To assess the associations between the severity of PFPS (in terms of the objective and subjective clinical measures) and patella mobility (direction of mobility loss and degree of motion loss).

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.

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Acknowledgements:

I would like to thank my parents for all there support and trust in this long endeavor.

I would like to thank Dr. A. van Der Meurlin and Dr. C. Korporaal for all there help and guidance during the whole of the research process from conception, inception and conclusion.

To my examiners: Barry, Deon, Emeile, James and Vinnie. Thanks for your time and dedication in coming every Monday and Tuesday to examine those knees. Thanks guys.

To friends and extended family for there support and encouragement, during those long hours and helping to source information.

To those individuals who participated in my study I thank you because without you I would be nowhere.

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Dedication:

I dedicate this work to all those people who helped me and encouraged me on this odyssey.

My parents who without there support and encouragement I would have not completed my studies.

My extended family, Aunty Judy and the Dunlops, for grounding me and being there if I needed anything.

My friends who have had to put up, helped and inspired me during those times where there did not seem to be a light at the end of the tunnel.

Merrick and Leigh who were my IT specialists and great friends.

Paul and Charise who were a home away from home.

Neil and Lily, all the way from Singapore giving guidance and encouragement the whole way.

To Taryn who got me going again in my life and in research. For your support and encouragement and giving me a good push in the right direction.

To Charmaine who without your guidance in the write up this last journey would have been an odyssey.

Thank you all.

GLOSSARY

Active Myofascial Trigger Point:

A focus of hyperirritability in a muscle or its fascia that is symptomatic with respects to pain: it causes a pattern of reffered pain at rest and/ or on motion that is specific for that muscle. An active trigger point is tender, prevents full lengthening of the muscle, weakness of the muscle, usually refers pain on direct compression, mediates a local twitch response of its taut muscle fibers when adequately stimulated, causes tenderness in the pain reference zone, and often produces a specific reffered autonomic phenomena, generally in its pain reference zone (Travell and Simons 1983:1).

Arthrogenic muscle inhibition:

A presynaptic, ongoing reflex inhibition of the musculature surrounding a joint following distention or damage to that joint (Hopkins *et al.* 2002).

Fribromyalgia:

Fibromyalgia is identified by widespread pain of at least 3 months' duration in combination with tenderness at 11 or more of the 18 specified tender point's sites (Travell and Simons 1983:2).

Latent Myofascial Trigger Point:

A focus of hyperirritability in muscle or its fascia that is clinically quiescent with respects to spontaneous pain: it painful only when palpated (Travell and Simons 1983:3).

Local Twitch Response:

Transient contraction of the group of muscle fibers (usually a palpable band) that contains a trigger point. The contraction of the fibers is in response to stimulation (usually by snapping palpation or needling) of the trigger point, or sometimes of a nearby trigger point (Travell and Simons 1983:3).

Motion palpation

Palpatory diagnosis of passive and active segmental joint range of motion (Gatterman, 1990:412).

Myofascial Pain Syndrome:

Synonymous with Myofascial syndrome and Myofasciatis, often a significant component of somatic dysfunction. This needs to be distinguished from fibromyalgia (Travell and Simons 1983:4).

Myofascial Syndrome:

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).

Myofascial Trigger Point:

A hyperirritable spot, usually associated within a taut band of skeletal muscle or in the muscle fascia. The spot is painful on compression and can give rise to characteristic referred pain, tenderness, and autonomic phenomena. A Myofascial trigger point is to be distinguished from cutaneous, ligamentous, periosteal, and nonmuscular fascial trigger points, types include active, latent, primary, associated, satellite, and secondary (Travell and Simons 1983:4).

Nonparametric Analysis:

These methods do not rely on the estimation of parameters (mean or standard deviation) describing the distribution of the variables of interest in the population (SPSS (version 9) software suite).

Pearson's Correlation:

The linear relationship / correlation between two variables that reflect the degree to which the variables are related (-1 < 0 > 1) (SPSS (version 9) software suite).

