniello, 1993) and localized peri- or retropatella pain (Rowlands and Brantingham, 1999).

C] Participants presented with at least two out of the following five questions (Powers et al. 1996). Do you experience pain:-

- During and/ or after activity?
- During and/ or after sitting?
- During walking up/ or down stairs?
- During squatting?
- During an isometric quadriceps femoris muscle contraction?

Exclusion criteria:

OA: - (Naidoo, 2001; Nell, 2001; Fish, 2001)

Participants were excluded from the study if they presented with any of the following:

A] Patients were excluded from the study if they were under the age of 35 or over 50 years (Dowdy et al. 1998).

B] Pregnant or lactating females as x-rays were taken.

C] Patients were excluded if they presented with or showed any indication of the following:-

- Grade 3 ligamentous instability of the knee.
- Neoplastic disease or malignancy.
- Infective arthritides.
- Haematological disease.
- Systemic arthritis: rheumatoid arthritis or psoriatic arthritis.

- Acutely painful knees.
- Bony enlargements, crepitus, swelling (in order to maintain homogeneity).

PFPS: (Wilson, 1990; Thomee et al. 1995; Maitland, 1977)

Participants were excluded from the study if they had a history of one of the following:

A] Bilateral knee pain specific for PFPS.
B] A history of recurrent patella subluxation or dislocation.
C] A history of intermittent or persistent knee joint swelling.
D] Other injuries of the knee joint such as tears of the menisci; ligaments or joint capsule; damage to the articular cartilage; or overuse symptoms such as bursitis, patella tendonitis and fatpad syndrome.
E] Any systemic arthritide that may affect the knee such as gout or rheumatoid arthritis (Powers et al. 1996).
F] Having undergone any knee surgery within the past two years.
G] Participants were excluded if they received any form of chiropractic, physiotherapy or massage therapy.
H] Pregnant or breast feeding participants were excluded from the study (Kannus et al. 1999).

Subjects found suitable for this study were given a letter of information (Appendix F) and were asked to complete an informed consent form (Appendix G).

At the ***second consultation***, all the subjective and objective data were collected by the researcher. Once the data was collected, the examiners were allowed into the examination room to motion palpate the patients one at a time, and in random order. It is important to note here that subjective and objective data collected by the researcher were kept confidential and the examiners were unaware of the researchers findings such as: the history, physical examination, knee regional findings, diagnosis reached, inclusion and exclusion criteria of the study, and whether or not x-rays were taken, in the patients that were motion palpated. As a result, blinding was achieved amongst the examiners. Further to this, the researcher was not one of the five examiners, in order to ensure accurate blinding.

3.4 Motion palpation:

For purposes of this study, the method chosen for motion palpation of the patella was Bergmann's Technique. This is the method that the chiropractic students at the Durban Institute of Technology Chiropractic department were taught to use. Bergmann's technique is simple and easy to understand. It evaluates the patella in eight directions.

However, for purposes of this study, only four directions were used:

- medial to lateral glide,
- lateral to medial glide,
- superior to inferior glide and
- inferior to superior glide, as per the directions utilized by Bezuidenhout (2002) and Scott (2005).

This was principally to avoid excessive mobilization of the patella by the five examiners.

The five examiners were given a thorough workshop to standardize the motion palpation technique, which was held over two days. The examiners were taught to evaluate the patellofemoral articulation in the four directions with the patient lying supine and the involved leg straight in passive knee extension. The examiners contacted the borders of the patella with both thumbs and applied stress to the patella in the directions mentioned above. The examiners then felt for a comparable amount of movement from side to side (Bergmann et al. 1993:676).

Furthermore, before each motion palpation session, the researcher pointed out to the examiners the symptomatic knee that was to be motion palpated without revealing the condition the patient presented with based on the history, physical and radiographic findings (if radiographs were taken). Furthermore, the researcher also made sure that the patients were instructed to keep communication with the examiners at a minimum. The reason for this was to avoid any predetermined outcomes and to avoid any unwarranted errors.

3.5 Measurement and observation:

The data

The study incorporated both subjective and objective data mentioned below:

3.5.1 Subjective data

A] Numerical Pain Rating Scale (NRS) (Jenson et al. 1988) (Appendix H):

The NRS 10 assess the patient's perception of their pain intensity. The questionnaire consists of a numerical scale of eleven points with 10 representing pain at its worst and 0 representing no pain. The NRS has been found to be a reliable and valid method to record subjective data relating to the patients level of pain.

3.5.2 Objective data

A] The Goniometer (Appendix I);-

The goniometer was used to measure the knee range of motion. Readings were taken at full flexion and full extension. The procedure for assessing knee range of motion was as follows:-

- The patient was asked to lie supine on the table.
- The centre binding ring of the goniometer was placed over the central aspect of the lateral femoral condyle.

- One arm of the goniometer was extended to line with lateral malleolus of the ankle, while the other arm was extended to line up with the trochanteric notch of the femur.
- The patient was asked to fully extend the knee, and the angle was measured and recorded.
- The patient was asked to fully flex the knee and again the reading was recorded.

B] Objective pain rating scale for PFPS (Appendix J):-

This scale consists of orthopaedic examination (Reid, 1992:369; Magee, 1997:566), and stress tests of the pathognamonic signs of PFPS (Thomee et al. 1995), pain being a positive indicator. Each positive answer was given a score of 2 and a negative answer resulted in a score of 0. The maximum score the participant could achieve was 18.

C] Patella motion palpation record sheet (Appendix K) (Bergmann et al. 1993; Bezuidenhout, 2002):-

Participants were placed in random order and the examiners motion palpated both patellae. Examiners were also randomized in terms of the order in which they motion palpated the patellae of each participant. The motion palpation record sheet consisted of a three point grading system of general patella mobility (normal mobility, mild to moderate restrictions and severely restricted) in the 4 directions of motion (superior to inferior, inferior to superior, medial to lateral and lateral to medial).

3.6 Statistical analysis:

Intra-group (within group A: OA subjects) and group B (PFPS subjects) inter-rater reliability was assessed using Cohen's Kappa statistic calculated with Graphpad software (http://graphpad.com/quickcals/Kappa2.cfm). Weighted Kappa statistics were used because the categories were ordinal. MS Excel was used to calculate weighted means and standard deviations of the Kappa statistics based on the number of pairs in each agreement tabulation. This was done in order to obtain an overall mean Kappa statistic per group, and to compare these means between the two groups using independent t-tests.

SPSS version 11.5 was used for further analysis (SPSS Inc, Chicago, Ill, USA). Demographics were compared between groups using Fisher's exact tests or chi square tests where appropriate for categorical variables, and t-tests were used to compare age between the two groups.

Median responses of the 5 examiners were calculated in order to assess the associations between type of restriction and symptoms. Where the responses were tied, an average of the two categories was used, e.g., if a participant was given a score of 1 by two examiners and a score of 2 by two examiners that participant received a median score of 1.5. Associations between the type of restriction and symptoms were assessed using one way ANOVA on each group separately, with Bonferroni post hoc tests.

3.7 Definition of statistical terms:

- **ANOVA:**

Analysis of variants between groups is used to test hypothesis about differences between two or more means.

- **Bonferroni:**

Bonferroni correction / adjustment procedure concerns an issue about which there is much, and ongoing discussion. Incase of doing more than one test in a particular study, the alpha level should be adjusted downward to consider chance capitalization.

- **Standard Deviation:**

Standard deviation shows how closely the sample values are clustered around the mean, but it is not the average distance of each sample value from the mean. It is a measure of the average dispersion of the variable.

- **t-tests:**

This is used to test whether a sample belongs to a distribution with a known mean. The t-test is valid for a variable with a normal distribution, although it has been shown that where the t-test is used with minor deviations from the normal distribution, the results are valid.

- **Chi square:**

This is used to test whether the proportions across a number of categories of two or more independent groups is the same.

- **Fishers exact test:**

This is used to test whether the proportions in 2 categories of 2 independent groups is the same.

- **P-value:**

A p-value is the probability of getting the output observed, assuming the null hypothesis to be true. It is a measure of strength of evidence against the null hypothesis. The smaller the p-value, the stronger the evidence (the less likely the outcome occurred by chance). 0.05 or 0.01 is called the significant level of the hypothesis test and denoted as alpha.

- **Cohen's Kappa:**

Kappa is used to assess strength of agreement between two raters. Kappa co-efficients range between 0 and 1. The closer it is to one the greater the reliability. The following scale was used to assess the reliability of the Kappa co-efficients:

<0.00	**-**	**not better than by chance alone (i.e. any negative denoting that the Kappa score is less than 0.00)**
0.00 < and < 0.20	-	**poor**
0.20 < and < 0.40	**-**	**fair**
0.40 < and < 0.60	**-**	**moderate**
0.61 < and < 0.80	**-**	**good**
0.81 < and <1.00	**-**	**very good**
1.00	**-**	**excellent / perfect correlation**

- **Degrees of freedom (df):**

Any of the unrestricted, independent random variables that constitute a statistic. It is the "index number" for identifying which distribution is used.

CHAPTER FOUR
RESULTS AND DISCUSSION

This chapter involves the discussion of the demographic data (age, gender, race and activity levels) and the results after statistical analysis of the data obtained from the subjective (Numerical Pain Rating Scale) (NRS) and objective (Goniometer readings; Objective Pain Rating Scale and motion palpation results).

Criteria Governing the Admissibility of Data:

Data was collected only from those patients who met the research criteria and who participated for the full duration of the research program. Only subjective pain perception (NRS) data that was completed by the participants under the supervision of the researcher was utilized. Only objective goniometer readings, objective pain rating scale and the motion palpation readings taken by the researcher were utilized.

Key:

- Osteoarthritis: OA
- Patellofemoral Pain Syndrome: PFPS
- Superior to Inferior direction: SI
- Inferior to Superior direction: IS
- Medial to Lateral direction: ML
- Lateral to Medial direction: LM
- Quadriceps Femoris muscle: QF
- Vastus Lateralis muscle: VL
- Vastus Medialis Oblique muscle: VMO
- Rectus Femoris muscle: RF
- Iliotibial band: ITB
- Number of participants: n
- Standard deviation: SD

4.1 Demographic Data:

The following tests were used to compare the demographics: Fisher's exact tests or Chi-Square tests where appropriate for categorical variables, and t-tests were used to compare age between the two groups (OA and PFPS).

Table 1: Comparison of demographic characteristics between the two groups (n=60)

	Group A – OA (n=30)	Group B – PFPS (n=30)	p value
Age -mean (SD)	43.9 (4.4)	42.1 (5.1)	0.143
Gender- n (%):			0.180
Males	16 (53.3)	22 (73.3)	
Females	14 (46.7)	8 (26.7)	
Race- n (%):			0.394
White	9 (30.0)	11(36.7)	
Black	3 (10)	5 (16.7)	
Indian	17 (56.7)	11 (36.7)	
Coloured	1 (3.3)	3 (10)	
Activity- n (%):			**<0.001**
Athletic	12 (40)	28 (93.3)	
Sedentary	18 (60)	2 (6.7)	

There were 60 subjects in the study: 30 (50%) symptomatic OA (group A) and 30 (50%) symptomatic PFPS (group B).

4.1.1] Age:

Participants' mean age did not differ significantly between the two groups (p=0.143) although the mean age in group A (43.9) was slightly higher than in group B (42.1). Literature suggests that OA is a common knee problem affecting the older population with a slightly higher female predominance (Dowdy et al. 1998).

PFPS is also one of the most common musculoskeletal disorders of the knee (Sandow and Goodfellow 1985; Wilson, 1990; Boucher et al. 1992; Thomee et al. 1995), however it affects young adults and sports men and women more commonly (Devereaux and Lachman 1984; Sandow and Goodfellow 1985; Davidson, 1993).

Therefore one would expect to see a difference with respect to age relative to the two groups under study; however the statistical findings indicate more small variances with respect to age, even in view of the fact that these presentations are consistent with disease aetiology. Therefore it could be stated that the lack of significance between two groups is not a disadvantage to the study but rather an advantage as it allows for greater homogeneity as the sample groups are more comparable (Mouton, 1996).

4.1.2] Gender Distribution:

There was a slightly higher ratio of males to females in group B (73.3%) than in group A (53.3%), but this difference was not statistically significant ($p=0.180$).

In the literature females have a greater predisposition to OA than males (Dowdy et al. 1998), which is not supported by the statistical findings of this study in which the male distribution was found to be slightly higher than the female distribution (53.3% male). In agreement with this, PFPS also occurs more commonly amongst females than males (Devereaux and Lachman, 1984; Sandow and Goodfellow 1985; Davidson, 1993), which is also in contrast to the results obtained in this study. Nevertheless it would seem that the higher percentage of males participating in this study does correlate with findings in other South African studies on PFPS (Stakes, 2000; Clifton, 2003; Dippenaar, 2003).

4.1.3] Racial Distribution:

The racial distribution was similar between the groups (p=0.394). Overall, the sample consisted of mainly Indian participants, followed by White participants. Black and Coloured participants made up a small percentage of the sample.

As can be seen in table 1, there was no correlation between the distributions of race in this study and the demographics of race in South Africa as discussed above. This was largely influenced by the fact that this study awaited the response of the public to the advertisement (only available in English as per Appendix K) and / or relied on the response of the population that are already aware of and use the facilities offered by the Durban Institute of Technology Chiropractic Clinic. In addition, this could be accounted for in that the selection of individuals was by means of convenience sampling, which relied on patient self-selection for the research.

Nevertheless, the homogeneity achieved within the racial groups is important for this study in order to be able to compare the results obtained from both groups (Mouton, 1996).

4.1.4] Activity Level Distribution:

As expected, the groups differed very significantly on the activity levels (p<0.001). This therefore indicates that the PFPS group was potentially more athletic than the OA group, with the OA group showing 60% were sedentary with only 6.7% being sedentary in the PFPS group. In the OA group, only 40% were athletic as opposed to 93.3% of the PFPS group being athletic.

According to Ettinger and Afable (1994), the clinical and functional status of persons with OA, appears to worsen gradually over time. Individuals begin to modify their activity and daily routines in response to joint pain, which leads to a lack of activity associated with a decline in health status (Klinger et al. 1999).

On the other hand, the incidence of PFPS may be as high as 40% in the general population (Rowlands and Brantingham, 1999) and is most often found amongst the athletic individuals (Gelfound and Devore 1995; Watson et al. 2001).

The demographic results in this study would therefore support literature indicating that PFPS is a functional syndrome (associated with activity) whereas OA is a degenerative syndrome (associated with inactivity).

4.2 INTER-RATER RELIABILITY (INTRA-GROUP):

In order to address objective one as set out in chapter one (1.3), the inter-examiner reliability will be discussed under the following headings: 4.2.1 and 4.2.2 for each of the respective groups in this study (OA and PFPS).

For purposes of obtaining results with respect to the reliability between examiners, four examiners were required in order to gather the baseline data for this study. However for pragmatic purposes, a fifth examiner was included when any one of the principle four examiners was unavailable. Therefore with respect to the inter-rater agreement tables (tables 2 – 5), it will be noticed that the number of pairs for which comparisons are available for examiner one are less than for examiners two to five.

In order to increase the validity of assessments made with respect to grading of patella restrictions, the examiners were presented with patients that had either OA or PFPS. The clinical presentation of both these syndromes were homogenous (as per chapter 3) in order that the examiners did not identify restrictions based on clinical identification of the syndrome (i.e. they were blinded). This however had the effect that the OA present in this study was predominantly mild with some moderate cases.

4.2.1 OA group:

4.2.1.1 Grade:

A grading for general patella mobility was utilized (Appendix I) which recorded normal mobility, mild to moderate restriction of mobility and severe restriction of mobility. The grading of patella motion was recorded by the examiners as normal mobility (A), mild/ moderate restricted (B) and severely restricted (C) on their motion palpation record sheet (Appendix K). The scale used to assess and interpret the levels of reliability of Kappa co-efficients has been included for the benefit of the reader, and can be found on page 62 in chapter three.

Table 2: Inter-rater agreement for grade in the OA group

Examiner comparisons	Percentage agreement	N pairs	Weighted Kappa	Classification of agreement
1 vs. 2	33.33%	6	-0.20	Worse than expected by chance alone
1 vs. 3	87.5%	8	0.00	Poor
1 vs. 4	100%	8	1.00	Perfect
1 vs. 5	75%	4	0.00	Poor
2 vs. 3	57.14%	28	0.219	Fair
2 vs. 4	46.43%	28	0.028	Poor
2 vs. 5	58.33%	24	0.322	Fair
3 vs. 4	70%	30	0.366	Fair
3 vs. 5	61.54%	26	0.340	Fair
4 vs. 5	69.23%	26	0.342	Fair

Mean weighted Kappa =0.267 (fair).

As indicated by table 2, the mean weighted Kappa outcome with respect to mean inter-examiner reliability is kappa = 0.267 (fair). By implication, this result implies one of two things:

1 Participants were homogenous with respect to the aetiological factors which predispose these participants to the condition in terms of age (4.1.1); race (4.1.2); gender (4.1.3) and activity levels (4.1.4) as well as

symptomatology i.e. pain (section 4.4), therefore the results achieved are valid and reliable (Mouton, 1996)

2 The agreement between the examiners in respect of the grade of restrictions found could have been based on:

a] The examiners being aware of the fact that the researcher was possibly only examining OA participants at the time. This could have been attributed to a communication discrepancy whereby the possibility that the examiners were in contact amongst one another and with the participants cannot be ruled out. Furthermore, this research took place in an outpatient clinic at the Durban Institute of Technology, where various research studies take place. Hence, it is possible that the examiners were aware of the conditions being researched. However, before each motion palpation session, the researcher pointed out to the examiners the symptomatic knee that was to be motion palpated without revealing the condition the patient presented with. Furthermore, the researcher also made sure that the patients were instructed to keep communication with the examiners at a minimum.

b] The examiners preconceived idea of the type of restriction the participant had presented with.

c] **Chance agreement**. It is possible that the examiners could achieve agreement purely by chance alone.

d] **Technique of motion palpation**. Through the years of practice, the student examiners could have developed their own unique style of motion palpation and hence could influence the outcome of the results obtained.

e] **Level of experience**. This is related to the number of patients with knee problems, the students have examined in the clinic environment. Certain students could have more experience with the treatment of knee disorders than others.

In the context of this study, point one could have assisted the examiners in obtaining a consistent result which would further have been aided by points (2.a) and (2.b), had the clinical conditions been overtly / clinically determinable without the need for a case history or more substantial evaluation. On the contrary, point's c, d, and e would have countered these effects in view of the fact that this research aimed at ensuring that the clinical presentations of the patients was homogenous

Furthermore, table 2 shows that there was perfect agreement between examiners 1 and 4 for grade in the OA group, even though there was no communication between participant and examiner or examiner and examiner. Thus this agreement could possibly be due to one of three reasons related to the examiners:

- **Chance agreement**.
  It is possible that all the other examiners did not get 100% agreement purely by chance or the inverse is true that examiners 1 and 4 were able to achieve 100% agreement by chance
- **Technique of motion palpation**.
  Through the years of practice, the student examiners could have developed their own unique style of motion palpation and hence could influence the outcome of the results obtained. This was despite the fact that motion palpation workshops were allocated in order to obtain a more accurate result. If techniques are similar then the chances of there being similar results are higher, therefore allowing a greater degree of agreement being reflected.
- **Level of experience**.
  This is related to the number of patients with knee problems, the students have examined in the clinic environment. Certain students could have more experience with treating knee disorders than others. Again the ability to detect motion parameters within a particular joint is perfected with practice and therefore increased exposure to a particular condition (e.g. knee

condition) would make that or those examiners tend to agree purely from a pragmatic clinical experience point of view.

However this result was only based on eight participants, therefore the discussion at best is based on speculation that would require further research. Notwithstanding examiners one and four, the overall agreement was fair, which could be due to the fact that this research only involved subjects with mild OA, in order to maintain homogeneity with the PFPS group. A homogenous group with participants that have mild OA was required due to the possibility that, had the patients had more severe OA or specific clinical indications of OA, examiners may have tended to name the grade of the restriction based on clinical presentation rather than the presentation as per their own tactile stimuli.

In view of the overall fair agreement obtained in this group between all the examiners, this research seems to indicate that the procedure of motion palpation for the knee is sensitive to the underlying pathology.