Primary Myofascial Trigger Point

A hyperirritable focus within a taut band of skeletal muscle. The hyperirritability was activated by acute/ chronic overload (mechanical strain), of the muscle in which it occurs, and was not activated as the result of trigger point activity in another muscle of the body (Travell and Simons 1983:5).

Reffered Autonomic Phenomena:

Vasoconstriction, coldness, sweating, pilomotor responses, vasodilatation and hypersecretion caused by activity of a trigger point but occurring in a region separate from the trigger point. The phenomena usually appear in the general area to which that trigger point refers pain (Travell and Simons 1983:5) .

Reffered Trigger Point Pain:

Pain that arises in a trigger point, but is felt at a distance, often entirely remote from its source. The pattern of reffered pain is reproducible related to its site of origin. The distribution of reffered trigger point pain rarely coincides with the entire distribution of a peripheral nerve or dermatomal segment (Travell and Simons 1983:5).

Reffered Trigger Point Phenomena:

Sensory, motor and autonomic phenomena, such as pain, tenderness, increased motor unit activity (spasm), vasoconstriction, vasodilation and hypersecretion caused by a trigger point, which usually occur at a distance from the trigger point Travell and Simons 1983:5).

Satellite Myofascial Trigger Points;

A focus of hyperirritability in a muscle or its fascia that becomes active because the muscle was located within the zone of reference of another active trigger point (Travell and Simons 1983:5).

Secondary Myofascial Trigger Points:

A hyperirritable spot in a muscle or its fascia that becomes active because its muscle was overloaded as a synergist substituting for, or was an antagonist

countering the force of the muscle that contained the primary trigger point (Travell and Simons 1983:6).

Spearman's Rank Order Correlation:

Is a nonparametric test for the strength of the relationship between pairs of variables (p value) (SPSS (version 9) software suite).

ABSTRACT

Patellofemoral Pain Syndrome (PFPS) is a common knee problem that affects 25% of the general population. PFPS generally affects adolescents, especially females, young adults and sports men and women. PFPS is defined as anterior knee pain arising from dysfunction of the patellofemoral articulation including its connective and contractile tissues. Literature suggests an extensor mechanism dysfunction as the most probable etiology. The majority of literature suggests that PFPS is associated with restricted patella motion, especially medial glide, resulting from a tight lateral retinaculum and/or tight iliotibial band. The beneficial effect of patella mobilization in the management of PFPS, suggested by the results of a number of studies, further suggests that restricted patella motion may be an integral feature of PFPS, as a causative and/or perpetuating factor. The purpose of this study was to assess the associations between the severity of PFPS (in terms of the objective and subjective clinical measures) and patella mobility (direction of mobility loss and degree of motion loss).

This was a quantitative, non- intervention clinical assessment, and reliability study consisting of one group of 60 individuals with PFPS, selected by convenience sampling. Individuals were allocated to one of three groups, according to the time spent running per week. Individuals were required to participate in two consultations. At the first consultation, after an informed consent had been obtained, each participant underwent a full Case History, abridged Physical Examination, a full Knee Regional Examination, pain and patellofemoral functional examination (which consisted of subjective recordings, the Numerical Pain Rating Scale (NRS) and objective measurements, the Objective Pain Rating Scale for Patellofemoral Pain Syndrome (OPRS) and a mechanical algometer reading and a subjective and objective record sheet, the Patellofemoral Joint Evaluation Scale (PJES)). At the second consultation, five examiners motion palpated the patella of the individuals' most symptomatic knee.

The clinical data was collected after the first consultation (subjective, objective and subjective and objective data) and second (motion palpation findings) consultation.

Various Descriptive and Inferential Statistical techniques were used. The Descriptive procedures used were various tables and graphs and a few summary statistics including but not limited to means and proportions. Inferential Statistics included various correlation testing techniques, included using ANOVA for age, with post-hoc Bonferroni and Chi Square for gender and race, Univariate ANOVA was used for NRS, Post Hoc Tests were used for group multiple comparisons. Spearman's Rank Order Correlation (for all groups) was used for the nonparametric correlation between NRS and PJES, Algometer and OPRS and OPRS and PJES, Pearson's Product Moment Correlation Coefficients (for all groups) was used for the parametric correlation between Algometer and OPRS, Algometer and PJES, OPRS and PJES. All correlation tests used a type 1 error with a significance level of $\alpha = 0.05$.

The PJES and the associated algometer reading was the most closely correlated / sensitive test for PFPS. The OPRS seemed to be an indicator for more of a myofascial / muscular pain syndrome than a scale for PFPS. The NRS was found not to be a reliable indicator for perceived pain in PFPS; this may be due to its subjective testing nature. There was a relationship between the OPRS and the general restrictions of the patella, but only for group. Three hypotheses were proposed: Hypothesis one proposed was that there was a relationship between the severity of PFPS and the objective clinical findings which were significant. The hypothesis was accepted for group 2 and rejected for groups 1 and 3. Hypothesis two proposed was that there was a relationship between the severity of PFPS and the subjective clinical findings which were significant. The hypothesis that severity of PFPS is related to the subjective clinical outcomes cannot be accepted for the entire population in this study and therefore cannot be extrapolated to the general population, as the results

varied in significance and association dependant on the particular presentation as has previously been associated with each group. Hypothesis three proposed that there was a relationship between the severity of PFPS and patella motion (the degree and direction of restriction. The hypothesis was rejected as the incidence and strength of the relationships are sporadic and limited either by group or by correlation with an assessment modality and therefore no generalized statements can be made.

PFPS does not appear to be a defined clinical entity, but refers to a pathogenic process that evolves over time. This would explain why patients present with the classic signs and symptoms as measured in this study, but have varying degrees of significance between the variables or tendencies towards indicating different portions of the pathogenic process, indicating that Patellofemoral Pain Syndrome appears to refer to an evolving syndrome with pathognomonic signs and symptoms of PFPS. This is indicated by individuals tending towards a myofascial / muscular pain syndrome in group 1, with evolution to a defined PFPS (group 2 ,supported by the results) to a PFPS with possible degenerative or long terms changes in group 3.

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CHAPTER ONE:

INTRODUCTION

1.1 THE PROBLEM AND ITS SETTING

Patellofemoral Pain Syndrome (PFPS)[1] is defined as anterior knee pain arising from the dysfunction of the patellofemoral articulation including its connective and contractile tissues and as such PFPS is a common knee problem affecting approximately 25% of the general population (McConnel 1986) and may account for almost 10% of visits and 20 to 40% of all knee complaints, in clinics dealing with musculoskeletal complaints (Kannus et al. 1999).

PFPS is particularly common in adolescents, especially females, young adults and sports men and women of any age (Devereaux 1984, Sandow et al. 1985, Meyer et al. 1990, Wilson 1990, Boucher et al. 1992, Davidson 1993, Thomee et al. 1995, Heng et al. 1996).

The cause of PFPS appears to be an enigma with a variety of possible etiologies being sited in the literature: anatomical abnormalities,

[1] Other terms used to describe PFPS are patellagia, gonalgia, paresthetica, anterior knee pain syndrome, retropatella arthralgia, patellar tracking problem and the peripatellar syndrome. The term chondromalacia patella has been reserved to describe only those changes in the articular cartilage, which may or may not be associated with PFPS (Reid 1996:349- 350).

misalignments or anatomical predisposition (Walsh 1994) and repetitive trauma (Davidson 1993).