Furthermore, it would be fair to assume that the results achieved, indicate that for a mild pathological disorder that motion palpation may be one tool that could be used in identifying the type of therapy to be employed. However, as the results indicate that there is only a fair chance of obtaining isolated information with regard to the grade of restricted motion with this test, it is suggested that it form part of an extended assessment and is not used as the principle indicator of therapy for OA, which is consistent with other research (Bezuidenhout, 2002).

4.2.1.2 Direction of Motion Restriction:

There were four principle directions assessed by the examiners as per tables three, four, five and six below. Discussion of the results obtained will be presented after table six.

4.2.1.2.1 Superior to Inferior direction (SI):

Table 3: Inter-rater agreement for SI in the OA group

Examiner comparisons	Percentage agreement	N pairs	Weighted Kappa	Classification of agreement
1 vs. 2	83.33%	6	0.667	Good
1 vs. 3	37.5%	8	0.167	Poor
1 vs. 4	75%	8	0.500	Moderate
1 vs. 5	25%	4	-0.500	Worse than expected by chance alone
2 vs. 3	64.29%	28	0.300	Fair
2 vs. 4	46.43%	28	0.087	Poor
2 vs. 5	37.5%	24	-0.216	Worse than expected by chance alone
3 vs. 4	50%	30	0.255	Fair
3 vs. 5	50%	26	0.153	Poor
4 vs. 5	46.15%	26	0.125	Poor

Mean weighted Kappa =0.148 (poor).

Table 3 shows that agreement ranged from worse than expected by chance alone, to good. Overall agreement however was poor.

4.2.1.2.2 Inferior to Superior direction (IS):

Table 4: Inter-rater agreement for IS in the OA group

Examiner comparisons	Percentage agreement	N pairs	Weighted Kappa	Classification of agreement
1 vs. 2	66.67%	6	0.500	Moderate
1 vs. 3	12.5%	8	-0.167	Worse than expected by chance alone
1 vs. 4	25%	8	-0.043	Worse than expected by chance alone
1 vs. 5	50%	4	0.333	Fair
2 vs. 3	46.43%	28	-0.087	Worse than expected by chance alone
2 vs. 4	35.71%	28	-0.177	Worse than expected by chance alone
2 vs. 5	54.17%	24	0.200	Fair
3 vs. 4	53.33%	30	0.250	Fair
3 vs. 5	57.69%	26	0.356	Fair
4 vs. 5	57.69%	26	0.364	Fair

Mean weighted Kappa =0.140 (poor).

Table 4 shows that agreement ranged from worse than expected by chance alone, to moderate. Overall agreement however was poor.

4.2.1.2.3 Medial to Lateral direction (ML):

Table 5: Inter-rater agreement for ML in the OA group

Examiner comparisons	Percentage agreement	N pairs	Weighted Kappa	Classification of agreement
1 vs. 2	50%	6	0.308	Fair
1 vs. 3	75%	8	0.529	Moderate
1 vs. 4	50%	8	0.130	Poor
1 vs. 5	75%	4	0.500	Moderate
2 vs. 3	60.71%	28	0.379	Fair
2 vs. 4	46.43%	28	0.108	Poor
2 vs. 5	41.67%	24	0.061	Poor
3 vs. 4	60%	30	0.308	Fair
3 vs. 5	46.15%	26	0.108	Poor
4 vs. 5	42.31%	26	0.181	Poor

Mean weighted Kappa =0.218 (fair).

Table 5 shows that agreement ranged from poor, to moderate. Overall agreement however was fair.

4.2.1.2.4 Lateral to Medial direction (LM):

Table 6: Inter-rater agreement for LM in the OA group

Examiner comparisons	Percentage agreement	N pairs	Weighted Kappa	Classification of agreement
1 vs. 2	50%	6	0.182	Poor
1 vs. 3	37.5%	8	0.040	Poor
1 vs. 4	50%	8	0.059	Poor
1 vs. 5	50%	4	0.000	Poor
2 vs. 3	82.14%	28	0.590	Moderate
2 vs. 4	57.14%	28	0.176	Poor
2 vs. 5	58.33%	24	0.053	Poor
3 vs. 4	63.33%	30	0.384	Fair
3 vs. 5	69.23%	26	0.432	Moderate
4 vs. 5	61.54%	26	0.356	Fair

Mean weighted Kappa =0.301 (fair).

Table 6 shows that agreement ranged from poor to moderate. Overall agreement however was fair.

Conclusion:

Therefore in summary, OA Kappa scores per direction are:

Table 7:

	OA group	
	N	**Kappa**
Grade	188	0.266787
SI	188	0.148234
IS	188	0.139787
ML	188	0.217947
LM	188	0.301128

N refers to the sum of the number of pairs of comparisons between examiners.

From the summary table above, it can be seen that there was fair agreement between the examiners for the direction of lateral to medial (kappa=0.301) and medial to lateral direction (kappa=0.217). The rest of the agreement between directions of movement ranged from worse than expected by chance alone (IS) (0.139) to poor (SI) (0.148).

Decreased movement in the **LM** direction implies that the following anatomical structures could be restricting movement:

- ***Retinaculum*** (lateral / medial) (Scuderi, 1995; Fulkerson, 1997).
- ***Lateral compartment of the knee*** (Scuderi, 1995; Sharma et al. 1999).
- ***Muscles and pain sensitive structures involving Arthrogenic Muscle inhibition*** (Suter et al. 2000; Arokoski et al. 2002)
- ***ITB*** (Wood, 1998; Hinman et al. 2002).

By implication these structures could be affected by OA as a result of any one or more of the following:

- OA which is a degenerative condition of the knee, is associated with medial compartment (of the knee) degeneration (Lewek et al. 2004). This degeneration is often associated with increased movement in the medial compartment due to an increased rate of degeneration (Sharma et al. 1999) and as a result retinacular laxity on the medial aspect of the knee (Lewek et al. 2004) leading to hypermobility within the medial retinaculum. This is further supported by Scuderi (1995), where he indicates that with the pain and / or inflammation in one ***retinaculum*** is thought to affect both retinaculae simultaneously (Scuderi, 1995), as hypermobility in one retinaculum is associated with hypomobility in the other retinaculum (Reid, 1992:354-355), causing a restriction in movement away from the hypomobile segment. This implies that there would be restricted movement related to the tethering of the patella by the lateral retinaculum, thereby restricting lateral to medial movement. Thus the resulting increase in the tightening effect on the lateral retinaculum could be associated with the joint degeneration, allowing for examiners to agree.

  Furthermore, Fulkerson (1997:166) stated that abnormal tension in the lateral retinaculum develops during the course of growth, only to be clinically revealed after an injury or with the passage of time. This implies that the patients with OA would find this decrease in movement insidious in onset and is therefore under reported and something that is not routinely assessed clinically. This is especially true of patients presenting with mild OA, where Sharma et al. (1999) indicate that varus-valgus laxity is more common in mild, clinically quiescent OA.

- Furthermore, literature suggests that patellofemoral arthritis is typically idiopathic or secondary to malalignment (Scuderi, 1995:291), and is therefore found to involve primarily the lateral aspect of the joint in terms of attaining stability through the development of osteophytic growth (Sharma et al. 1999). This is achieved in the ***lateral compartment***, by a decreased lateral joint space of the patellofemoral articulation which is narrowed, with osteophytic formation evident on the lateral patella and trochlea (Scuderi, 1995:291) as well as superimposed muscle contraction which all add to the stiffness perceived by the patient (Sharma et al. 1999). Furthermore, a tight lateral retinaculum leads to overload of the lateral facet and subsequent arthrosis within the lateral compartment first (Scuderi, 1995:291).

- In general, knee joint pathologies (including OA) are associated with a loss of knee-extensor muscle strength (Hassan et al. 2001). This weakness has been attributed to ***Arthrogenic Muscle Inhibition (AMI),*** where AMI is defined as the inability of a muscle to recruit all motor units of a muscle group to their full extent during a maximal effort voluntary muscle contraction and is a natural response designed to protect the joint from further damage (Suter et al. 2000). AMI has been identified in subjects with both asymptomatic and symptomatic OA (Arokoski et al. 2002) and thus it (OA) serves as a potential aetiological factor of AMI. There are several sources for AMI; however in principle any pain producing structure can cause such inhibition.

  In the knee, the first muscle to show signs of AMI is that of the VMO (Hopkins and Ingersoll, 2000). Therefore it has received much literature attention with respect to rehabilitation and strength correction (Hopkins and Ingersoll 2000; Suter et al. 2000). As a result exercise interventions emphasize the importance of the VMO because of the medial pull on the patella. However, it is not clear whether it is possible to selectively activate the VMO during exercise (Thomee, Augustsson and Karlsson, 1999) and thus quadriceps femoris strengthening exercises may simply bring the VMO up to its “threshold” necessary for proper patella tracking, without selective VMO activation (Theil-Brody and Theil, 1998), which has implications for the proper biomechanical function.

Therefore in terms of applicability to this research, the increased atrophy of the VMO, leads to a force differential whereby the VL is more powerful than the VMO and therefore results in a supero-lateral pull on the patella, decreasing its ability to move from lateral to medial, supporting the hypothesis in the literature that states that the Vastus Medialis Oblique (VMO) muscle strength is essential for proper patella tracking (Theil-Brody and Theil, 1998). This would therefore account for the decreased lateral to medial mobility of the patella noted by the examiners.

- Patellofemoral mechanics can also be altered by a tight ***ITB*** or quadriceps femoris (Walsh, 1994; William, 1998; Wood, 1998; Clifton, 2003), due to altered gait patterns (Hinman et al. 2002) and postural sway (Hassan et al. 2001). With movement, the patella is normally drawn posteriorly with flexion, within the midline; however an abnormally tight retinaculum between the patella and ITB will tend to draw the patella into a laterally tilted position, and as a result will compress the lateral facet (Scuderi, 1995:77), limiting lateral to medial movement.

In view of the fact that this research was to assess inter-examiner reliability with respect to the four different directions being motion palpated, the factors presented above represent suggestions as to why certain directions were more restricted than others, as found consistently by the examiners in this study, even though this is contrary to other literature that would support a generalized decrease in all directions of movement of the patella or involved joints that have OA (Golding, 1989: 148).

In a similar light however, the **ML** direction also revealed that agreement between examiners was fair (K=0.2179).

Decreased movement in the ML direction implies that the following anatomical structures could possibly be restricting movement:

- ***Chondromalacia of the medial facet*** (Fulkerson, 1997: 235, 227).
- ***Medial retinaculum contracture*** (Calliet et al. 1992:158; Fulkerson 1997:14).
- ***Medial collateral ligament weakness*** (Calliet et al. 1992:23, 118).

By implication these structures could be affected by OA as a result of any one or more of the following:

- ***Chondromalacia of the medial facet*** may be secondary to deficient contact or to a combination of compression and shearing forces (Fulkerson, 1997:227) which can eventually lead to medial facet articular cartilage breakdown. Furthermore the convex shape of the medial facet subjects its articular cartilage to greater localized stresses (Scuderi, 1995:2). Cartilage damage can become severe; leaving little or no articular cartilage on the medial patella (Fulkerson, 1997:235). As a consequence, medialisation is necessary to provide stability of the patella. Hence, as a result of the articular cartilage changes mentioned above, it can be reasonably assumed that the possibility exists of there being mobility restrictions particularly in the medial aspect of the patella, thereby restricting movement in the ML direction (Fulkerson, 1997:235).

- ***Medial retinaculum contracture*** or shortening may cause the retinaculum to thicken. As a result, the contained nerve may become painful (Calliet et al. 1992: 158). This shortening tends to pull the patella medially, causing the medial facets to be excessively compressed which may lead to degenerative arthritis (Calliet et al. 1992: 158). This may result in a restricted movement in the medial direction due to there being more retinacular support on the lateral aspect as opposed to the medial aspect of the patella (Fulkerson, 1997:14).

- Calliet et al. (1992:23) state that the medial collateral ligament plays a role in maintaining alignment of the patella within the femoral condylar groove in knee actions. Thus injury to this ligament will cause ***weakness*** in the area and tenderness over the medial aspect of the knee is expected (Calliet et al. 1992:118). Therefore, one would expect that this tenderness could produce guarding over the area and hence limit movement in the ML direction.

Based on the results of this study, there appears to be a difference between the levels of agreement between examiners when different directions are assessed based on the degree of involvement of certain anatomical structures.

It is therefore suggested, that patella restrictions based on particular stages of the clinical pathogenesis of PFPS be addressed, and all the structures involved in enabling or restricting movement in all directions be addressed as well.

4.2.2 PFPS group

4.2.2.1 Grade

Table 8: Inter-rater agreement for grade in the PFPS group

Examiner comparisons	Percentage agreement	N pairs	Weighted Kappa	Classification of agreement
1 vs. 2	65.22%	23	0.292	Fair
1 vs. 3	52.17%	23	0.080	Poor
1 vs. 4	56.52%	23	0.115	Poor
1 vs. 5	66.67%	18	0.426	Moderate
2 vs. 3	76.67%	23	0.462	Moderate
2 vs. 4	73.33%	30	0.322	Fair
2 vs. 5	60%	25	0.183	Poor
3 vs. 4	83.33%	30	0.595	Moderate
3 vs. 5	52%	25	0.020	Poor
4 vs. 5	44%	25	-0.215	Worse than expected by chance alone

Mean weighted Kappa =0.231 (fair).

As indicated by table 8, the mean weighted Kappa outcome with respect to mean inter-examiner reliability is Kappa = 0.231 (fair). By implication, this result is also applicable to the OA group and the reasoning of which can be found on page 68, table 2 (points 1 and 2a-e).

Therefore it would be fair to assume that the results achieved, indicate that for a biomechanically dysfunctional disorder that motion palpation may be one tool that could be used in identifying the type of therapy to be employed. However, as the results indicate that there is only a fair chance of obtaining isolated information with regard to the grade of restricted motion with this test, it is suggested that it form part of an extended assessment and is not used as the principle indicator of therapy for PFPS, which is consistent with other research (Bezuidenhout, 2002).

4.2.2.2 Direction of Motion Restriction:

There were four principle directions assessed by examiners one, two, three, four and five as per tables nine, ten, eleven and twelve below. Discussion of the results will be presented after table twelve.

4.2.2.2.1 Superior to Inferior direction (SI):

Table 9: Inter-rater agreement for SI in the PFPS group

Examiner comparisons	**Percentage agreement**	**N pairs**	**Weighted Kappa**	**Classification of agreement**
1 vs. 2	69.57%	23	0.435	Moderate
1 vs. 3	56.52%	23	0.115	Poor
1 vs. 4	60.87%	23	0.213	Fair
1 vs. 5	44.44%	18	-0.088	Worse than expected by chance alone
2 vs. 3	56.67%	30	0.009	Poor
2 vs. 4	73.33%	30	0.492	Moderate
2 vs. 5	64%	25	0.370	Fair
3 vs. 4	53.33%	30	0.037	Poor
3 vs. 5	64%	25	0.247	Fair
4 vs. 5	64%	25	0.332	Fair

Mean weighted Kappa =0.222 (fair).

Table 9 shows that agreement ranged from worse than expected by chance alone, to moderate. Overall agreement however was fair.

4.2.2.2.2 Inferior to Superior direction (IS):

Table 10: Inter-rater agreement for IS in the PFPS group

Examiner comparisons	Percentage agreement	N pairs	Weighted Kappa	Classification of agreement
1 vs. 2	65.22%	23	0.009	Poor
1 vs. 3	43.38%	23	-0.258	Worse than expected by chance alone
1 vs. 4	82.61%	23	0.625	Good
1 vs. 5	70%	20	0.375	Fair
2 vs. 3	56.67%	30	-0.054	Worse than expected by chance alone
2 vs. 4	76.67%	30	0.406	Moderate
2 vs. 5	59.26%	27	0.090	Poor
3 vs. 4	53.33%	30	0.000	Poor
3 vs. 5	62.96%	27	0.195	Poor
4 vs. 5	62.96%	27	0.335	Fair

Mean weighted Kappa= 0.167 (poor).

Table 10 shows that agreement ranged from worse than expected by chance alone, to good. Overall agreement however was poor.

4.2.2.2.3 Medial to Lateral Direction (ML)

Table 11: Inter-rater agreement for ML in the PFPS group

Examiner comparisons	Percentage agreement	N pairs	Weighted Kappa	Classification of agreement
1 vs. 2	69.57%	23	0.447	Moderate
1 vs. 3	52.17%	23	0.118	Poor
1 vs. 4	59.09%	22	0.241	Fair
1 vs. 5	73.68%	19	0.509	Moderate
2 vs. 3	63.33%	30	0.268	Fair
2 vs. 4	55.17%	29	0.106	Poor
2 vs. 5	46.15%	26	0.046	Poor
3 vs. 4	44.83%	29	-0.065	Worse than expected by chance alone
3 vs. 5	50%	26	0.052	Poor
4 vs. 5	64%	25	0.439	Moderate

Mean weighted Kappa= 0.201 (fair).

Table 11 shows that agreement ranged from worse than expected by chance alone, to moderate. Overall agreement was fair.

4.2.2.2.4 Lateral to Medial direction (LM):

Table 12: Inter-rater agreement for LM in the PFPS group

Examiner comparisons	Percentage agreement	N pairs	Weighted Kappa	Classification of agreement
1 vs. 2	69.57%	23	0.431	Moderate
1 vs. 3	52.17%	23	0.066	Poor
1 vs. 4	65.22%	23	0.313	Fair
1 vs. 5	61.11%	18	0.292	Fair
2 vs. 3	63.33%	30	0.108	Poor
2 vs. 4	66.67%	30	0.167	Poor
2 vs. 5	56%	25	0.061	Poor
3 vs. 4	70%	30	0.118	Poor
3 vs. 5	48%	25	-0.109	Worse than expected by chance alone
4 vs. 5	72%	25	0.403	Moderate

Mean weighted Kappa =0.177 (poor).

Table 12 shows that agreement ranged from worse than expected by chance alone, to moderate. Overall, agreement was poor.

Conclusion:

Therefore in summary, PFPS Kappa scores per direction are:-

Table 13:

	PFPS group	
	N	**Kappa**
Grade	245	0.231449
SI	252	0.221548
IS	260	0.167108
ML	252	0.20127
LM	252	0.17679

N refers to the sum of the number of pairs of comparisons between examiners.

As can be seen from table 13, the agreement between examiners for the superior to inferior direction was fair (k=0.222) and the medial to lateral direction was also fair (0.201). The rest of the agreement between directions of movement showing poor agreement with both inferior to superior (k=0.167) as well as the lateral to medial direction (k=0.176).

Decreased movement in the SI direction implies that the following anatomical structures could possibly be restricting movement:

- ***Altered patella tracking*** (Tria et al. 1992; Davidson, 1993).
- ***ITB*** (Post, 1998).
- ***Imbalance between the VMO and VL*** (Dippenaar, 2003; Daly, 2005)
- ***Biomechanical considerations*** (Scuderi, 1995:144; Travell and Simons, 1983).
- ***Myofascial dysfunction*** (Travell, Simons and Simons 1999; Scott, 2005).
- ***Infrapatella tendon*** (Davidson, 1993; Fulkerson, 1997)

The implication of these structures being affected by PFPS could be as a result of any one or more of the following:

- ***Altered patella tracking*** occurs when the patella is pulled laterally as the knee is straightened under load. Proper tracking of the patella during flexion and extension is influenced by a number of factors (Davidson, 1993; Reive, 2000) which include:
    - The height of the femoral condyles and hence the depth of the sulcus which keeps the patella seated and tracking properly.
    - The shape of the facets on the undersurface of the patella, which helps to determine the "fit" between the patella and the femoral groove (Tria et al. 1992 and Singerman et al. 1994).
    - The medial and lateral retinaculae, which keep the patella centred between the femoral condyles during movement.
    - The composite angle of the pull of the quadriceps group (the Q-angle) (Davidson, 1993).
    - Relative strength of individual muscles of the quadriceps group (Outerbridge and Dunlop, 1975).
    - Sufficient strength of the abductor muscles is essential to prevent excessive rotation in the femur.
    - Any abnormality of the anatomical structures influencing the patella movement can cause excessive pressure between the patella and the femoral condyles (Hungerford and Lennox, 1983).

    Any one or more of these factors that affect the ability of the patella to move within its ranges of motion would result in the presence of a decreased movement in a particular direction. This would be influenced by further factors that are discussed below.