Even with this background of uncertainty, the main biomechanical function of the patella is to increase the effective lever arm of the quadriceps femoris muscle in affecting extension or resisting knee flexion (Callaghan et al. 1996) and therefore the current trend in the literature suggests an extensor mechanism dysfunction as the most probable aetiology (Galantly et al. 1994, William 1998, Juhn 1999). This dysfunction may involve instability of the patellofemoral joint and inflammation of the surrounding tissues, or any combination thereof (Puniello 1993, Wood 1998). However Walsh (1994) states that PFPS may be associated with increased or *decreased* patella mobility, along with the majority of literature which suggests that PFPS is associated with restricted patella motion, especially medial glide, resulting from a tight lateral retinaculum (McConnel 1986) and/or tight iliotibial band (Post 1998).

Further to this it is noted that PFPS, due to extensor mechanism dysfunction, presents with the following signs and symptoms:

- Peripatella or retropatella pain that is worse with physical activity, negotiating stairs (especially going up) and prolonged sitting (Juhn 1999, Post 1998).
- Powers et al. (1996) and Delee et al. (1994) include kneeling, deep squats and isometric quadriceps femoris contractions as factors that aggravate the associated pain of PFPS.

Therefore it would seem that there could be a beneficial effect of patella mobilization in the management of PFPS, as suggested by the results of a number of studies (Rowlands 1999, Stakes 2000, Goldberg 2000).

Furthermore Rowlands (1999), Stakes (2000) and Goldberg (2000) suggest that restricted patella motion may be an integral feature of PFPS, as a causative and / or perpetuating factor.

Should this be the case, there are no studies that have investigated whether the severity of PFPS is proportional to the degree of restricted patella motion. Therefore given the evidence that limited patella motion could be one of the causes or perpetuating factors in PFPS, it is the purpose of this study to investigate the association between the severity of PFPS and the degree of limited patella motion in symptomatic patients.

This could assist in providing insight into the extent to which restricted patella motion is associated with the pain and dysfunction typical of PFPS and may help the practitioner to gauge more accurately the severity of PFPS and monitor improvements once treatment has been initiated.

1.2 AIM/ PURPOSE OF THE STUDY

1.2.1 To assess the associations between the severity (degree of clinical dysfunction) of PFPS (in terms of the objective and subjective clinical measures) and patella mobility (direction of mobility loss and degree of motion loss).

1.3 HYPOTHESIS

1.3.1 There is a relationship between the severity of PFPS and the objective clinical findings which is significant

1.3.2 There is a relationship between the severity of PFPS and the subjective clinical findings which is significant

1.3.3 There is a relationship between the severity of PFPS and the degree and direction of restriction of patella motion.

CHAPTER TWO:
REVIEW OF RELATED LITERATURE

2.1 INTRODUCTION

This chapter is concerned with the available literature on anatomy of the patellofemoral joint, biomechanics of the patellofemoral joint, patellofemoral pain syndrome (PFPS) as well as assessment of the patellofemoral joint in patients with PFPS.

In respect of PFPS, the literature review will consider current etiology, diagnosis and treatment of PFPS. Bergman's technique for motion palpation of the patella will also be discussed.

2.2 ANATOMY OF THE PATELLOFEMORAL JOINT

2.2.1 Patellofemoral joint:

The patella is a sesamoid bone contained within the quadriceps femoris tendon (Lumley et al. 1987:297, Reid 1992: 347, Delee and Drez 1994: 1164 – 1166, Scuderi 1995: 16-20, Fulkerson 1997: 15, Moore and Dalley 1999: 532-534, Cailliet 1992, 27-33), which is formed by the superficial layer of the rectus femoris, the middle layer from tendons of the vastus lateralis and medialis, and a deep layer from the vastus intermedius (Lumley et al. 1987:297, Fulkerson et al. 1997, Moore and Dalley 1999: 532-534).

As a result of their distribution, some of the tendon fibers pass anteriorly to the patella, some attach to the superior margin, and some to the lateral margins. Fibers both from the medial and lateral aspects fan out to attach to the femoral condyles, while others pass to the capsular collateral ligaments of the knee joint (Lumley et al. 1987:297, Cailliet 1992: 27, Scuderi 1995: 16-20, Fulkerson 1997: 13-14).