- Post (1998), suggested that the ***ITB,*** which is frequently tight in subjects with PFPS, may result in a patella restriction due to the iliotibial bands strong attachment to the patella through the lateral retinaculum. Thus limiting the ability of the retinaculum in allowing movement from lateral to medial most commonly. However as the ITB is not a contractile tissue, its relative stiffness and / or tightness is predetermined by the pull of muscles inserted into its length (VL, TFL, Glut maximus and hamstring (biceps femoris) (Travell and Simons, 1983:222). As not all of these muscles are implicated in PFPS, its role would be of a smaller proportion.

- On the contrary literature supports more strongly the fact that the VMO and VL relationship are of greater importance in PFPS (Gilleard et al. 1998; Dippenaar, 2003; Scott, 2005). The ***imbalance between VMO and VL*** muscles, results in differing pulling forces on the patella thus potentially positioning it outside of its normal / congruent position in the intercondylar groove, thereby limiting movement. Furthermore, there seems to be a superior–lateral translation of the patella (without being patella alta), which could be as a result of: the pull of the quadriceps femoris muscle superiorly (and slightly laterally as the VL has a greater force generating capacity than VMO (Dippenaar, 2003; Daly, 2005; Scott, 2005). In addition the possibility of muscle hypertonicity due to pain / discomfort or overload (Scott, 2005) would result in restricted movement inferiorly.

- ***Biomechanical considerations*** include the development of a tight quadriceps muscle can occur as s result of running on uneven ground which could potentially lead to a functional short leg and hence, internal rotation of the tibia (Reid, 1992: 1142-1143). Quadriceps tightness may also refer pain in the anterior knee (Scuderi, 1995:144; Travell and Simons, 1983). It is therefore suggested that this tightness increases the potential of the extensor mechanism overload (Scuderi, 1995:144). This is further complicated by the unrestricted movement of the entire lower kinetic chain which is vital for proper functioning of the patellofemoral joint (Scuderi, 1995:143), which places additional load on the patellofemoral articulation. As a result the restrictions are most readily observed as a result of changes in the RF muscle (limiting superior to inferior movement), with VMO or VL altering the tracking of the patella within the available range of motion (lateral to medial movement). However with the RF muscle being the strongest of the QF group, its limitation on patella motion overrides all other limitations in patella motion.

- ***Myofascial syndrome*** refers to pain, tenderness and autonomic phenomena referred from active myofascial trigger points, with associated dysfunction. The specific muscle or muscle group that causes the symptoms should be identified (Travell and Simons, 1983:4). According to Travell, Simons and Simons (1999), the presence of myofascial trigger points in the quadriceps femoris (QF) muscle could result in signs and symptoms including peri- and retropatella pain, weakness of the QF muscle and loss of full lengthening. The above would result in inhibition of QF muscle activity and a resultant extensor mechanism dysfunction (Travell and Simons, 1983). Dippenaar (2003) showed a large overlap in the signs and symptoms of PFPS and Myofascial pain syndrome. According to Travell and Simons (1983), the following referred pain pattern is produced with the presence of myofascial trigger points in the QF muscle:
    1. anterior knee pain
    2. the medial aspect of the knee
    3. the lateral aspect of the knee
    4. deep within the knee joint

Dippenaar (2003) concluded that there is a high degree of overlap between the presence of a myofascial pain syndrome and PFPS, when patients present with PFPS. Furthermore, Scott (2005) concluded that PFPS does not seem to be a defined clinical entity, but refers to a pathological process that evolves over time.

Therefore the presence of myofascial trigger points could also contribute to the restriction of motion within the patella (principally aiding the restriction parameters as set out by the QF in particular the RF).

- Lastly and inferior to the patella, the ***patella tendon*** limits the proximal ascent of the patella from the tibia (Fulkerson, 1997:13). The patella tendon is also one of the important passive elements of soft tissue stabilization (Fulkerson, 1997:13-15). Therefore repetitive stress and strain placed on the ligament will result in the creep or deformation of the ligament with its resultant increase in length (Solomonow, 2004). This process results in the tendon to decrease its ability to perform its role and therefore most patients with anterior knee pain have distinct tenderness in the patella tendon (Davidson, 1993), particularly where it originates on the patella (Fulkerson, 1997:144). This increase in length and the concomitant increase in muscle pull could possibly counter the natural effects of the tendon (limiting movement), thereby allowing movement in the superior direction, allowing for the clinical presentation of decreased movement in the SI direction.

In a similar light however, the **ML** direction also revealed that agreement between examiners was fair (K=0.201).

Decreased movement in the ML direction implies that the following anatomical structures could possibly be restricting movement:

- ***Tight VMO*** (Travell and Simons, 1983:250)
- ***Soft tissue dysplasia*** (Fulkerson, 1997:134)
- ***Variability in the angles of insertion of the VMO*** (Fulkerson, 1997:134)
- ***Chondromalacia of the medial facet*** (Scuderi, 1995:2; Fulkerson, 1997:227)

The implication of these structures being affected by PFPS could be as a result of any one or more of the following:

- Myofascial trigger points in the VMO refer pain to the anterior aspect of the knee (Travell and Simons, 1983:250) and as a result, ***tightness of the VMO.*** According to Voight and Weider (1991), the pull of the VM and VL provides dynamic stability and hence correct alignment of the patella. Lieb and Perry (1968) and Felder and Leeson (2002) concluded that the function of the VM is to maintain patella alignment and stability. As a result, trigger points in this muscle could lead to a restriction in ML movement. Bearing this in mind, the pain produced by this muscle is eventually replaced by quadriceps weakness that produces buckling of the knee.
- ***Soft tissue dysplasia*** is a factor in many patients with patella instability (Fulkerson, 1997:134). More commonly the peripatella retinaculum becomes adaptively dysplastic in association with chronic malalignment (Fulkerson, 1997:134) of the patella. Similarly, the medial retinaculum is also commonly affected. As a result of the dysplastic medial retinaculum, this disordered architecture could possibly result in an altered movement pattern, thereby limiting motion within the plane which can be accounted for by the lack of movement in the ML direction.
- Soft tissue balance is important in maintaining correct patella alignment and congruency of the patellofemoral joint. Hence any mechanism that could disrupt this balance will eventually affect the alignment of the patella. ***Variability in the in the angles of insertion of the VMO*** has been proposed as one of these mechanisms (Fulkerson, 1997:134). As a result of this, there is an alteration in this muscle balance which can either be congenital or induced (Fulkerson, 1997:134). This in return

might result in patellofemoral imbalance, thereby limiting movement in the lateral direction.

- With PFPS as an evolving syndrome (Scott, 2005), exhibiting various stages of the disease process, it is likely that that certain subjects could have presented with PFPS at a stage where degenerative changes were present. Chondromalacia is quite commonly encountered and often asymptomatic, with chondromalacic changes frequently present on the medial facet of the patella (Outerbridge, 1961:752-757). ***Chondromalacia of the medial facet*** may be secondary to deficient contact or to a combination of compression and shearing forces (Fulkerson, 1997:227) which can eventually lead to medial facet articular cartilage breakdown. Furthermore the convex shape of the medial facet subjects its articular cartilage to greater localized stresses (Scuderi, 1995:2). With the articular cartilage changes, there is an increased likelihood of there being mobility restrictions particularly in the medial aspect of the patella, thereby restricting movement in the ML direction.

Based on the results of this study, there appears to be a difference between the levels of agreement between examiners when different directions are assessed based on the degree of involvement of certain anatomical structures.

It is therefore suggested, that restrictions based on particular stages of the clinical pathogenesis of PFPS be addressed, and all the structures involved in enabling or restricting movement in all directions be addressed as well.

4.3 COMPARISONS OF MEAN KAPPA SCORES BETWEEN THE TWO GROUPS:

In order to address objective two as set out in chapter one (1.3), the inter-examiner reliability will be discussed under this heading with respect to comparison of the reliability scores between the groups.

Table 14: Comparison of mean Kappa score between groups:

	OA GROUP			PFPS GROUP			P value
	N	MEAN	SD	N	MEAN	SD	
Grade	188	0.266787	0.3291	245	0.231449	0.239859	0.2155
SI	188	0.148234	0.330743	252	0.221548	0.194304	0.0071
IS	188	0.139787	0.24888	260	0.167108	0.263971	0.2644
ML	188	0.217947	0.169203	252	0.20127	0.196844	0.3409
LM	188	0.301128	0.201303	252	0.17679	0.170811	<0.001

Table 14 summarizes the mean and SD Kappa score for each question by group. In addition the p values for the t-test comparing the means between the two groups are given in the table. There was a significant difference between scores for SI (p=0.0071) where the mean Kappa score for the PFPS group (k=0.2215) was higher than for the OA group (k=0.1482). LM was also significantly different in terms of Kappa scores (p<0.001). Kappa scores for the OA group (k=0.3011) were significantly higher than the Kappa scores in the PFPS group (k=0.176).

As can be seen from the table above, the Kappa scores for ML direction in the PFPS group revealed a fair Kappa score (k=0.2012), which was similar to the OA group which also revealed a fair Kappa score (k=0.2179). Due to the similarity in Kappa scores between these two groups with respect to ML direction, the p value (p=0.3409) did not reveal a significant difference between these two groups; unlike the p-values with regard to SI (p=0.0071) and LM (p<0.001) directions discussed above.

<u>From table 14, the following can be deduced from both the OA and PFPS groups:-</u>

1. The p-values did not reveal a statistical significant difference for the IS (p=0.2644) and ML (p=0.3409) directions. This implies that for the IS and ML direction in movement, agreement was poor as for IS or fair for ML, irrespective of the condition. The condition (OA or PFPS) was not related to examiner agreement. This implies that :
    - a] Blinding according to materials and methods was effective.
    - b] Motion palpation cannot be used as an isolated tool and that it should form part of an extended assessment.

2. The p-values did reveal a statistical significant difference for the SI and the LM directions between the two groups. There was significant statistical agreement between the examiners in the SI direction for PFPS as compared to the OA group; and in the LM direction for the OA group as compared to the PFPS group. This implies that the there is support for the condition having distinct decrease in motion parameters, which could suggest further research in this matter.

    - a] The SI direction restriction was commonly associated with the PFPS group. This correlation supports the assertion that there seems to be a pull of the patella into a superior position, as suggested in [4.2.2.2.1] table 9. This was also noted by Scott (2005), who stated that this finding could be as a result of the quadriceps femoris muscle hypertonicity causing a superior pull of the patella, resulting from an association or possible presence of a myofascial / muscular pain syndrome (Dippenaar, 2003).

b] The LM direction restriction is commonly associated with the OA group in terms of the findings presented in 4.2.1.2.4 (table 6). This significant finding with respect to OA is further significantly highlighted as a specific condition restriction when compared with PFPS. Literature suggests (Scuderi, 1995:291) that patellofemoral arthritis is typically idiopathic or secondary to malalignment, and is found to involve primarily the lateral facet. The lateral joint space of the patellofemoral articulation is narrowed, with osteophytic formation evident on the lateral patella and trochlea (Scuderi, 1995:291). Furthermore, a tight lateral retinaculum leads to overload of the lateral facet and the development of subsequent arthrosis, thus decreasing lateral to medial movement.

c] Furthermore, the ML direction was fair for both groups (OA and PFPS) in terms of the findings presented in 4.2.1.2.3 and 4.2.2.2.3, respectively. Literature suggests that chondromalacia of the medial facet may be secondary to deficient contact or to a combination of compression and shearing forces (Fulkerson, 1997:227) which can eventually lead to medial facet articular cartilage breakdown in patients suffering from OA. Furthermore, myofascial trigger points in the VMO refer pain to the anterior aspect of the knee (Travell and Simons, 1983: 250) and as a result, tightness of the VMO. According to Voight and Weider (1991), the pull of the VM and VL provide dynamic stability and hence correct alignment of the patella. Lieb and Perry (1968) and Felder and Leeson (2002) concluded that the function of the VM is to maintain patella alignment and stability. Therefore, as a result, due to the articular cartilage breakdown and trigger points in the VMO muscle, ML direction in patella movement may be restricted.

These results serve to support the suggestions and recommendations with regard to future research as found in the conclusion of 4.2.1.2, in addition to implying that there could be a possible link and/or association between the conditions under study and the findings of motion palpation of the patellofemoral joint, in terms of the most commonly restricted direction noted in each condition (In the OA participants the examiners found that the most common restriction was that of lateral to medial glide; and in the PFPS participants, the examiners found that the most common restriction was that of superior to inferior glide). This perhaps requires further research within a clinical context and possibly to the exclusion of set research parameters with the exception of the blinding of examiners to the particular conditions under study.

4.4 ASSOCIATION BETWEEN GRADE AND DIRECTION OF RESTRICTION; WITH RESPECT TO THE SYMPTOMATOLOGY (PAIN PERCEPTION AND RANGE OF MOTION:

In order to address objective three as set out in chapter one (1.3), the correlations between examiners in terms of the grade of restriction found and the relevant directions in which they were found; as well as correlations between examiners in terms of the grades and directions of restriction with respect to the symptomatology (pain perception and range of motion) of the patient will be addressed in 4.4.1 with respect to the OA group and 4.4.2 with respect to the PFPS group.

The grading of patella motion was recorded by the examiners as normal mobility (A), mild/ moderate restricted (B) and severely restricted (C). For purposes of analysis, it was therefore important to include all observations recorded by the examiners with respect to the grading of patella restrictions (including grade A which was equivalent to normal patellar mobility or no patella restrictions).

The reason for this was in order to ensure that the correlations between the symptoms and the restrictions or lack of restriction be reflected in the analysis. The exclusion of any data set would have possibly resulted in an altered interpretation of data or correlations, because the excluded data might either emphasize or distract from correlations that were present. Thus, because the data set is representative of the entire sample population as opposed to only depicting those subjects with patella restrictions as recorded by the examiners, it gives a more accurate picture of the relationships/correlations found in this study, and it also might allow for a range from which correlations that were drawn to be reflective of clinical practice.

4.4.1 OA group:

With respect to all findings in the OA group related to the grade of restriction, median responses of the grade of general patella restrictions between the five examiners were calculated in order to assess the associations between type of restriction and symptoms. Where the responses were tied, an average of the two categories was used, for example, if a participant was given a score of 1 by two examiners and a score of 2 by two examiners, that participant received a median score of 1.5. Associations between type of restriction and symptoms were assessed using one way ANOVA on each group separately, with Bonferroni post hoc tests.

4.4.1.1 Grade:

The grading of patella motion was recorded by the examiners as normal mobility (A), mild/ moderate restricted (B) and severely restricted (C). For purposes of analysis, grade A was recorded as 1, grade B was recorded as 2 and grade C was recorded as 3.

Table 15: Frequency of median grade in OA group

	Frequency	Percent
2.00	18	60.0
1.50	6	20.0
1.00	4	13.3
2.50	1	3.3
3.00	1	3.3
Total	30	100.0

In the OA group the most common grade of patella restrictions was 2 (mild to moderate restrictions; n=18; 60%). This is shown in Table 15 in order of most to least frequent grade. Within the OA group, the overall result revealed that there were more restrictions noted (86.6%) as opposed to a normal grading (13.3%) of patella mobility. This was a significant result as the OA group was a symptomatic population where it was expected that restrictions would be found due to the pathological process.

This further indicated that:

- Overall, examiners were able to reliably detect restrictions in a symptomatic population as opposed to normal patella motion, in the OA group.
- Examiners were able to reliably agree that the patella restrictions found were graded as mild to moderate (grade 2) in the OA group.

Furthermore, with respect to the grade of patella restriction noted, a mild to moderate grade (grade 2) was expected to be found more commonly (if any), because the sample population chosen for this study had to be homogenous and clinically indistinguishable from PFPS, in order to blind the examiners to the presenting condition. This lead to the condition of OA being relatively mild and therefore the outcomes concur with Sharma et al. (1999), where they indicate that the milder the OA, the greater the degree of laxity (predominantly medial (Lewek et al. 2004)) and therefore predisposing to greater degrees of patellofemoral hypomobility on the lateral aspect of the knee (lateral retinaculum) (Bergmann et al.1993). This would have increased the agreement between examiners, thereby increasing the reliability of the inter-rater reliability testing.

In support of and addition to the above it is of interest to note that of the restrictions found, that 63.3% of the 86.6% (2/3rds of the noted restrictions) were unanimously agreed upon by the examiners – i.e. the majority within the group of examiners, definitively indicated that a restriction was present and agreed that it was at the same level or grade of severity (i.e. 2 or 3) respectively.

4.4.1.2 Direction of Restriction:

It should be noted that in the previous discussion (4.2.1.2 and 4.2.2.2) on the direction of motion restriction that the context was that of the clinical condition (OA or PFPS) only. Here the context has been slightly altered as the context now includes that of direction of restriction, grade of restriction and the clinical condition (OA or PFPS).

Therefore the possibility could exist that the motion parameters that were linked to the conditions previously were changed with respect to the grade of motion that was restricted.

Example: With PFPS it was found previously (4.2.2.2, table 13) that the motion that was most restricted was that of SI. However with the modification of grade, the worst restrictions noted by the examiners could well have been LM. But as LM did not have as many restrictions it has lesser or no relationship to the condition as compared to SI.

Table 16: Frequency of median SI in OA group

	Frequency	Percent
1.00	15	50.0
1.50	8	26.7
2.00	6	20.0
3.00	1	3.3
Total	30	100.0

Table 16 shows that in the OA group the most frequent response in the SI direction was 1 (normal, n=15, 50%). A mild to moderate response was expected as participants were required to have a mild presentation of OA in keeping with the homogeneity of the PFPS group. With respect to the remaining grades of restriction, agreement between examiners varied.

Grade 1.5 (26.7%) indicated that examiners showed an undecided opinion.

Grade 2, however showed a 20% agreement whereas grade 3 showed a 3.3% agreement. With these two grades, total agreement existed as opposed to being undecided (26.7%), therefore attaining a 23.3% agreement level between examiners that a restriction was either mild to moderate, or that it was severe.

Table 17: Frequency of median IS in OA group

	Frequency	Percent
1.00	12	40.0
1.50	9	30.0
2.00	7	23.3
2.50	1	3.3
3.00	1	3.3
Total	30	100.0

Table 17 shows that in the OA group the most frequent response in the IS direction was 1 (normal, n=12, 40%). This is also the case as with the SI direction (table 16), where the grade was expected to be close to a mild to moderate agreement due to the homogeneity between the two groups. With respect to the remaining grades of restriction, agreement between examiners varied. Thus the agreement for grade 2 was 23.3% and agreement for grade 3 was 3.3%, where total agreement (26.6%) existed as opposed to grade 1.5 and grade 2.5 where the examiners where undecided (33.3%).

Table 18: Frequency of median ML in OA group

	Frequency	Percent
2.00	14	46.7
1.00	10	33.3
1.50	5	16.7
3.00	1	3.3
Total	30	100.0

Table 18 shows that in the OA group the most frequent response in the ML direction was 2 (mild to moderate restriction, n=14, 46.7%). This was followed by normal (33.3%). Grade 3 also showed a 3.3% agreement, thus the total agreement that existed between the examiners with regards to grades 2 and 3 was 50%. Grade 1.5 revealed an undecided opinion amongst examiners, which consisted of only 16.7% of the examiners findings.

Table 19: Frequency of median LM in OA group

	Frequency	**Percent**
1.00	16	53.3
2.00	8	26.7
1.50	5	16.7
3.00	1	3.3
Total	30	100.0

Table 19 shows that in the OA group the most frequent response in the LM direction was 1 (normal, n=16, 53.3%). Grade 2 showed a 26.7% agreement between examiners and grade 3 revealed a 3.3% agreement. Grade 1.5 revealed a 16.7% agreement with the examiners showing an undecided opinion. Thus the total agreement that existed between examiners with regards to grades 2 and 3 was 30%.

Overall, with respect to the previous tables (tables 16 to 19), the results revealed that there was more inter-examiner agreement in terms of the grades of patella restrictions as well as in the detection of normal patella movement (i.e. grades 1 to 3) as opposed to an undecided opinion (grades 1.5 or 2.5).

Furthermore, from the previous tables (tables 16 to 19), the examiners noted that for ***grading of general patella*** restrictions, the most frequently agreed response was 2 (mild to moderate restrictions) in the ***ML*** direction. Therefore in summary, majority of the motion detected by the examiners was found to be normal (viz. LM, IS and SI, with the exception of ML, which was found to be mild to moderately restricted).

This would appear to be in contradiction with the findings in (4.2.1.2.4) where it was stated that the most commonly ***agreed direction*** was ***LM***. This can be accounted for by the fact that the agreement between examiners in the first instance (this instance), direction is the principle independent variable defining the outcome of the result, as opposed to the second instance where grade was the principle independent variable defining the outcome. Thus it would seem that with respect to inter-rater reliability that it is dependant on the construct by which the comparisons of examiner reliability are measured against.

This indicates that even though motion palpation is lacking conclusive research defining it as an integral assessment tool, these findings suggest that motion palpation does seem to demonstrate a certain level of efficacy in distinguishing between different constructs utilized.

Therefore, overall examiners noted that for the ML direction 50% agreement existed whereby examiners noted a definitive patella restriction, followed by the **LM** direction which revealed a 30% agreement in patella restrictions.

In addition and in terms of the OA patient:

LM movement is governed by tight soft tissue structures (muscles and ligaments) (Walsh, 1994; William, 1998; Theil-Brody and Theil, 1998; Wood, 1998; Sharma et al. 1999; Hopkins and Ingersoll, 2000) giving a soft end feel (spongy end feel) that has no solid limitations (Bergmann et al. 1993:90-92); therefore agreement by the examiners may have been that this motion was only a grade 1 restriction.

On the converse, the ML movement may have been predisposed to a bone on bone or hard end feel (Bergmann et al. 1993:90-92), as a result of the relatively laterally placed patella being pushed into the lateral femoral condyle (Scuderi, 1995:291; Sharma et al. 1999). This would then allow the examiners to agree that the grade would be more severe, than that of LM.

4.4.1.3 Grade with respect to symptomatology (pain perception and range of motion (OA group) :

Table 20: Descriptive statistics for NRS, goniometer flexion and extension by median grade in OA group

Median grade		NRS	Goniometer flexion	Goniometer extension
1.00	Mean	40.0000	122.1667	4.4167
	N	4	4	4
	Std. Deviation	17.19981	3.31662	.95743
1.50	Mean	58.3333	114.8889	5.0556
	N	6	6	6
	Std. Deviation	8.89757	10.12953	.97563
2.00	Mean	51.6667	118.7778	4.1667
	N	18	18	18
	Std. Deviation	11.01470	7.93684	.84984
2.50	Mean	75.0000	110.3333	4.3333
	N	1	1	1
	Std. Deviation	.	.	.
3.00	Mean	27.5000	110.0000	6.0000
	N	1	1	1
	Std. Deviation	.	.	.
Total	Mean	51.4167	117.8778	4.4444
	N	30	30	30
	Std. Deviation	13.49782	8.04655	.94416

Table 20 shows the mean and SD of each symptom measurement by median grade. There was only one participant with a median score of 2.5 and one with a median score of 3, thus these categories were omitted from ANOVA analysis. Figure 1 shows these statistics graphically.

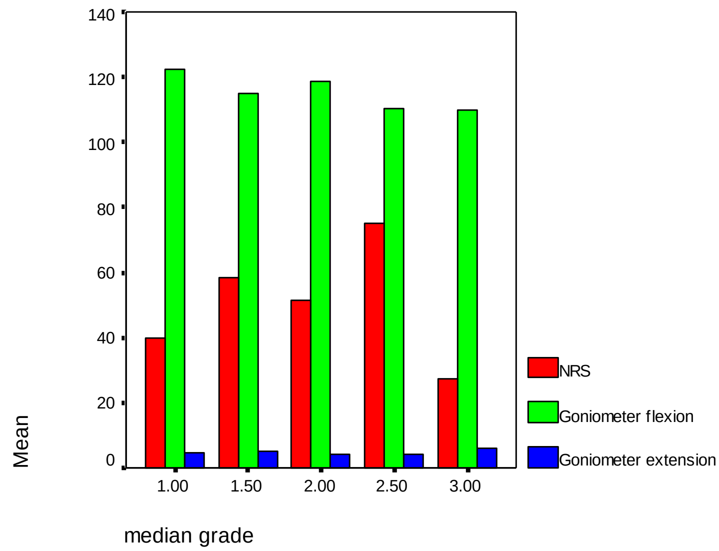


Figure 1: Summary statistics for NRS, goniometer flexion and extension by median grade in the OA group (n=30)

Table 21: ANOVA tests for the comparison of NRS, goniometer flexion and extension between median grade in the OA group (n=30)

		Sum of Squares	df	Mean Square	F	p value
NRS	Between Groups	809.524	2	404.762	3.024	0.067
	Within Groups	3345.833	25	133.833		
	Total	4155.357	27			
Goniometer flexion	Between Groups	133.265	2	66.632	1.030	0.372
	Within Groups	1616.926	25	64.677		
	Total	1750.190	27			
Goniometer extension	Between Groups	3.558	2	1.779	2.248	0.127
	Within Groups	19.787	25	.791		
	Total	23.345	27			

Table 21 shows that there were no significant differences in NRS or goniometer flexion or extension between the grades of mobility in the OA group. Thus grade did not significantly affect symptoms in this group.

4.4.1.4 Grade and direction with respect to symptomatology (pain perception and range of motion):

The discussion pertinent to the relationship between the direction of restriction and the patients recorded symptomatology will be discussed in 4.4.1.5.

4.4.1.4.1 Superior to inferior direction and symptomatology (OA group):

Table 22: Descriptive statistics for NRS, goniometer flexion and extension by median SI category in the OA group

Median SI		NRS	Goniometer flexion	Goniometer extension
1.00	Mean	49.3333	120.3778	4.3556
	N	15	15	15
	Std. Deviation	13.74080	5.13758	1.01157
1.50	Mean	52.8125	117.4167	4.4583
	N	8	8	8
	Std. Deviation	11.29455	9.12827	.94176
2.00	Mean	58.7500	113.5556	4.3889
	N	6	6	6
	Std. Deviation	12.42477	11.44779	.74287
3.00	Mean	27.5000	110.0000	6.0000
	N	1	1	1
	Std. Deviation	.	.	.
Total	Mean	51.4167	117.8778	4.4444
	N	30	30	30
	Std. Deviation	13.49782	8.04655	.94416

Table 22 shows the mean and SD of each symptom measurement by median SI category. There was only one participant with a median score of 3, thus this category was omitted from ANOVA analysis. Figure 2 shows these statistics graphically

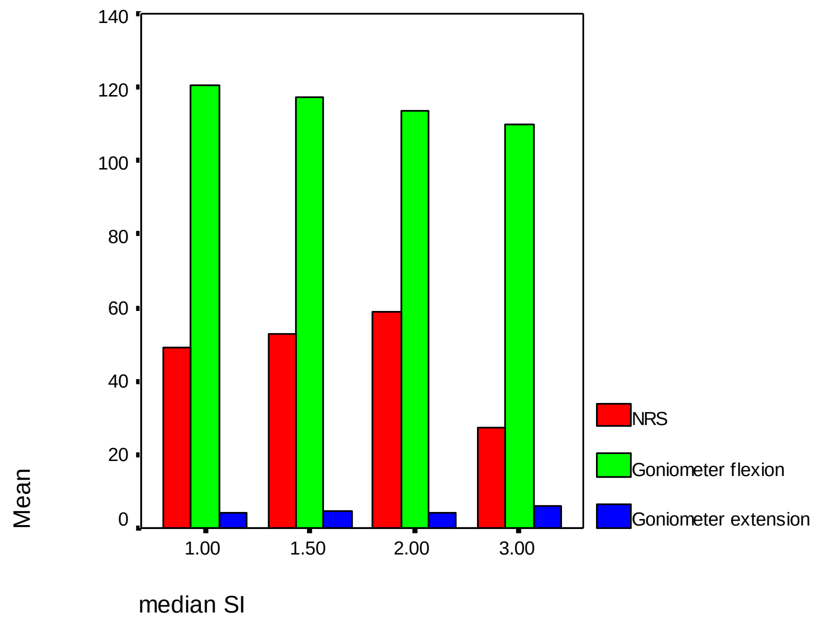


Figure 2: Summary statistics for NRS, goniometer flexion and extension by median SI groups in the OA group (n=30)

Table 23: ANOVA tests for the comparison of NRS and goniometer between median SI groups in the OA group.

		Sum of Squares	**df**	**Mean Square**	**F**	**P value**
NRS	Between Groups	383.633	2	191.817	1.158	0.330
	Within Groups	4308.177	26	165.699		
	Total	4691.810	28			
Goniometer flexion	Between Groups	205.401	2	102.700	1.661	0.210
	Within Groups	1608.063	26	61.849		
	Total	1813.464	28			
Goniometer extension	Between Groups	.055	2	.028	.031	0.970
	Within Groups	23.294	26	.896		
	Total	23.349	28			

Table 23 shows that there were no significant differences between the SI groups and any of the symptom measurements. Thus SI restriction did not influence symptoms significantly in the OA group.

4.4.1.4.2 Inferior to superior direction and symptomatology (OA group):

Table 24: Descriptive statistics for NRS, goniometer flexion and extension by median IS category in the OA group (n=30)

Median IS		NRS	Goniometer flexion	Goniometer extension
1.00	Mean	47.7083	118.6389	4.6111
	N	12	12	12
	Std. Deviation	6.34772	8.88360	1.06205
1.50	Mean	54.1667	120.1481	4.4815
	N	9	9	9
	Std. Deviation	18.87459	3.05101	.72860
2.00	Mean	54.2857	115.8571	3.9048
	N	7	7	7
	Std. Deviation	9.75900	11.06188	.85449
2.50	Mean	75.0000	110.3333	4.3333
	N	1	1	1
	Std. Deviation	.	.	.
3.00	Mean	27.5000	110.0000	6.0000
	N	1	1	1
	Std. Deviation	.	.	.
Total	Mean	51.4167	117.8778	4.4444
	N	30	30	30
	Std. Deviation	13.49782	8.04655	.94416

There was only one participant with a median IS score of 2.5 and one with a score of 3, thus these categories were omitted from ANOVA analysis (Table 24). The table shows the descriptive statistics for the symptom measures by median IS category, and Figure 3 shows these graphically.

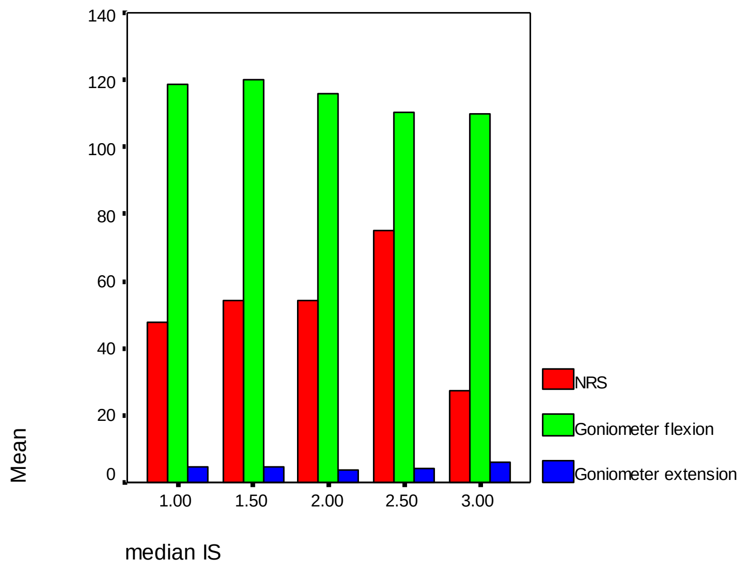


Figure 3: Summary statistics for NRS and goniometer by median IS groups in the OA group (n=30)

Table 25: ANOVA tests for the comparison of NRS, goniometer flexion and extension between median IS groups in the OA group (n=30).

		Sum of Squares	df	Mean Square	F	P value
NRS	Between Groups	290.699	2	145.350	.940	0.404
	Within Groups	3864.658	25	154.586		
	Total	4155.357	27			
Goniometer flexion	Between Groups	73.429	2	36.715	.547	0.585
	Within Groups	1676.761	25	67.070		
	Total	1750.190	27			
Goniometer extension	Between Groups	2.310	2	1.155	1.373	0.272
	Within Groups	21.035	25	.841		
	Total	23.345	27			

Table 25 shows that there were no significant differences between any of the symptom means by IS category in the OA group. Thus IS category did not influence any of the symptoms in this group.

4.4.1.4.3 Medial to Lateral direction and symptomatology (OA group):

Table 26: Descriptive statistics for NRS, goniometer flexion and extension by median ML category in the OA group (n=30)

Median ML		NRS	Goniometer flexion	Goniometer extension
1.00	Mean	49.2500	121.0667	4.4333
	N	10	10	10
	Std. Deviation	13.99653	3.54094	.78646
1.50	Mean	50.5000	120.6667	5.0667
	N	5	5	5
	Std. Deviation	15.04161	3.12694	1.11555
2.00	Mean	55.0000	115.1667	4.1190
	N	14	14	14
	Std. Deviation	11.80775	10.45197	.85342
3.00	Mean	27.5000	110.0000	6.0000
	N	1	1	1
	Std. Deviation	.	.	.
Total	Mean	51.4167	117.8778	4.4444
	N	30	30	30
	Std. Deviation	13.49782	8.04655	.94416

Table 26 shows the summary statistics for ML direction in the OA group. Once again there was only 1 participant who had a median score of 3 and thus was omitted from ANOVA analysis. Figure 4 shows the means graphically.

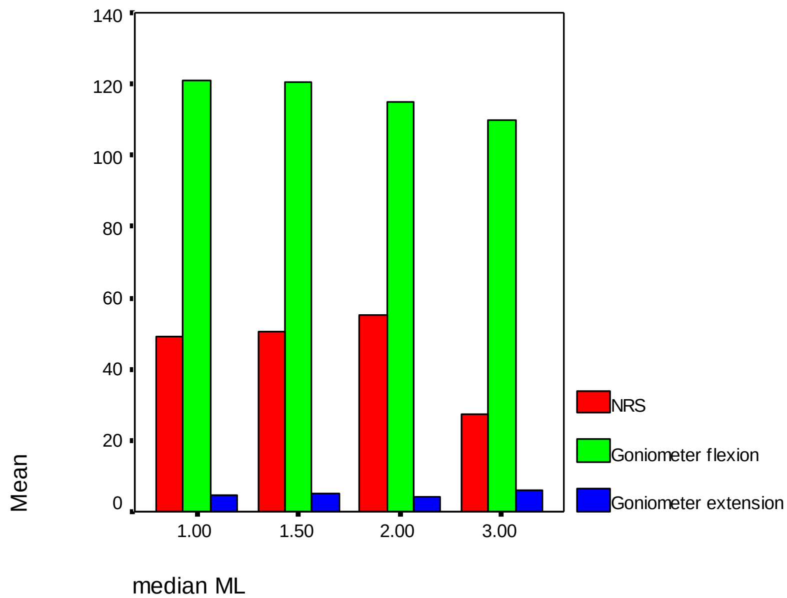


Figure 4: Summary statistics for NRS and goniometer by median ML category in the OA group (n=30)

Table 27: ANOVA tests for the comparison of NRS, goniometer flexion and extension between median ML categories in the OA group

		Sum of Squares	df	Mean Square	F	P value
NRS	Between Groups	211.185	2	105.593	.613	0.550
	Within Groups	4480.625	26	172.332		
	Total	4691.810	28			
Goniometer flexion	Between Groups	241.341	2	120.671	1.996	0.156
	Within Groups	1572.122	26	60.466		
	Total	1813.464	28			
Goniometer extension	Between Groups	3.336	2	1.668	2.167	0.135
	Within Groups	20.013	26	.770		
	Total	23.349	28			

There were no significant differences overall between the means of the ML groups in terms of symptom scores in the OA group. This is shown in Table 27.

4.4.1.4.4. Lateral to Medial direction and symptomatology (OA group);

Table 28: Descriptive statistics for NRS, goniometer flexion and extension by median LM category in the OA group (n=30)

Median LM		NRS	Goniometer flexion	Goniometer extension
1.00	Mean	52.3437	120.0000	4.2083
	N	16	16	16
	Std. Deviation	14.38949	5.06550	.72903
1.50	Mean	53.0000	115.2667	4.9333
	N	5	5	5
	Std. Deviation	6.47109	11.59358	1.32077
2.00	Mean	51.5625	116.2500	4.4167
	N	8	8	8
	Std. Deviation	14.20120	10.45891	.95535
3.00	Mean	27.5000	110.0000	6.0000
	N	1	1	1
	Std. Deviation	.	.	.
Total	Mean	51.4167	117.8778	4.4444
	N	30	30	30
	Std. Deviation	13.49782	8.04655	.94416

Table 28 shows descriptive statistics for LM categories, and Figure 5 shows this graphically for the OA group.

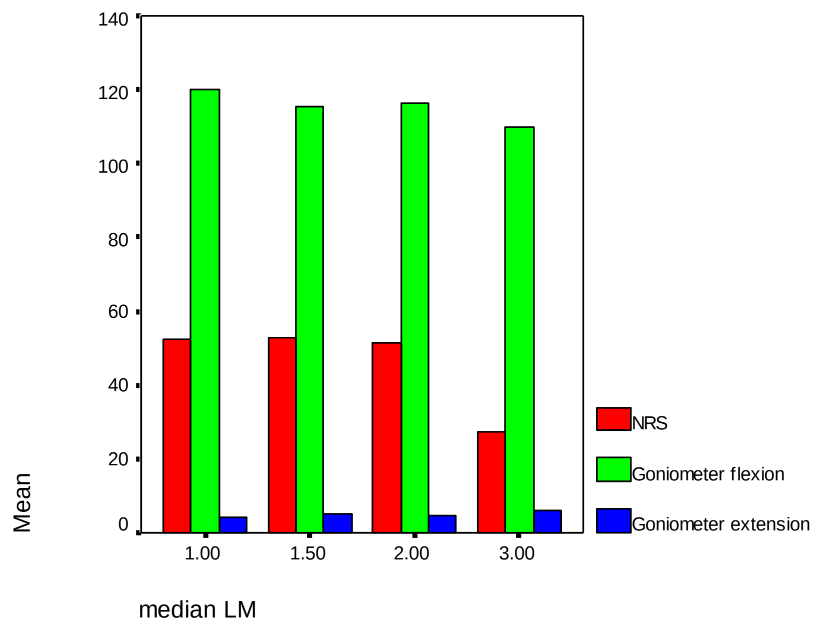


Figure 5: Summary statistics for NRS and goniometer by median LM category in the OA group (n=30)

Table 29: ANOVA tests for the comparison of NRS, goniometer flexion and extension between median LM groups in the OA group (n=30).

		Sum of Squares	df	Mean Square	F	P value
NRS	Between Groups	6.732	2	3.366	.019	0.982
	Within Groups	4685.078	26	180.195		
	Total	4691.810	28			
Goniometer flexion	Between Groups	125.208	2	62.604	.964	0.395
	Within Groups	1688.256	26	64.933		
	Total	1813.464	28			
Goniometer extension	Between Groups	2.010	2	1.005	1.224	0.310
	Within Groups	21.339	26	.821		
	Total	23.349	28			

Table 29 shows that there was no significant overall difference in any of the symptoms between the LM groups.