The uncovered undersurface of the patella is covered with cartilage and glides on the cartilage of the femoral condylar notch (Cailliet 1992: 31-33, Reid 1992: 347-349, Scuderi 1995: 31-34, Fulkerson 1997: 27-31). The facets, there are several: three medial, three lateral and a nonarticular facet on the medial side, the “odd facet, of the patella make contact with the femoral condyles differently at varying degrees of flexion:

- At 20˚ of flexion the contact is a small area of the upper pole of the patella.
- By 45˚ of flexion the middle portion of the lateral facets make contact with the femoral condyles. In addition, at 45˚ of flexion the patella is the only tissue separating the quadriceps from the femoral condyles, and thus, only a small point of contact of the patella sustains all the weight of the body during knee flexion at this angle (Cailliet 1992: 32-33), and
- At 90˚ of flexion the contact is entirely on the inferior lateral facet.
- The medial facet makes contact with the medial femoral condyle after 135˚ of flexion when the patella has undergone rotation and is in the intercondylar notch (Reid 1992: 347-349, Scuderi 1995: 31-34, Fulkerson 1997: 27-31).

The third or odd facet (medial) on the medial aspect of the ridge, separating the facets does not make contact with the femoral condyles until 135˚ of flexion (Reid 1992: 347-349, Scuderi 1995: 31-34, Fulkerson 1997: 27-31).

As a result of this 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 infrapatellar surfaces and the femoral condyles as the knee flexes and extends (Reid 1992: 347-349, Scuderi 1995: 31-34, Fulkerson 1997:27-31), which may result in aberrant motion or biomechanics.

2.2.2 Anatomy of the Quadriceps Femoris Muscle

This extensive muscle mass forms the bulk of the anterior region of the thigh. It is divided into four separate muscles, all attached inferiorly to the upper border and the sides of the patella (Lumley et al. 1987:292-293, Moore and Dalley 1999: 532-534):

(a) **Rectus femoris**- this muscle lies superficially along the middle of the thigh.

Attachments

SUPERIOR- by the two heads

(i) straight head- from the anterior inferior iliac spine.

(ii) reflected head- from the ilium just above the acetabulum.

INFERIOR- by a tendon into the upper border of the patella.

(b) **vastus lateralis**- lies deep to the rectus femoris and also covers the lateral side of the femoral body.

Attachments

SUPERIOR- by an aponeurosis from the lateral side of the greater trochanter and the tibial tuberosity, and the lateral lip of the linea aspea.

INFERIOR- its tendon passes to the lateral side of the patella and lends with the fibres of rectus femoris.

(c) **vastus medialis**- lies deep to rectus femoris and also covers the medial side of the femoral body.

Attachments

SUPERIOR- by an aponeurosis from the spiral line joining the lesser trochanter to the linea aspera, the medial lip of the linea aspera and the medial supracondylar line of the femur.

INFERIOR- the muscle passes to the medial side of the patella and blends with the fibres of rectus femoris. The lower fibres are almost horizontal.

(d) **vastus intermedius**- this muscle covers the front of the femur deep to the rectus femoris and lies between the other two vasti.

Attachments

SUPERIOR- the anterior and lateral surfaces of the upper part of the femoral body

INFERIOR- to the upper border of the patella deep to the three previous three muscles.

The four portions of the quadriceps are thus attached to the upper border and the sides of the patella forming a single musculotendinous expansion. From the apex of the patella a strong tendon, the **patellar ligament**, descends and is attached to the tibial tubercle. On each side of the patellar ligament the capsule of the joint is formed largely by downward fibrous expansions of the quadriceps (the **retinacular**) through which the muscles gain attachment to the tibial condyles.

The **iliotibial tract** is a broad thickening of the fascia lata passing from the outer lip of the iliac crest to the anterolateral aspect of the upper end of the tibia. The tract receives the attachments of the gluteus maximus and fascia latae and these muscles, acting through it, extend and stabilize the knee joint.

Nerve supply

Each part is supplied by branches of the femoral nerve.

Actions

The whole muscle is a powerful extensor at the knee joint. Rectus femoris also flexes the hip joint. The lower fibres of vastus medialis prevent the patella moving too far laterally when the lower leg is being extended at the knee.

2.3 BIOMECHANICS OF THE PATELLOFEMORAL JOINT

2.3.1 Function of the Patella

The patella's most important function is facilitating extension of the knee by increasing the distance of the extensor apparatus from the axis of flexion and extension of the knee (Reid 1992: 347, Scuderi 1995:25; Fulkerson 1997:23-24). Throughout the entire range of motion, the patella increases the force of extension by as much as 50% (Fulkerson 1997:24), with the hyaline cartilage (with its low compressive stiffness and coefficient of friction), being indispensable for transmitting the quadriceps force around the distal femur to the tibia and therefore assists in allowing the extensor mechanism to function smoothly (Fulkerson 1997:23). Healthy cartilage also 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 (Reid 1992:347, Fulkerson 1997:24), at the cartilage itself is not innervated.

Essentially the patella acts as a guide for the quadriceps tendon in centralizing the divergent input from the four muscles of the quadriceps femoris, transmitting these forces to the patellar tendon, into the tibia (Reid 1992: 347, Cailliet 1992: 27-29, Delee and Drez 1994: 1164 – 1166, Scuderi 1995: 16-20, Fulkerson 1997: 24). This decreases the possibility of dislocation of the extensor apparatus and controls the capsular tension of the knee. The patella also protects the cartilage of the trochlea as well as the condyles by acting as a bony shield (Reid 1992: 347, Fulkerson 1997: 24). It is also well known that tendons (as in the infrapatella tendon) are capable of withstanding great tensile loads, but not high friction or compression (Fulkerson 1997: 24). The presence of the patella in the

extensor apparatus protects the tendon from friction and permits the extensor apparatus to tolerate high compressive loads (Scuderi 1995: 34-35, Fulkerson 1997: 24).

Therefore as can be seen from the preceding literature, the most important role of the patella is in extension of the knee. Trauma or surgical intervention in the form of a patellectomy can result in weakened extension of the knee or even incomplete knee extension. Some muscle atrophy inevitably follows patellectomy despite sustained and intensive physical therapy (Scuderi 1995: 26, Fulkerson 1997: 24).

In the early stages however, potential etiologic factors of AMI could include osteoarthritis (Arokoski et al. 2002), joint effusion (Hopkins et al. 2002), immobilization (Reid 1992: 49), pain (Hopkins et al. 2002) and traumatic injury / damage to joint structures (Hopkins et al. 2002 and Hurley et al. 1994). However, the most common denominator appears to be joint injury. Following joint injury the patient experiences some deficits in range of motion and immobilization (Hopkins and Ingersoll 2000). Immobilization could result from swelling, pain and/or muscle spasm (Hopkins and Ingersoll 2000), where AMI is thought to be responsible for initiating a negative cycle that leads to eventual atrophy (Hopkins and Ingersoll 2000).

2.4 INTRODUCTION TO PATELLOFEMORAL PAIN SYNDROME

2.4.1 Definition of PFPS

PFPS is defined as anterior knee pain arising from dysfunction of the patellofemoral articulation including its connective and contractile tissues. PFPS is a syndrome comprising the following signs and symptoms (Puniello 1993, Wood 1998):

- Anterior knee pain.
- An imbalance of the extensor mechanism of the knee.
- Instability of the patellofemoral joint.
- Inflammation of the surrounding tissues, or any combination thereof.

The patellofemoral pain syndrome as defined has posed many unsolved mysteries and challenges in the medical community and remains a difficult condition to treat (Kolowich et al. 1990, Reid 1993). This is due to its multifactorial etiology (Walsh 1994, Davidson 1993).