4.4.1.5. Discussion of grade and direction with respect to symptomatology

A] Numerical Pain Rating Scale

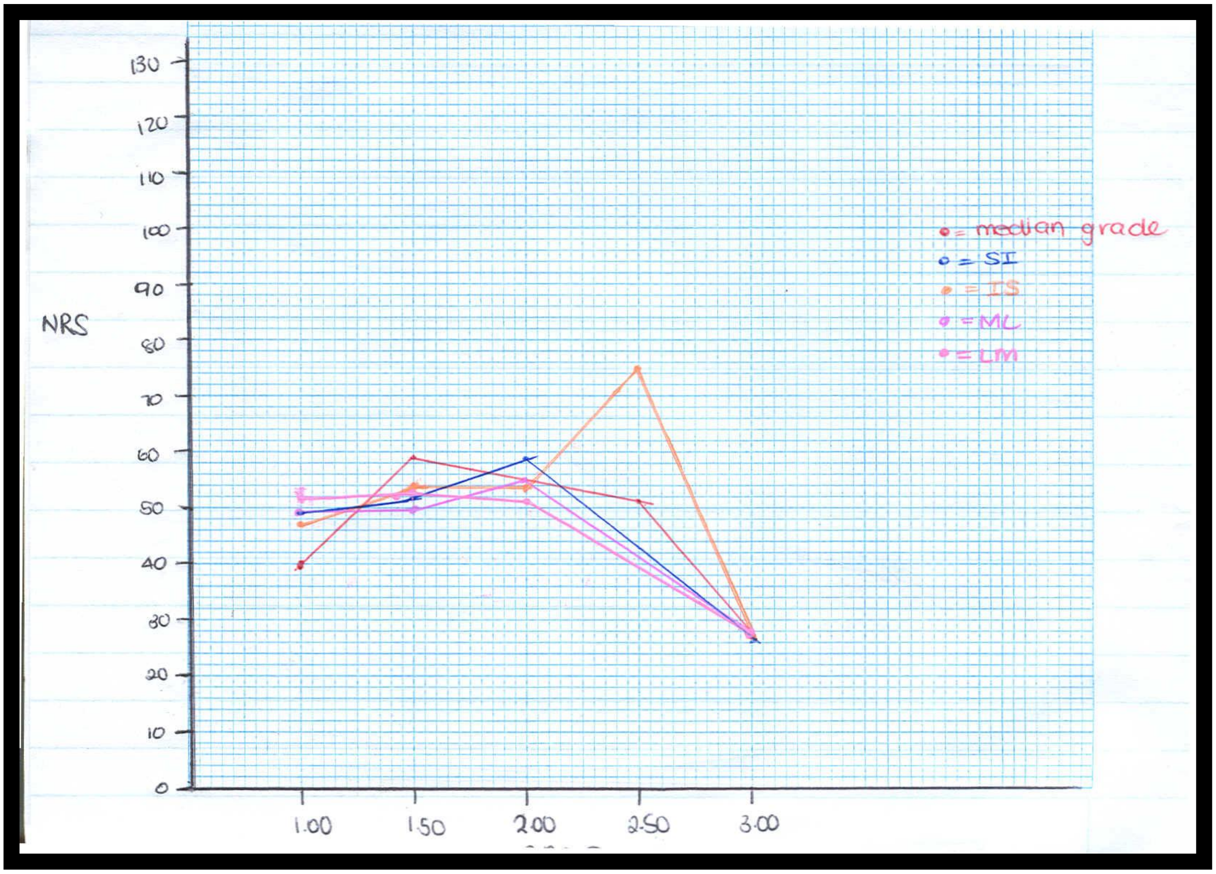


Figure 6

The reported pain rating was recorded using a NRS. The subjective scale consists of numbers from zero to ten; with 0 being no pain and 10 being the worst pain that the participant had experienced with their condition. Participants were asked to complete the NRS to indicate their pain rating prior to objective evaluation of the participant by the researcher (Jensen et al. 1986).

It would stand to reason that for the NRS to increase as the grade of patella restriction increases there is an increase in the severity of patella restrictions, which is congruent with the pathogenesis of OA (viz. inflammation, degenerative joint disease damage and stimulation of pain sensitive tissues) (Golding, 1989:148;

Walker and Helewa, 1996:30) . Hence, a proportionate relation between NRS and grade should be noted. However, this is not so, as seen from the findings above, where the NRS rating for pain appears to increase (worsen) with an increase in the grade of restriction, until grade 2 – 2.5 is achieved, thereafter it decreases, suggesting an inverse relation. This finding could have been attributed to the following:

- Participants with OA experience degenerative changes within the knee compartments (Scuderi, 1995) and as a result suffer from limited mobility (Golding, 1989:148). Over time, participants could have developed mechanisms to adapt and control situations in which pain may arise (Leach, 1994). For example: with the limited mobility within the joint, participants could lead a more sedentary lifestyle, causing a physiological adaptation thereby resulting in a decreased severity rate and an increase in pain tolerance (Melzack and Wall, 1965).
- In addition to this, an increase in degeneration within the joint, is associated with an increase in osteophyte formation which leads to an increase in stabilization effects (Sharma et al. 1999) resulting in decreased movement and decreased pain.

B] Flexion range of motion (measured by the goniometer)

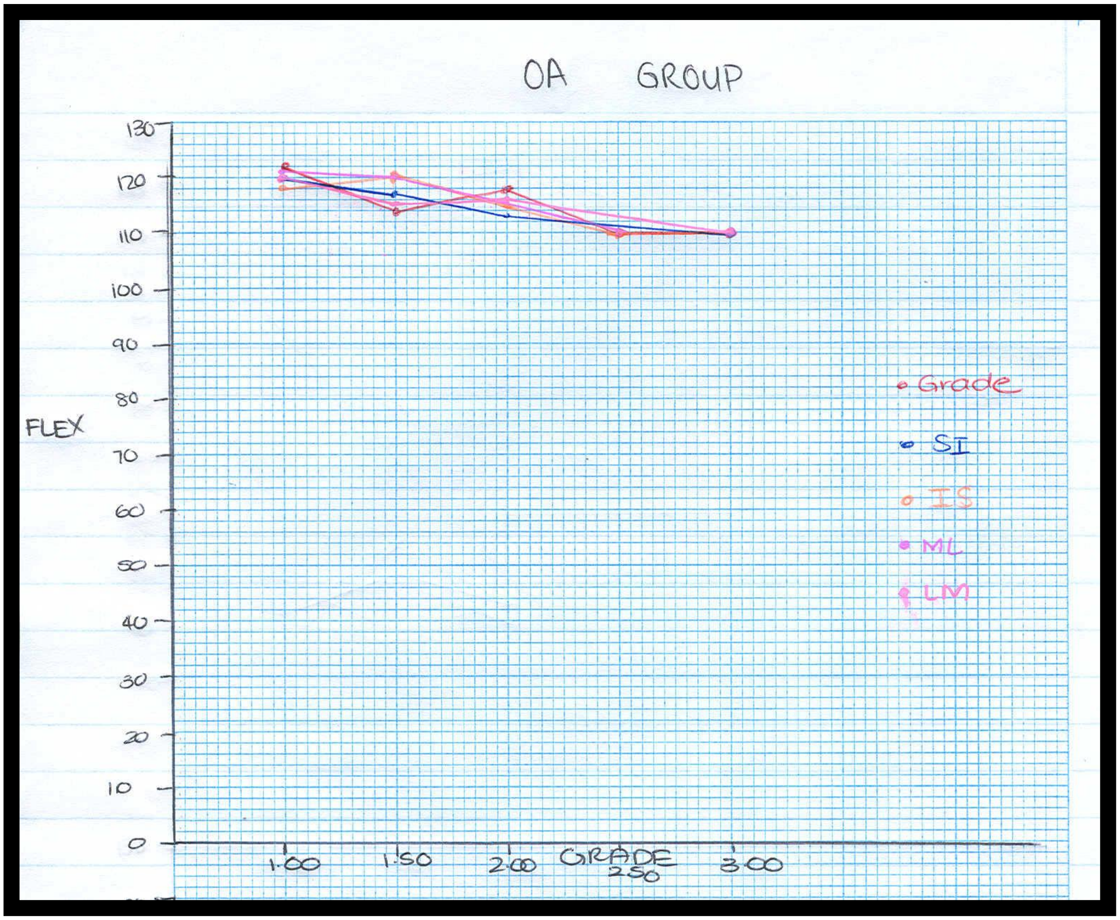


Figure 7

As can be seen by figure 7, there appears to be a decrease in flexion with an increase in grading. This can be expected, as the range of motion of the knee may be decreased by capsular fibrosis, osteophytes, irregularity of articular surfaces or impaction of loose bodies (Naidoo 2001; Sharma et al. 1999). These findings could also be related to the following:-

- The possibility of human error when taking objective measurements. The goniometer reading may be influenced by the researcher's interpretation of the exact positioning of the instrument. With this comes the possibility of human error. Environmental changes may also influence the measurement obtained by the goniometer. Participants may show an increased sensitivity to pain.

C] Extension range of motion (measured by the goniometer)

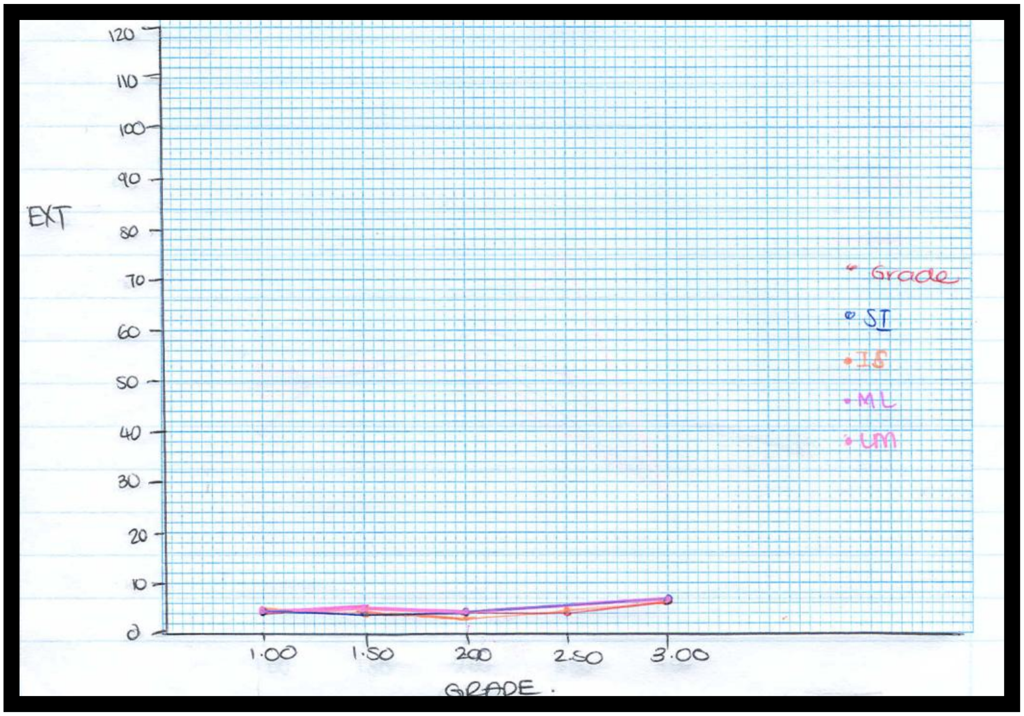


Figure 8

Extension range of motion remained relatively stable throughout the grades of mobility restriction. Although extension range of motion in the knee is generally minimal, these findings could be related to the following:-

- This measurement tool for extension may not have been sensitive enough to detect small changes in extension and therefore the results obtained, may not indicate significant trends.
- The possibility of human error when taking objective measurements. The goniometer reading may be influenced by the researcher's interpretation of the exact positioning of the instrument. With this comes the possibility of human error.
- Environmental changes may also influence the measurement obtained by the goniometer. Participants may show an increased sensitivity to pain.

Therefore in summary it is noted that the presentation of the patients grade of restriction would seem to be directly related to the pathogenesis of OA, as characterized by NRS (pain perception) and range of motion (extension and flexion).

An analogy which could be imposed in this scenario is that of the low back pain model suggested by Kirkaldy – Willis and Burton (1992), which follows the phases of dysfunction, instability and stabilization. With the patients that presented in this study, the majority would have been classified in the unstable phase, although mild presentations of dysfunction and / or stabilization could have been present.

The analogy implies that with increased instability there is increased laxity of the ligamentous structures which is continued through the stabilization phase as the processes of hysteresis and creep (Solomonow, 2004) are irreversible allowing for an increase in extension over this time with a concomitant decrease in flexion. This results as flexion is controlled almost exclusively by musculature and extension by ligamentous structures alone as the knee has very little inherent bony stability. With this in mind it stands to reason that with decreased mobility as stabilization becomes greater, this will further limit the flexion as the reliance on musculature and osteophytic changes becomes greater, yet there will be a decrease in pain as the stabilization of the joint results in decreased reactive inflammation (due to inactivity within the joint as well as patient mobility).

Therefore it is suggested that patients presenting with mild OA are treated with respect to the ligamentous laxity in order to prevent further degeneration in the knee. However having said this, there is controversy in the literature regarding the precursor – effect relationship of the ligamentous laxity with regard to OA and therefore further research in this regard is warranted.

4.4.2 PFPS group:

With respect to all findings in the PFPS group related to the grade of restriction, median responses of the grade of general patella restrictions between the five examiners were calculated in order to assess the associations between type of restriction and symptoms. Where the responses were tied, an average of the two categories was used, for example, if a participant was given a score of 1 by two examiners and a score of 2 by two examiners that participant received a median score of 1.5. Associations between type of restriction and symptoms were assessed using one way ANOVA on each group separately, with Bonferroni post hoc tests.

4.4.2.1 GRADE

Table 30: Frequency of median grade in PFPS group

	Frequency	Percent
2.00	22	73.3
1.00	6	20.0
1.50	2	6.7
Total	30	100.0

In the PFPS group, the most common grade of restriction was mild to moderate (grade 2) restriction (n=22, 73.3%). This is shown in Table 30. The overall result revealed that there were more restrictions noted (80%) as opposed to a normal grade (20%) of patella mobility. This was a significant result as the PFPS group was a symptomatic population where it was expected that restrictions would be found due to the functional process of the syndrome.

This further indicated that:

- Overall, examiners were able to reliably detect restrictions in a symptomatic population as opposed to normal patella motion, in the PFPS group.

- Examiners were able to reliably agree that the patella restrictions found were graded as mild to moderate (grade 2) in the PFPS group.

Furthermore, with respect to the grade of patella restriction noted, a mild to moderate grade (grade 2) was expected because the sample population chosen for this study had to be homogenous and clinically indistinguishable from OA, in order to blind the examiners to the presenting condition.

In addition to the above it is of interest to note that of the restrictions found, that 73.3% of the 80% were unanimously agreed upon by the examiners – i.e. the majority within the group of examiners, definitively indicated that a restriction was present and agreed that it was at the same level or grade of severity (i.e. grade 2).

In the clinical context of patellofemoral pain syndrome, there are very few if any structural changes to the joints of the knee (with respect to degeneration) and or bony lesions (Dippenaar, 2003; Scott, 2005), therefore it could be stated that this condition is one that is principally governed by changes between and within soft tissue structures (muscles, ligaments and fascia). As a result the type of end feel felt by the examiners would at best be one reflecting soft tissue restriction (Bergmann et al. 1993:90-92). This would therefore by default imply that the grade allocated would be lower than that found in OA, however with respect to this study; the grade should be similar in both the PFPS and OA groups due to the homogenous sample. However with the scale used in this research not being able to delineate between mild / moderate severity in restriction, we are unable to state whether the assumption presented is of relevance and would therefore recommend that future studies incorporate a 4 level / graded scale such that :

0 = normal movement (i.e. no restrictions in movement)

1 = mild restriction in movement

2 = moderate restriction in movement

3 = no movement at all

<u>4.4.2.2 Direction of Restriction:</u>

It should be noted that in the previous discussion (4.2.1.2 and 4.2.2.2) on the direction of motion restriction that the context was that of the clinical condition (OA or PFPS) only. Here the context has been slightly altered as the context now includes that of direction of restriction, grade of restriction and the clinical condition (OA or PFPS).

Therefore the possibility could exist that the motion parameters that were linked to the conditions previously are changed with respect to the grade of motion that was restricted.

<u>Example:</u> With PFPS it was found previously (4.2.2.2) that the motion that was most restricted was that of SI. However with the modification of grade, the worst restrictions noted by the examiners could well have been LM. But as LM did not have as many restrictions, it has a lesser or no relationship to the condition as does SI.

<u>Table 31: Frequency of median SI in PFPS group</u>

	Frequency	Percent
1.00	16	53.3
2.00	12	40.0
1.50	2	6.7
Total	30	100.0

Table 31 shows that the most frequent response in the SI direction in the PFPS group was normal (53.3%) followed by mild to moderate restriction (40%). A mild to moderate response was expected as participants were required to have a mild presentation in keeping with the homogeneity of the OA group, in order to be clinically indistinguishable from the OA group. With respect to grade 1.5 (6.7%) examiners showed an undecided opinion and grade 2, however showed a 40%

agreement. With grades 1 and 2, total agreement existed (93.3%) as opposed to being undecided (6.7%).

Table 32: Frequency of median IS in PFPS group

	Frequency	Percent
1.00	22	73.3
1.50	3	10.0
2.00	3	10.0
3.00	2	6.7
Total	30	100.0

Table 32 shows that the most frequent response in the IS direction in the PFPS group was normal (73.3%). Although there was only a small percentage of agreement in grade 2 (10%) and in grade 3(6.7%), this is relevant as there was total agreement (16.7%) between examiners as opposed to an undecided opinion (10%).

Table 33: Frequency of median ML in PFPS group

	Frequency	Percent
2.00	13	43.3
1.00	11	36.7
1.50	6	20.0
Total	30	100.0

Table 33 shows that the most frequent response in the ML direction in the PFPS group was mild to moderate (43.3%), followed by normal (36.7%). This was a significant finding as it represented a population that was symptomatic. 20% of the examiners showed an undecided opinion, whereas 43.3% were in total agreement with respect to grade 2.

Table 34: Frequency of median LM in PFPS group

	Frequency	Percent
1.00	20	66.7
2.00	6	20.0
1.50	4	13.3
Total	30	100.0

Table 34 shows that the most frequent response in the LM direction in the PFPS group was normal (66.7%) followed by mild to moderate restriction (20%). 13.3% of the examiners showed an undecided opinion as opposed to 20%, where the examiners were in total agreement.

Overall, with respect to the previous tables (tables 31 to 34), the results revealed that there was more examiner agreement in terms of the grades of patella restrictions as well as in the detection of normal patella movement (i.e. grades 1 to 3) as opposed to an undecided opinion (grade 1.5 or 2.5).

Furthermore, from the previous tables, the examiners noted that for ***grading of general patella*** restrictions, the most frequently agreed response was 2 (mild to moderate restrictions) in the ***ML*** direction. Therefore in summary, majority of the motion detected by the examiners was found to be normal (viz. LM, IS and SI, with the ***ML*** being mild to moderately restricted).

This would appear to be in contradiction with the findings in (4.2.2.2, table 13) where it was stated that the most commonly ***agreed direction*** was ***SI***. This can be accounted for by the fact that the agreement between examiners in the first instance (this instance), grade is the principle independent variable defining the outcome of the result, as opposed to the second instance where direction was the principle independent variable defining the outcome. Thus it would seem that with respect to inter-rater reliability that it is dependant on the construct by which the comparisons of examiner reliability are measured against.

This indicates that even though motion palpation is lacking conclusive research defining it as an integral assessment tool, these findings suggest that motion palpation does seem to demonstrate a certain level of efficacy in distinguishing between different constructs utilized.

<u>In addition to the above and in terms of the PFPS patient:</u>

SI movement is governed by tight soft tissue structures (muscles and ligaments) (Outerbridge and Dunlop, 1975; Travell and Simons, 1983; Scuderi, 1995; Fulkerson, 1997; Scott, 2005) giving a soft end feel (spongy end feel) that has no solid limitations (Bergmann, 1993:90-93); therefore agreement by the examiners may have been that this motion was only a grade 1 restriction although it was the most commonly noted in terms of the clinical condition with respect to direction of restriction.

On the converse, the ML movement may have been predisposed to a bone on bone or hard end feel (Bergmann, 1993:90-93); as a result of the relatively laterally placed patella being pushed into the lateral femoral condyle (Scuderi, 1995; Sharma <u>et al</u>. 1999). This would then allow the examiners to agree that the grade would be more severe, than that of SI.

4.4.2.3 Grade with respect to symptomatology (pain perception and range of motion) (PFPS group):

Table 35: Descriptive statistics for NRS, goniometer flexion and extension, and objective pain by median grade in PFPS group (n=30)

Median grade		NRS	Goniometer flexion	Goniometer extension	Objective pain
1.00	Mean	42.0833	128.9444	5.2778	13.00
	N	6	6	6	6
	Std. Deviation	7.48610	5.11823	.57413	2.098
1.50	Mean	49.7500	122.5000	5.5000	8.00
	N	2	2	2	2
	Std. Deviation	.35355	17.67767	.70711	2.828
2.00	Mean	43.9773	125.2879	5.1212	11.09
	N	22	22	22	22
	Std. Deviation	15.42376	6.95511	.81355	2.810
Total	Mean	43.9833	125.8333	5.1778	11.27
	N	30	30	30	30
	Std. Deviation	13.60051	7.30179	.75167	2.852

Table 35 and Figure 9 show the descriptive statistics for symptoms by median grade in the PFPS group.

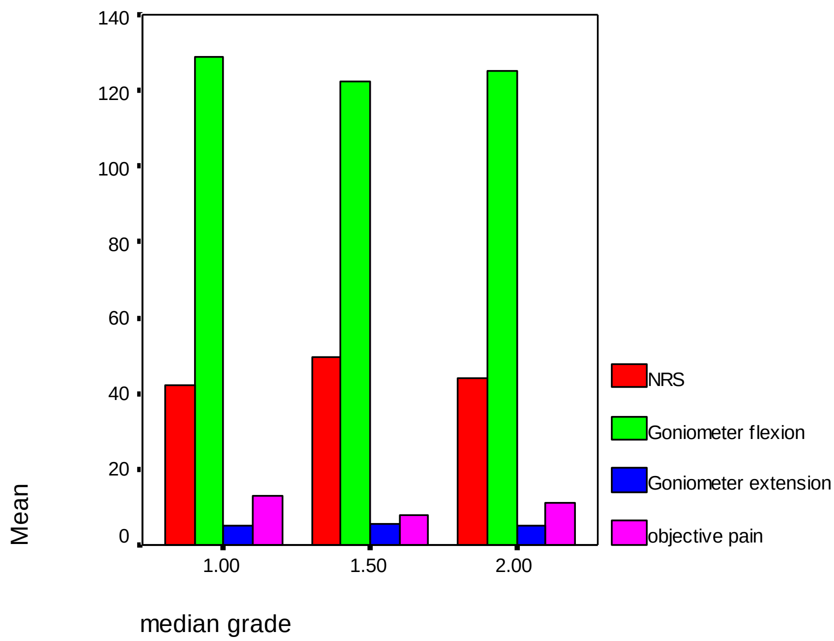


Figure 9: Summary statistics for NRS, goniometer and objective pain by median grade in the PFPS group (n=30)

Table 36: ANOVA tests for the comparison of NRS, goniometer and objective pain scale between median grade in the PFPS group (n=30).

		Sum of Squares	df	Mean Square	F	P value
NRS	Between Groups	88.170	2	44.085	.226	0.800
	Within Groups	5276.072	27	195.410		
	Total	5364.242	29			
Goniometer flexion	Between Groups	86.842	2	43.421	.803	0.458
	Within Groups	1459.325	27	54.049		
	Total	1546.167	29			
Goniometer extension	Between Groups	.338	2	.169	.284	0.755
	Within Groups	16.047	27	.594		
	Total	16.385	29			
objective pain	Between Groups	40.048	2	20.024	2.761	0.081
	Within Groups	195.818	27	7.253		
	Total	235.867	29			

Table 36 shows that there were no significant differences in the symptoms between the grades of mobility in the PFPS group. Only objective pain approached statistical significance (p=0.081).

4.4.2.4 Grade and direction with respect symptomatology (pain perception and range of motion):

4.4.2.4.1 Superior to inferior direction and symptomatology (PFPS group):

Table 37: Descriptive statistics for NRS, goniometer flexion and extension, and objective pain by median SI in PFPS group (n=30)

Median SI		NRS	Goniometer flexion	Goniometer extension	Objective pain
1.00	Mean	42.3438	127.9375	5.2500	11.50
	N	16	16	16	16
	Std. Deviation	13.05338	6.99970	.74536	2.875
1.50	Mean	54.7500	120.8333	4.5000	8.00
	N	2	2	2	2
	Std. Deviation	7.42462	15.32065	2.12132	2.828
2.00	Mean	44.3750	123.8611	5.1944	11.50
	N	12	12	12	12
	Std. Deviation	15.00473	6.09762	.48113	2.714
Total	Mean	43.9833	125.8333	5.1778	11.27
	N	30	30	30	30
	Std. Deviation	13.60051	7.30179	.75167	2.852

Mean and standard deviations for the various symptoms are shown in the PFPFS group by median SI category in table 37.The means are plotted in figure 10.

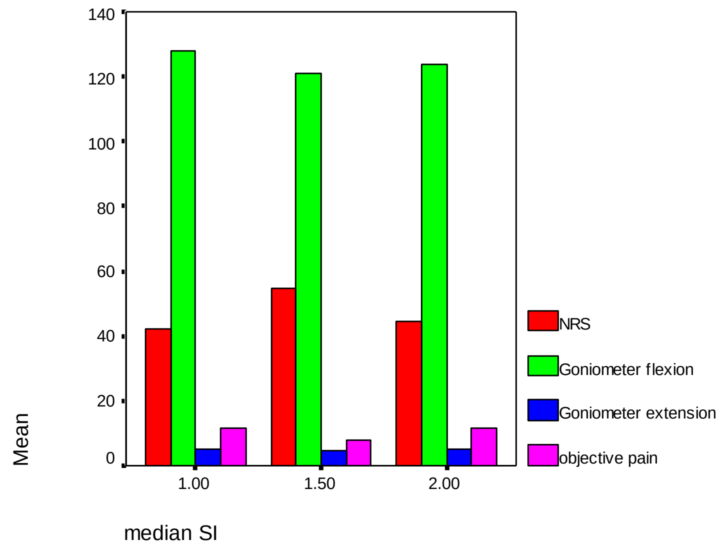


Figure 10: Summary statistics for NRS, goniometer and objective pain by median SI in the PFPS group (n=30)

Table 38: ANOVA tests for the comparison of NRS, goniometer and objective pain scale between median SI in the PFPS group (n=30).

		Sum of Squares	df	Mean Square	F	p value
NRS	Between Groups	276.695	2	138.347	.734	0.489
	Within Groups	5087.547	27	188.428		
	Total	5364.242	29			
Goniometer flexion	Between Groups	167.516	2	83.758	1.640	0.213
	Within Groups	1378.650	27	51.061		
	Total	1546.167	29			
Goniometer extension	Between Groups	1.006	2	.503	.883	0.425
	Within Groups	15.380	27	.570		
	Total	16.385	29			
objective pain	Between Groups	22.867	2	11.433	1.449	0.252
	Within Groups	213.000	27	7.889		
	Total	235.867	29			

Table 38 shows the results of the ANOVA tests for difference in mean symptoms scores between the SI category groups. There were no significant differences, thus SI group did not influence symptom scoring in the PFPS group.

4.4.2.4.2 Inferior to superior direction and symptomatology (PFPS group):

Table 39: Descriptive statistics for NRS, goniometer flexion and extension, and objective pain by median IS in PFPS group (n=30)

Median IS		NRS	Goniometer flexion	Goniometer extension	Objective pain
1.00	Mean	41.1136	126.6212	5.3788	10.82
	N	22	22	22	22
	Std. Deviation	11.02047	7.39032	.60242	3.065
1.50	Mean	37.5000	127.5556	4.6667	12.00
	N	3	3	3	3
	Std. Deviation	23.84848	6.00309	1.45297	2.000
2.00	Mean	60.8333	124.1111	4.3333	13.33
	N	3	3	3	3
	Std. Deviation	1.44338	7.91857	.57735	1.155
3.00	Mean	60.0000	117.1667	5.0000	12.00
	N	2	2	2	2
	Std. Deviation	.00000	4.47834	.00000	2.828
Total	Mean	43.9833	125.8333	5.1778	11.27
	N	30	30	30	30
	Std. Deviation	13.60051	7.30179	.75167	2.852

Table 39 and Figure 11 shows the descriptive statistics for symptoms scores by IS category.

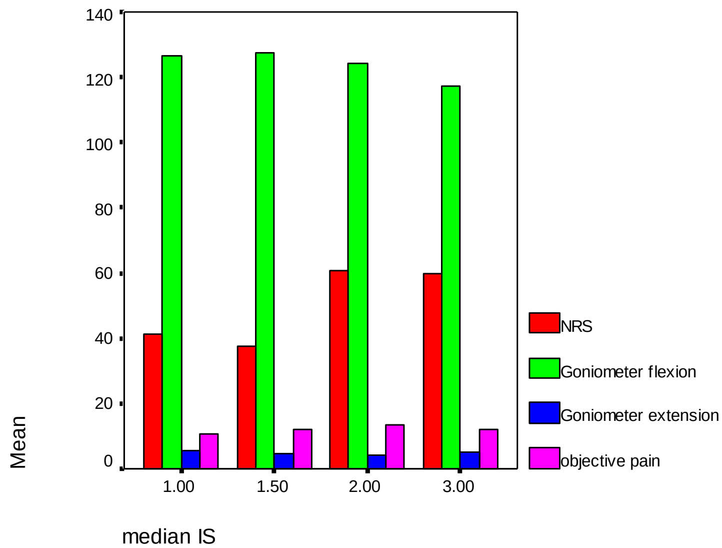


Figure 11: Summary statistics for NRS, goniometer and objective pain by median IS in the PFPS group (n=30)

Table 40: ANOVA tests for the comparison of NRS, goniometer and objective pain scale between median IS in the PFPS group (n=30).

		Sum of Squares	df	Mean Square	F	P value
NRS	Between Groups	1672.109	3	557.370	3.925	0.020
	Within Groups	3692.133	26	142.005		
	Total	5364.242	29			
Goniometer flexion	Between Groups	181.675	3	60.558	1.154	0.346
	Within Groups	1364.492	26	52.480		
	Total	1546.167	29			
Goniometer extension	Between Groups	3.875	3	1.292	2.685	0.067
	Within Groups	12.510	26	.481		
	Total	16.385	29			
objective pain	Between Groups	19.927	3	6.642	.800	0.505
	Within Groups	215.939	26	8.305		
	Total	235.867	29			

Table 40 shows that the mean NRS was significantly different between the IS categories (p=0.020). Bonferroni multiple comparison post hoc tests showed that there was no significant difference between any two individual groups after adjustment for multiple comparisons (not shown). Figure 8 shows that the NRS mean score increased between a IS score of 1.5 and 2. Goniometer extension was marginally significant (p=0.067). There was a decrease in extension between normal and mild to moderate restriction (Table 39).

4.4.2.4.3 Medial to Lateral direction and symptomatology (PFPS group):

Table 41: Descriptive statistics for NRS, goniometer flexion and extension, and objective pain by median ML in PFPS group (n=30)

Median ML		NRS	Goniometer flexion	Goniometer extension	Objective pain
1.00	Mean	47.0455	127.1212	5.0000	12.36
	N	11	11	11	11
	Std. Deviation	11.33679	6.34608	.76012	2.335
1.50	Mean	39.5000	118.1111	5.5000	11.67
	N	6	6	6	6
	Std. Deviation	18.06931	7.34444	.34960	2.944
2.00	Mean	43.4615	128.3077	5.1795	10.15
	N	13	13	13	13
	Std. Deviation	13.59911	5.90270	.86726	2.996
Total	Mean	43.9833	125.8333	5.1778	11.27
	N	30	30	30	30
	Std. Deviation	13.60051	7.30179	.75167	2.852

Table 41 and Figure 12 show the descriptive statistics for the symptoms measurements between the ML group categories.

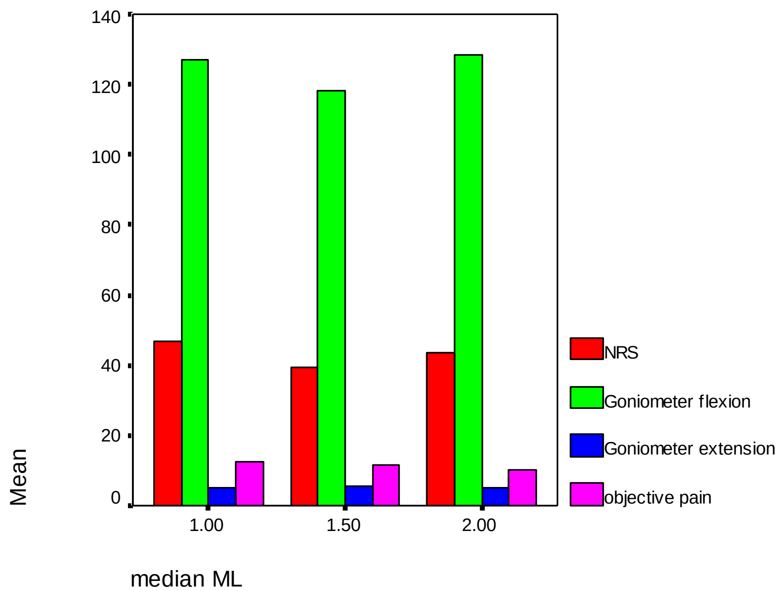


Figure 12: Summary statistics for NRS, goniometer and objective pain by median ML in the PFPS group (n=30)

Table 42: ANOVA tests for the comparison of NRS, goniometer and objective pain scale between median ML in the PFPS group (n=30).

		Sum of Squares	**df**	**Mean Square**	**F**	**p value**
NRS	Between Groups	227.284	2	113.642	.597	.557
	Within Groups	5136.958	27	190.258		
	Total	5364.242	29			
Goniometer flexion	Between Groups	455.633	2	227.817	5.640	.009
	Within Groups	1090.534	27	40.390		
	Total	1546.167	29			
Goniometer extension	Between Groups	.971	2	.485	.850	.438
	Within Groups	15.415	27	.571		
	Total	16.385	29			
objective pain	Between Groups	30.296	2	15.148	1.990	.156
	Within Groups	205.571	27	7.614		
	Total	235.867	29			

Table 42 shows that the mean flexion was significantly different between the ML categories (p=0.009). Bonferroni multiple comparison post hoc tests showed that the significant difference lay between groups 1 and 1.5 (p=0.028), and between groups 1.5 and 2 (p=0.009) (not shown). Table 41 shows that flexion was lowest in the 1.5 ML category.

4.4.2.4.4 Lateral to Medial direction and symptomatology (PFPS group);

Table 43: Descriptive statistics for NRS, goniometer flexion and extension, and objective pain by median LM in PFPS group (n=30)

Median LM		NRS	Goniometer flexion	Goniometer extension	Objective pain
1.00	Mean	44.1000	127.5833	5.0833	10.90
	N	20	20	20	20
	Std. Deviation	13.12451	7.67305	.73250	3.210
1.50	Mean	48.1250	121.4167	5.5833	12.00
	N	4	4	4	4
	Std. Deviation	16.25000	6.42550	.41944	1.633
2.00	Mean	40.8333	122.9444	5.2222	12.00
	N	6	6	6	6
	Std. Deviation	15.30251	4.78152	.98131	2.191
Total	Mean	43.9833	125.8333	5.1778	11.27
	N	30	30	30	30
	Std. Deviation	13.60051	7.30179	.75167	2.852

Table 43 and Figure 13 show the descriptive statistics for the symptoms measurements between the ML group categories.

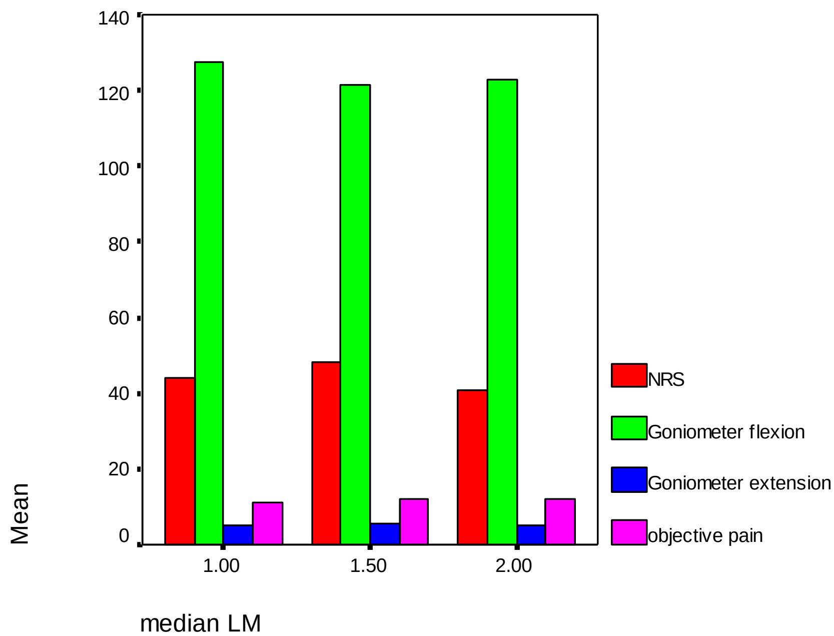


Figure 13: Summary statistics for NRS, goniometer and objective pain by median LM in the PFPS group (n=30)

Table 44: ANOVA tests for the comparison of NRS, goniometer and objective pain scale between median LM in the PFPS group (n=30).

		Sum of Squares	df	Mean Square	F	P value
NRS	Between Groups	128.421	2	64.210	.331	0.721
	Within Groups	5235.821	27	193.919		
	Total	5364.242	29			
Goniometer flexion	Between Groups	189.352	2	94.676	1.884	0.171
	Within Groups	1356.815	27	50.252		
	Total	1546.167	29			
Goniometer extension	Between Groups	.848	2	.424	.737	0.488
	Within Groups	15.537	27	.575		
	Total	16.385	29			
objective pain	Between Groups	8.067	2	4.033	.478	0.625
	Within Groups	227.800	27	8.437		
	Total	235.867	29			

Table 44 shows that there were no significant differences between any of the symptoms by LM group. Thus LM category did not influence symptoms

4.4.2.5 Discussion of grade and direction with respect to symptomatology

A] Numerical Pain Rating Scale

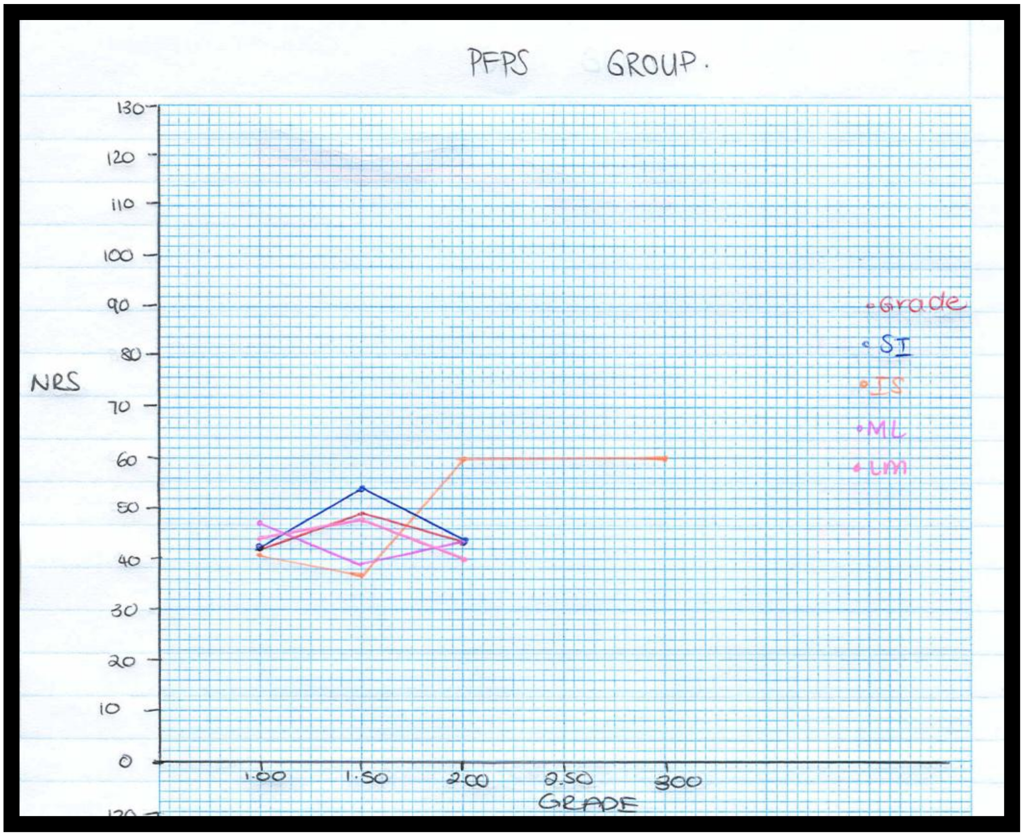


Figure 14

The NRS rating was low for a normal (1) grading of mobility, and then increased slightly with a median grading of 1.5, thereafter decreasing again with an objective increase in the grade of mobility.

Despite the minimal changes noted, there appeared to be a trend suggesting that PFPS does not seem to be a defined clinical entity, but refers to a pathogenic process that evolves over time (Scott, 2005), hence experiencing different symptomatology, as the condition progresses. It is thus possible that in the severe form of PFPS, also termed as “runners knee” (thus particularly affecting athletic individuals), increased musculoskeletal development (tone, muscle strength and co-ordination) and pain occurs. As a result, athletes run with appropriate physiological adaptation, thereby resulting in decreased severity and reported pain (Scott, 2005). Experienced athletes could also have developed mechanisms to avoid, adapt and control situations in which pain may arise (Leach, 1994).

It seems strange that the IS group is the only group that presents with marked pain levels (over and above the other grade readings), especially in view of the fact that the most common restriction noted was SI. However it cannot be discarded that with increased QF tightness, there is increased load on the infrapatella tendon, increasing chances of laxity (Solomonow, 2004) as well as friction conditions (bursitis and infrapatella tendonosis) (Puniello, 1993; Wood, 1998). These conditions could result in increased pain purely from the mechanism by which the motion of IS is palpated by the examiners, thus resulting in increased levels of pain reporting for that movement and inherent resistance of the body (guarding to pain produced by external stimuli) to the movement while it is being palpated.

B] Flexion range of motion (measured by the goniometer)

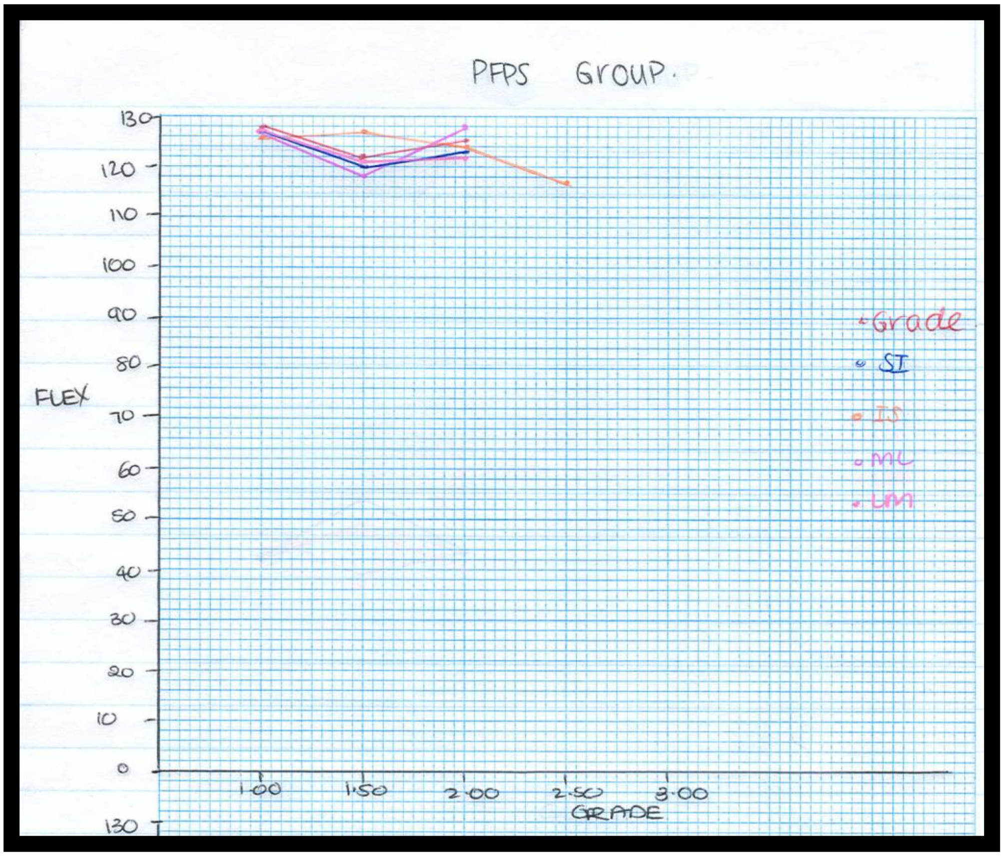


Figure15

As can be seen in figure 15, there appears to be an increase in flexion range of motion with a normal grading of mobility, as can be expected the greater the degree of restriction the greater the degree to which range of motion is decreased (principally seen in IS). It is interesting to note that there is a slight positive relationship between goniometer flexion range of motion and grading of patella mobility, which indicates that with an increase in patella mobility grading (2) (mild to moderate restrictions), there is also an increase in flexion range of motion.

The exception occurs in the mid –range (1.5), where the restrictions are graded as an average (therefore the examiners show an undecided opinion), this could result in there being a dichotomous relationship between the degree to which soft tissue or bony structures are responsible for the degree of restriction. Further to this it would also depend on the patients presenting with any infrapatella tenderness and / or pain (Puniello, 1993; Wood, 1998) at the time that they presented to the Chiropractic Day Clinic to participate in this study. Both of these could have resulted in the examiners being undecided and therefore not being able to peg the degree of restriction (or placement of the condition into one of the phases – dysfunction, instability or stabilization as proposed by Kirkaldy – Willis and Burton 1992) as described in the previous discussion (4.4.1.5, figure 8).

It is however recognized that the flexion range of motion as measured by the goniometer is not clearly associated with the reported severity of mobility restrictions by the examiners and that this could also be a function of the manner in which the readings were taken by the goniometer (i.e. measurement error due to placement within the bounds of certain anatomical landmarks, which vary slightly from patient to patient).

C] Extension range of motion (measured by the goniometer)

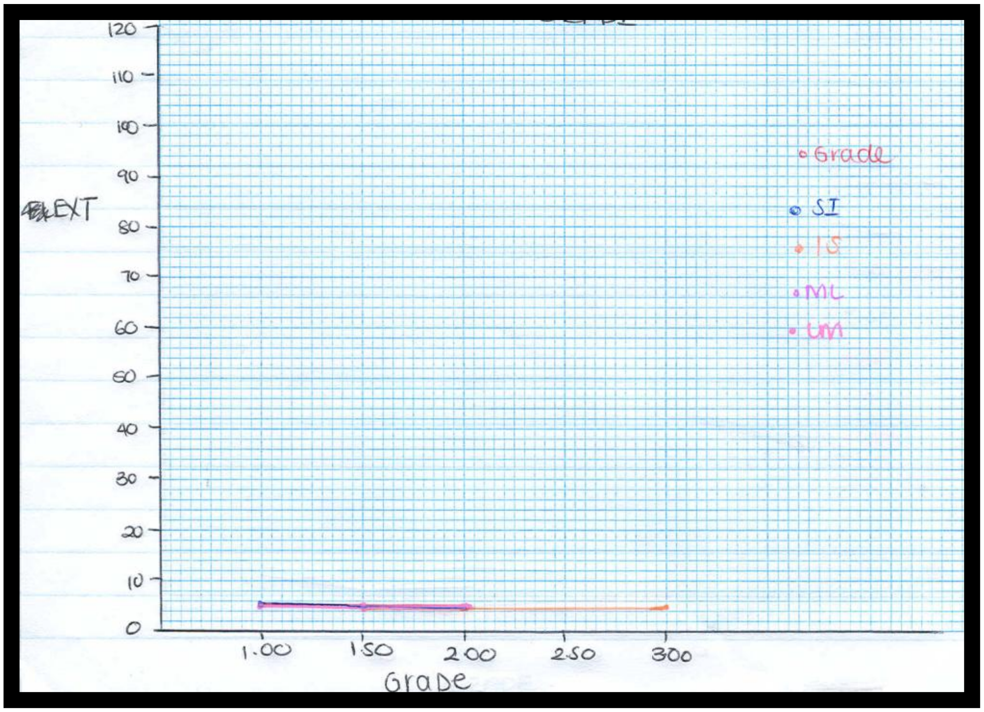


Figure 16

Extension range of motion remained relatively stable throughout the grades of patella mobility restrictions. Although extension range of motion in the knee is generally minimal, these findings could be related to the fact that majority of the literature suggests an extensor mechanism dysfunction as the most probable aetiology (Post, 1998), thereby limiting extension. This dysfunction may be aggravated by or result in instability of the patellofemoral joint and inflammation of the surrounding tissues, or any combination thereof (Puniello, 1993; Wood, 1998). This pain has been associated with AMI and thereby inhibition of the QF, limiting the degree of extension (Hopkins and Ingersoll 2000; Suter et al. 2000). Furthermore, Walsh (1994) stated that PFPS may also be associated with increased or decreased patella mobility both of which would be associated through their respective mechanisms to decrease extension ability viz. AMI (Hopkins and Ingersoll 2000; Suter et al. 2000) and stabilization respectively (Kirkaldy-Willis and Burton, 1992).

D] OPRS (Objective Pain Rating Scale for PFPS)

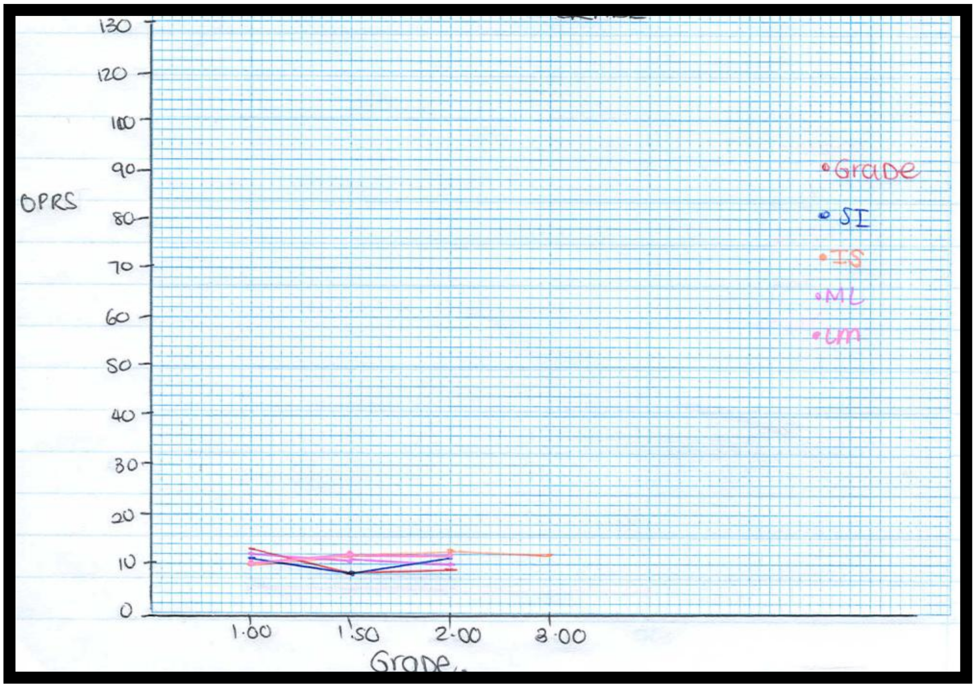


Figure 17

The OPRS is an objective PFPS scale (Thomee et al. 1995; Reid, 1992 and Magee 1997) that measures (individual's activity):-

- Pain during and/ or after activity?
- Pain during walking up or down stairs?
- Pain during squatting?
- Pain during isometric quadriceps muscle contraction?
- As well as the outcome of –
  - Clarke's test
  - McConnell test
  - Waldron test

As can be seen from figure 17, there appears to be a slight increase in the OPRS with a normal grading of mobility (1). Thereafter, the OPRS reading decreases slightly (with grade 1.5) followed by another slight increase (with grade 2). This correlates with the findings of Scott (2005) that PFPS appears to be an evolving syndrome, which does not have defined parameters in terms of clinical presentation.

In addition, it has been suggested that this scale measured individuals tending towards a myofascial / muscular pain syndrome rather than those with true PFPS or it is possible that participants could have presented with a myofascial component (in the early stages) of PFPS (Dippenaar, 2003). Thus, an increase in myofascial trigger points could have resulted in an increased reporting of OPRS scales (pain as indicated by the OPRS scores measuring myofascial constructs) at the less severe stages of the syndrome, where one would expect to find fewer if any restrictions of the patella.

This supports Dippenaar (2003) who noted a significant myofascial component as part of the OPRS.

Furthermore, at a mid-range of patella mobility grading (grade 1.5), restrictions appear to be graded as average (therefore examiners show an undecided opinion between them) as also seen in figure 15. The reasons as discussed at that point would be relevant to this discussion as well.

IS movement appeared to have a greater degree of mobility restrictions (grade 3) with an increased OPRS score. This could be due to patients presenting with infrapatella tenderness in the stages where PFPS has become a more clinically defined syndrome. With an increase in infrapatella tenderness, the tendon loses its ability to perform the role of limiting movement (i.e. proximal ascent of the patella from the tibia) (Fulkerson, 1997:13) thereby resulting in superior movement, allowing for the clinical presentation of decreased movement in the SI direction.

4.4.3 Summary and conclusion:

Overall, examiners were able to reliably detect a greater number of patella restrictions in a symptomatic population as opposed to normal patella motion in both groups. Specific agreement amongst examiners was noted for the direction of motion restriction as well as the grading of patella restrictions between the two conditions.

In OA, the LM direction was the most commonly restricted motion agreed upon by the examiners, which is in correlation with the findings in 4.2.1.2.4, table 7. In PFPS, the SI direction was the most commonly restricted motion agreed upon by the examiners, which is in correlation with the findings in 4.2.2.2.1, table 13. Direction was one of the two principle independent variables defining the outcome of this study.

In addition to the results mentioned above, this study also revealed that the Kappa scores for the ML direction in the PFPS group was fair (k=0.2012), which was similar to the OA group which also revealed a fair Kappa score (k=0.2179). Due to the similarity in Kappa scores between these two groups with respect to ML direction, the p value (p=0.3409) did not reveal a significant difference between these two groups; unlike the p-values with regard to SI (p=0.0071) and LM (p<0.001) which was significant.

The grade of patella restrictions as agreed upon by the examiners was mild to moderate (2) for both OA (4.4.1.2, table 18) and PFPS (4.4.2.2, table 33). This was expected in both the OA and PFPS groups because the sample population chosen for this study had to be homogenous and clinically indistinguishable from one another, in order to blind the examiners to the presenting condition.

The grade of patella restrictions therefore may reflect the absence or presence of the pathogenesis of the condition. It must be noted that the agreement between examiners in this respect was dependant on grade, being the principle independent variable defining the outcome of the result that was measured against the clinical features / symptomatology.

In support of and addition to the above it is of interest to note that of the restrictions found in the OA group, 63.3% of the 86.6% (2/3rds of the noted restrictions) were unanimously agreed upon by the examiners – i.e. the majority within the group of examiners, definitively indicated that a restriction was present and agreed that it was at the same level or grade of severity (i.e. 2 or 3) respectively.

Furthermore, it is of interest to note that of the restrictions found in the PFPS group, 73.3% of the 80% were unanimously agreed upon by the examiners – i.e. the majority within the group of examiners, definitively indicated that a restriction was present and agreed that it was at the same level or grade of severity (i.e. grade 2).

Overall, with respect to tables 16 to 19 in the OA group and tables 31 to 34 in the PFPS group, the results revealed that there was more inter-examiner agreement in terms of the grades of patella restrictions as well as in the detection of normal patella movement (i.e. grades 1 to 3) as opposed to an undecided opinion (grades 1.5 or 2.5).

In addition to the above, inter-examiner reliability might have been slightly lower due to the repeated motion palpation of the five examiners. This in turn might have had a mobilising effect on the patella, and reduced restrictions detected by the first or first few examiners. As examiners motion palpated the patella, the joint could have been mobilised and thus diminished or augmented the restrictions that might have been present originally (DeBoer et al. 1985, Carmichael, 1987). Hence, as an example, a restriction graded at a level three as detected by the first examiner could have been recorded as grade two, one or even normal by the time it was motion palpated by the second, third, fourth or fifth examiner.

With respect to the hypotheses made in chapter one, the initial ***hypotheses*** are discussed here in light of the findings and discussion in this chapter.

4.4.3.1 There is inter-examiner reliability of the patella, using Bergmann's Technique in subjects with OA and PFPS, despite the variance introduced by the respective conditions.

In the ***OA*** group, there was agreement between the examiners for the ***direction*** of lateral to medial (LM) (Kappa=0.301) which was fair, with a significant p-value of <0.001. However, the ML direction for the OA group was also fair (k=0.2179), but the p-value did not reveal a significant result (p=0.3409). The remainder of the agreements between directions of movement ranged from poor (SI) to worse than expected by chance alone (IS).

This concurs with the literature (Sharma et al. 1999; Lewek et al. 2004) where the following anatomical factors have been implicated as the cause of the LM direction frequently agreed upon by the examiners:

- Retinaculum (lateral or medial)
- Lateral compartment of the knee
- Muscles and pain sensitive structures involving Arthrogenic Muscle inhibition
- ITB

In view of the fact that this research was to assess inter-examiner reliability with respect to the four different directions being motion palpated, the factors presented above represent suggestions as to why certain directions were more restricted than others, as found consistently by the examiners in this study, even though this is contrary to other literature that would support a generalized decrease in all directions of movement of the patella or involved joints that have OA (Golding, 1989: 148). In mitigation of this literature based difference, the presentation of OA in this study was such that it had a clinical presentation similar to that of the PFPS group, thereby implying a mild form of OA, which may not follow the literature norm based on severe OA.

In the **PFPS** group there was agreement between the examiners for the ***direction*** of superior to inferior (SI) (k=0.222) which was fair, with a significant p-value of 0.0071. Similarly, the ML direction for the PFPS group also revealed a fair result (k=0.2012), however, the p-value was not significant (p=0.3409).

Similar to the OA group, this was related to the following anatomical structures being implicated as the cause of the SI direction, which may have increased the frequency of agreement between the examiners:

- Altered patella tracking
- ITB Imbalance between the VMO and VL
- Biomechanical considerations
- Myofascial dysfunction
- Infrapatella tendon

This presentation of SI in the PFPS group seems to be congruent with the literature in which an extensor mechanism dysfunction is cited as the most probable aetiological cause for the development of PFPS (Post, 1998).

Based on the ***results of this study*** there appears to be a difference between the levels of agreement between examiners when different ***directions of restriction*** are assessed***,*** based on the degree of involvement of certain anatomical structures and how they are affected within the clinical conditions of PFPS and OA. This suggests that restrictions based on a particular clinical pathogenesis of PFPS or OA seem to indicate that motion palpation is able to detect these subtle nuances suggesting a level of efficacy in this assessment tool.

The most common grade of patella restrictions as agreed upon by the examiners was mild to moderate (2) for both OA (4.4.1.2, table 18) and PFPS (4.4.2.2, table 33). This was expected in both the OA and PFPS groups because the sample population chosen for this study had to be homogenous and clinically indistinguishable from one another, in order to blind the examiners to the presenting condition.

In addition, ***amongst all the grade 2 restrictions*** (mild to moderate restrictions) found the most common direction in which inter-examiner agreement was found in the ***ML*** direction, for both OA and PFPS groups.

This would appear to be in contradiction with the findings in (4.2.1.2.4) where it was stated that the most commonly ***agreed direction*** was ***LM*** in the OA group; and with the findings in (4.2.2.2, table 13) where it was stated that the most commonly ***agreed direction*** was ***SI*** in the PFPS group.

This can however be explained in the context of the different constructs being measured. This means that direction is related to the most commonly noted restriction (as found congruent with the clinical syndromes above), whereas the degree of restriction is principally determined by the tissues that limit the movement being assessed. Thus ***ML*** movement may have been predisposed being noted by all examiners as this represented a bone on bone or hard end feel (Bergmann et al. 1993:90-92) restriction, as a result of the relatively laterally placed patella being pushed into the lateral femoral condyle (Scuderi, 1995:291; Sharma et al. 1999) in both OA and PFPS. Furthermore, due to the high lateral femoral condyle, the patella exhibits more motion medially than laterally, which restricts motion laterally. This would then allow the examiners to agree that the grade would be more severe, than that of LM or SI respectively.

This can be accounted for by the fact that the agreement between examiners in the first instance, **direction** was the principle independent variable defining the outcome of the result, as opposed to the second instance (this instance) where **grade** was the principle independent variable defining the outcome.

Thus, it would seem that with respect to the inter-rater reliability, that it is dependant on the construct (i.e. direction and grade) by which the comparison of examiner reliability is measured against. This indicates that that even though motion palpation is lacking conclusive research, these findings suggest that motion palpation does seem to demonstrate a certain level of efficacy in distinguishing between different constructs utilized.

Therefore, the hypothesis is accepted.

4.4.3.2 Motion palpation of the patella is equally reliable in a pathological (OA) as well as a functional (PFPS) condition, as both groups were symptomatic.

Inter-examiner reliability of motion palpation of the patella was equally reliable in both the pathological (OA) and functional (PFPS) conditions in terms of direction and grade of mobility restriction as related to the clinical presentation of the syndromes. Thus motion palpation appears to be reliable to a certain degree, despite the different conditions they presented with, or whether the patella was directly involved, or if the patella was not directly implicated.

Therefore, the hypothesis was accepted.

4.4.3.3 There would be more patella restrictions noted as opposed to no restrictions / normal patella mobility detected, irrespective of the direction or the severity of the grade of restriction, due to the involvement of symptomatic subjects.

Within the OA group, the overall result revealed that there were more restrictions noted (86.6%) as opposed to a normal grading (13.3%) of patella mobility (page 97, table 15). Furthermore, the overall result in the PFPS group revealed that there were more restrictions noted (80%) as opposed to a normal grade (20%) of patella mobility (page 119, table 30).

Therefore, the hypothesis was accepted.

4.4.3.4 Restrictions in movement in the pathological (OA) group would indicate that general movement (glide in all 4 cardinal directions) would be restricted.

With respect to 4.4.3.2, motion palpation was equally reliable in both groups and no one particular group dominated in terms of the restrictions detected by the examiners. In OA, as the cartilaginous surface becomes gradually denuded, there is an aberration of both gliding and shock absorbing functions. In addition to this, osteophyte formation occurs at the joint margins, which in turn may alter the contour of the joint and may also impair mobility (Brandt, 1996). Therefore one could clinically expect that with progression of OA, a gradual reduction in all ranges of motion would be seen. However this is not the case, as LM direction was the most commonly detected restriction in movement noted by the examiners.

Therefore, the hypothesis was rejected.

4.4.3.5 Restrictions in movement in the functional (PFPS) group would indicate that medial (lateral to medial movement) glide would be the most commonly restricted direction.

As stated above, motion palpation was equally reliable in both groups and no one particular group dominated in terms of the restrictions detected by the examiners. Post (1998) suggested that medial glide of the patella is commonly restricted in patients suffering from PFPS due to a tight ITB and/ or tight lateral retinaculum. However this is not the case, as SI direction was the most commonly detected restriction in movement noted by the examiners.

Therefore, the hypothesis was rejected.

4.4.3.6 There is an association between restricted patella motion and the symptomatology of OA and PFPS in each respective group.

OA:

NRS rating for pain appears to increase (worsen) with an increase in the grade of mobility, until grade 2 – 2.5 is achieved, thereafter it decreases, suggesting an inverse relation. With OA, there is a possible increase in degeneration within the joint, which is associated with an increase in osteophyte formation which leads to an increase in stabilization effects (Sharma et al. 1999) resulting in decreased movement and possibly decreased reporting of pain.

A decrease in flexion range of motion was noted with an increase in grading of patella mobility. This can be expected, as the range of motion of the knee may be decreased by capsular fibrosis, osteophytes, irregularity of articular surfaces or impaction of loose bodies (Naidoo, 2001; Sharma et al. 1999).

Extension range of motion remained relatively stable throughout the grades of mobility restriction. Although extension range of motion in the knee is generally minimal, many causes were noted for the results obtained.

Therefore in summary it is noted that the presentation of the patients grade of restriction would seem to be directly related to the pathogenesis of OA, as characterized by NRS (pain perception) and range of motion (extension and flexion).

PFPS:

The NRS rating for pain increased significantly as the grade of IS direction in movement became more severe. Due to increased QF tightness, there is increased load on the infrapatella tendon, increasing the chances of laxity (Solomonow, 2004). This could result in increased levels of pain reporting, for that movement.

There is a slight positive relationship between goniometer flexion range of motion and grading of patella restrictions, which indicates that with an increase in patella restriction grading (2) (mild to moderate restrictions); there is also an increase in flexion range of motion. It is however recognized that the flexion range of motion as measured by the goniometer is not clearly associated with the reported severity of mobility restrictions by the examiners and that this could also be a function of the manner in which the readings where taken by the goniometer (i.e. measurement error due to placement within the bounds of certain anatomical landmarks, which vary slightly from patient to patient).

Extension range of motion remained relatively stable throughout the grades of patella mobility restrictions. Although extension range of motion in the knee is generally minimal, these findings could be related to the fact that majority of the literature suggests an extensor mechanism dysfunction as the most probable aetiology (Post, 1998), thereby limiting extension.

There appears to be a slight increase in the OPRS with a normal grading of mobility (1). Thereafter, the OPRS reading decreases slightly (with grade 1.5) followed by another slight increase (with grade 2). This correlates with the findings of Scott (2005) that PFPS appears to be an evolving syndrome, indicated by individuals tending towards a myofascial / muscular pain syndrome, with evolution to a defined PFPS to a PFPS with possible degenerative or long term changes.

Overall, the grade of mobility restrictions did not appear to have much of a relationship with the symptoms experienced in the PFPS group.

Therefore, the hypothesis is accepted for the OA group but not for the PFPS group

CHAPTER FIVE:

CONCLUSION AND RECOMMENDATIONS OF THE RESULTS

5.1 Conclusions:

The aim of this research was to assess the inter-examiner reliability of motion palpation of the patella, using Bergmann's Technique in OA and PFPS. Statistically, the overall agreement between the examiners was fair with reference to 4.2.1.1, table 2 and 4.2.2.1, table 8.

Overall, examiners were able to reliably detect restrictions in a symptomatic population as opposed to normal patella motion. Specific agreement amongst examiners was noted for the direction of motion restriction as well as the grading of patella restriction between the two conditions.

Agreement in the direction of patella restriction was better for SI in the PFPS group and LM in the OA group. Therefore, based on the results of this study, there appears to be a difference between the levels of agreement between examiners when different directions are assessed based on the degree of involvement of certain anatomical structures within the clinical conditions. This implies that there is support for the conditions having a distinct decrease in certain motion parameters, implying that there could be a possible link and/or association between the conditions under study and the findings of motion palpation of the patellofemoral joint, in terms of the most commonly restricted directions noted in each condition.

In addition, ***amongst all the grade 2 restrictions*** (mild to moderate restrictions) found the most common direction in which inter-examiner agreement was found in the ***ML*** direction, for both OA and PFPS groups.

This therefore indicates that even though motion palpation is lacking conclusive research defining it as an integral assessment tool, these findings suggest that motion palpation does seem to demonstrate a certain level of efficacy in distinguishing between the different constructs (i.e. direction and grade) utilized, which are not bound to the clinical condition present.

By implication these results indicate that motion palpation is a useful clinical entity with respect to the clinical evaluation of the patient, as this research has shown some degree of reliability within the clinical setting. This means that motion palpation is a useful tool in determining the presence of motion restrictions as well as the grade of restriction within the context of clinical assessment. The suggestion therefore is that motion palpation of the patella be used as one of the clinical tools in assessing conditions of the knee joint.

It is important to note at this time that based on the methodology of this study, attempting to keep the examiners blinded as to the condition of the patient currently being motion palpated, the possibility of some degree of overlap between the two conditions may have existed in some patients. This is because participants with PFPS showing signs and symptoms of OA were sent for radiographic examination. If OA was confirmed with x-rays these patients were assigned to the OA group. This possibility of overlap of conditions and combination of conditions in certain participants may have had bearing on the outcome of this study.

In light of the findings mentioned above, this research does not advocate that motion palpation be utilized in isolation, as the outcomes of this study require further validation. Therefore, it is suggested that the use of motion palpation of the patella as the only assessment tool, is cautioned against.

5.2.1 Clinical Recommendations:

- In a biomechanically dysfunctional disorder such as PFPS and a pathological disorder such as OA, motion palpation may be one tool that could be used in identifying the type of therapy to be employed. However, as the results indicate there is only a fair chance of obtaining isolated information with regard to the grade of restricted motion with this test, it is suggested that it form part of an extended assessment and is not used as the principle indicator of therapy for PFPS or OA, which is consistent with other research (Bezuidenhout, 2002).
- It is suggested that patients presenting with mild OA are treated with respect to the ligamentous laxity in order to prevent further degeneration in the knee. However, there is controversy in the literature regarding the precursor – effect relationship of the ligamentous laxity with regard to OA and therefore further research in this regard is warranted.
- In view of the fact that this research was to assess the inter-examiner reliability of motion palpation of the patella, certain anatomical factors represent suggestions as to why certain directions were more restricted than others, even though this is contrary to the literature that would support a generalized decrease in movement of the patella or involved joints that have OA (Golding, 1989:148). Therefore, it is suggested based on this research that restrictions in motion based on particular stages of the clinical pathogenesis of OA and PFPS is addressed, and all the structures involved in enabling or restricting movement in all directions be addressed as well.
- The results of this study serve to support the suggestions and recommendations with regard to future research as found in the conclusion of 4.2.1.2., in addition to implying that there could be a possible link and/or association between the conditions under study and the findings of motion palpation of the patellofemoral joint, in terms of the most commonly restricted direction noted in each condition (In the OA participants the examiners found that the most common restriction was that of lateral to medial glide; and in the PFPS participants, the examiners found that the most common restriction was that of superior to inferior glide). This perhaps requires further research within a clinical context and possibly to the

exclusion of set research parameters (with respect to the conditions under study).

5.2.2 Research Recommendations:

- This study consisted of a higher percentage of males in the PFPS group (73.3%) than in the OA group (53.3%). Further studies should try to focus on one gender or compare the two gender differences utilizing a stratification table.
- The sample group consisted of mainly Indian participants (OA: 56.7% and PFPS: 36.7%) followed by White participants (OA: 30% and PFPS: 36%). Black participants (OA: 10% and PFPS: 16.7%) and Coloured participants (OA: 3.3% and PFPS: 10%) made up a small percentage. Further research should include a multilingual advertisement in order to get a more representative racially demographic sample, or race stratification tables could ensure sample homogeneity.
- Even though communication was kept at a minimum between participant and examiner or examiner and examiner, table 2 showed perfect agreement between examiners 1 and 4 in the OA group. This could be due to certain factors which could influence examiner reliability. For example: chance agreement, technique of motion palpation and level of experience, However, this is based on speculation and future research should consider eliminating these variables or making them more homogenous so that their effect on the outcomes of the research are minimized.
- A more sensitive pain rating scale that measures nuances in reported pain rather than utilization of only whole number options as found in the NRS is addressed for future research.
- The Motion Palpation Record Sheet (scale of severity) in this research was unable to delineate between mild to moderate severity in restriction of motion. As a result, the researcher was unable to state whether there was a variance between examiners in respect of category 2 (mild / moderate) or whether examiners utilized this category for both clinical presentations. Future studies should therefore incorporate a four level / graded scale:

    0: normal movement

1: mild restriction

2: moderate restriction

3: no movement at all

- Greater standardization of the examiners utilized in the assessment of patella motion could be achieved by increasing the number of workshops to ensure that the examiners work from a similar frame of reference and have a similar level of skill in motion palpation.

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Appendix A:

Are you aged between

35-50 years
And suffer from

KNEE PAIN?

Research is currently being carried out at the

Durban Institute of Technology
Chiropractic Day Clinic

FREE TREATMENT

Is available on completion of the study to those who qualify to take part in this study.

For more information

contact:

JANITA

On

(031) 2042205/251

Appendix B:

Telephonic Interview (Yochum and Rowe 1996:856)

Questions to be asked during the telephonic interview:

1] Are you between the ages of 35 and 50 years?

OA (inclusion criteria)

2] Are you suffering from the following?

- Do you experience knee pain on most days of the month?
- Do you suffer from morning stiffness of less than 30 minutes?
- Do you suffer from pain in the involved knee that is aggravated by activity and relived by rest?
- Do you suffer from decreased range of motion (Hart et al. 1995)?

PFPS (inclusion criteria)

3] Are you suffering from the following? (Patients must fulfill at least 2 out of the following 5 questions)

Do you experience pain:

- During and/or after activity?
- During and/or after sitting?
- During walking up/down stairs?
- During squatting?
- During an isometric quadriceps femoris muscle contraction?

OA (exclusion criteria)

4] Have you ever suffered from or show any indication of the following:

- Grade 3 ligamentous instability of the knee?
- Neoplastic disease or malignancy?

- Infective arthritides?
- Haematological disease?
- Systemic arthritis: Rheumatoid arthritis/ Psoriatic arthritis?
- Osteomyelitis?
- Acutely painful knees?
- Bony enlargements/deformity, crepitus or swelling?

Are you pregnant or breastfeeding at present?

PFPS (exclusion criteria)

5] Do you suffer from the following?

- A history of recurrent patella subluxation or dislocation?
- A history of intermittent or persistent knee joint swelling?
- Other injuries of the knee joint such as tears of the menisci, ligaments or joint capsule; damage to the articular cartilage; or overuse symptoms such as bursitis, patella tendonitis and fatpad syndrome?
- Any systemic arthritide that may affect the knee (for example gout or rheumatoid arthritis)?
- Having undergone any knee surgery within the past two years?

Appendix C:

DURBAN INSTITUTE 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 History 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. xrays
- 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

PHYSICAL EXAMINATION: SENIOR/RESEARCH. Appendix D

Patient Name :________________________ **File no :**__________ **Date :**
Interns Name : **Signature :**

VITALS:
Pulse rate:
Respiratory rate:
Blood pressure: R L
Temperature:
Height:
Weight: Recent change: Yes No

GENERAL EXAMINATION:

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

Clinicians Name: **Signature :**

SYSTEM SPECIFIC EXAMINATION

CARDIOVASCULAR EXAMINATION:

RESPIRATORY EXAMINATION:

ABDOMINAL EXAMINATION:

NEUROLOGICAL EXAMINATION:

COMMENTS:

Clinicians Name: **Signature :**

DURBAN INSTITUTE OF TECHNOLOGY Appendix E: 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 - 135°)_________________
Extension (0 - 15°)________________
Medial Rotation (20 - 30°)___________
Lateral rotation (30 - 40°)___________

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 InstabilityPosteromedial Rotatory Instability

Jacob ______________________ Hughston's Drawer Sign______________________
Hughston's Drawer Sign______________________
Reverse pivot shift test____________

- **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 F

LETTER OF INFORMATION.

Dear Patient,

Title of the study:

An investigation into the interexaminer reliability of motion palpation of the patella in Patellofemoral Pain Syndrome and Osteoarthritis.

Welcome to this research study on the reliability of motion palpation of the patella, in Patellofemoral Pain Syndrome, (anterior/ front knee pain) and osteoarthritis of the knee. I am investigating the reliability of different examiners being able to find the same characteristic when they assess the movement of your patella.

There will be 60 volunteers and you will be required to undergo a brief medical history, an abridged physical examination and a thorough knee regional examination and if there are no problems you will be included in the study. Those patients diagnosed with Osteoarthritis will be required to undergo x-rays of both knees. You will then be required to have your most affected patella examined by four different examiners in order to assess its movement. Please note that to participate in this study, the following will be required from you:

1] You must be between the ages of 35 and 50 years. A consent form must be completed prior to commencement of the examination.

2] Inclusion and exclusion criteria will have been fulfilled at the initial consultation with the 6^{th} year Chiropractic intern.

Risks to patients:
A] You might feel a slight discomfort around your knee due to the motion palpation, but you will benefit by being exposed to the procedures used by chiropractors to assess the motion of your patella.

B] X-rays are contraindicated in certain conditions (pregnant females, cancer. Blood dyscrasia, vertigo) and may pose as a risk by being exposed to ionizing radiation. However, patients will be thoroughly screened by means of a full Case History, Physical Examination and Knee Regional Exam before a decision to take x-rays will be made. It is my recommendation that you do not partake in any further research involving ionizing radiation for the next 5 years. However, if a situation arises, namely medical purposes, where x-rays are required of you, you are free to do so.

Your full co-operation 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 joints.

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

Participation in this study is free and will be performed under the supervision of a qualified chiropractor and you are free to withdraw from the study at any time with no consequences.

If you need to discuss any further matters, feel free to contact my supervisor and if you have any complaints you may contact the Technikon Faculty of Health Research Ethics committee.

Researcher: Janita Vaghmaria (031 204 2205).

Supervisors are: Dr. E. Lakhani (031 2042533).
: Dr. C. Korporaal (031 2042611).

Thank you for participating in this study.

Yours sincerely,
Janita Vaghmaria
Senior Chiropractic Intern.

INFORMED CONSENT FORM **Appendix G**

Date :

Title of research project: An investigation into the interexaminer reliability of motion palpation of the patella in Patellofemoral Pain Syndrome and Osteoarthritis

---

Name of supervisors: Dr E. Lakhani (031 2042533)
: Dr C. Korporaal (031 2042611)

Name of research student: Miss J. Vaghmaria
Tel: 031 204 2205

Please circle the appropriate answer
YES/NO

1. Have you read the research information sheet?
   Yes No
2. Have you had an opportunity to ask questions regarding this study? Yes No
3. Have you received satisfactory answers to your questions? Yes No
4 Have you had an opportunity to discuss this study? Yes No
5 Have you received enough information about this study? Yes No
6 Do you understand the implications of your involvement in this study? Yes No

7 Do you understand that you are free to withdraw from this study? At any time, without having to give any reason for withdrawing, and without affecting your future healthcare. Yes No
7 Do you agree to voluntarily participate in this study? Yes No
8 Who have you spoken to? Yes No

Please ensure that the researcher completes each section with you.
If you have answered NO to any of the above, please obtain the necessary information before signing.

Please print in block letters:

Patient/ Subject Name: ______________________ Signature:______________

Parent/ Guardian:__________________________ Signature:_______________

Witness Name:____________________________ Signature:_______________

Research Student:__________________________ Signature:_______________

Appendix H

Numerical Rating Scale-101 Questionnaire

Date: ______________ File no: _______________ **Visit no**______________

Patient name: ____

Please indicate on the line below, the number between 0 and 100 that best describes the pain you experience **when it at its worst.** A zero (0) would mean "no pain at all", and one hundred (100) would mean "Pain as bad as it could be". Please write only **one** number.

0 ____100

Please indicate on the line below, the number between 0 and 100 that best describes the pain you experience **when it at its least.** A zero (0) would mean "no pain at all", and one hundred (100) would mean "Pain as bad as it could be". Please write only **one** number.

0____100

Appendix I

Patient Name:

File No.:

Goniometer readings

GONIOMETER READINGS

	Reading 1	Reading 2	Reading 3	Average
Full Flexion				
Full Extension				

Appendix J:

Objective Pain Rating for Patellofemoral Pain Syndrome.

(Thomee et al. 1995, Reid 1992 and Magee 1997)

Patients name:

File No.:

• Clarke's sign:	[0] [2]
• Waldron's test:	[0] [2]
• McConnell's test	[0] [2]
• Do you have pain while sitting?	[0] [2]
• Do you have pain after sitting?	[0] [2]
• Do you have pain walking up stairs?	[0] [2]
• Do you have pain walking down stairs?	[0] [2]
• Do you have pain during squatting?	[0] [2]
• Do you have pain during an isometric quadriceps femoris muscle contraction?	[0] [2]
Total:	[18]

Appendix K:

Patella Motion Palpation Record Sheet.
(Bergman et al. 1993, Bezuidenhout 2002)

Patient name:

File No.:

	1	2	3	4	5
Examiner No.:	[ ]	[ ]	[ ]	[ ]	[ ]

Patient group:

A	B
[ ]	[ ]

Please tick the appropriate answer.

Dominant leg:	Right	[ ]
	Left	[ ]
Knee examined:	Right	[ ]
	Left	[ ]

Grading of general patella mobility:

1.	Normal mobility (A).	[ ]
2.	Mild to moderate restrictions (B).	[ ]
3.	Severe restrictions (C).	[ ]

Direction of motion: A] normal B] mild to moderate C] severe

		A	B	C
1.	Superiorly to inferiorly.	[ ]	[ ]	[ ]
2.	Inferiorly to superiorly.	[ ]	[ ]	[ ]
3	Medially to laterally.	[ ]	[ ]	[ ]
4.	Laterally to medially.	[ ]	[ ]	[ ]