Patellofemoral Pain Syndrome (PFPS) is a common knee problem, affecting adolescents, especially females, young adults and sports men and women (Devereaux 1984, Sandow et al. 1985, Meyer et al. 1990, Wilson 1990, Boucher et al. 1992, Davidson 1993, Thomee et al. 1995, Heng et al. 1996). The cause of PFPS appears to be an enigma with a variety of possible etiologies being sited in the literature: anatomical abnormalities, misalignments or anatomical predisposition (Walsh 1994) and repetitive trauma (Davidson 1993). The main biomechanical function of the patella is to increase the effective lever arm of the

quadriceps femoris muscle in affecting extension or resisting knee flexion (Callaghan et al. 1996). The current trend in the literature suggests an extensor mechanism dysfunction as the most probable etiology (Galantly et al. 1994, William 1998, Juhn 1999).

2.4.2 Incidence & Prevalence of PFPS

McConnel (1986) states that PFPS affects 25% of the general population. In clinics dealing with musculoskeletal complaints, PFPS may account for almost 10% of visits and 20 to 40% of all knee complaints (Kannus et al. 1999).

In a study of 196 consecutive injuries seen at the University of Cape Towns' SAB Sports Injury Clinic, Pinshaw et al. (1984) reported a 22% incidence of runner's knee, 44% of injuries was the knee and 50% of which were due to PFPS. Van Mechelen (1992) reported that running injuries to the knee and leg represented 70 to 80% of all injuries and that 25% of all knee injuries to the knee are caused by PFPS.

Dehaven et al. (1986) reported the incidence of PFPS to be 19, 6 % in female collegiate athletes and 7, 4 % amongst their male counterparts. Salem et al. 2001) reported that those athletes who participate in jumping and running activities are at a greater risk of developing patellofemoral injuries. PFPS frequently becomes chronic and may force subjects to limit physical activity (Kannus et al. 1999).

From the study undertaken by Pinshaw (1984), the South African' incidence and prevalence of PFPS is in the norm. There was however a greater number of individuals with PFPS (50%) compared with international standards (20 to 40%) among those who complained of knee pain.

2.4.3 Differentials for knee pain

For the purposes of this research, the following localised syndromes have been excluded because of the specific criteria for Patellofemoral Pain Syndrome:

Articular dysfunction, including tears or strains from the ligaments; menicial injury; tendonosus/ tendonitis or bursitis:

- Meniscial (medial and lateral) injury due to overuse or trauma. The signs and symptoms being similar. The most significant sign being joint line pain or retropatella pain. There is an associated "open/ closed locking of the knee". This must be differentiated from plica syndrome. (Cailliet 1991: 76-84, Reid 1992: 311-319, Fulkerson 1997: 119). Cruciate ligament tears which can lead to instability and retropatella pain.
- Bursitis of the infrapatella, anserine and iliotibial. That can lead to knee pain (Calliet 1992: 209-211, Reid 1992: 419-422).
- Tendonosis/ tendonitis of the infrapatella tendon. Pin point pain at the apex of the patella, there may be associated swelling (Reid 1992: 78-80).

History of arthritides such as:

- Osteoarthritis, which has a history of posterior knee pain with associated swelling, joint dysfunction and pain (Davidson's 1995: 878-879, Scuderi 1995: 60-61).

- Rheumatoid Arthritis which affects joint function and joint derangement (Davidson's 1995: 891, Scuderi 1995: 60-61).
- Gout causing swelling, redness, decreased function and pain of the joint (Cailliet 1992:207, Davidson's 1995: 885-886).

2.5 ASSESSMENT OF THE KNEE – INCLUDING MOTION PALPATION

The knee can be assessed using orthopaedic tests to assess if the individual had PFPS and to discount other pathologies of the knee, included in this assessment is the evaluation of patella motion.

The orthopedic tests that can be utilised in the assessment of the knee are list as follows according to Magee (1997: 519-591.):

- Instability- valgus/ varus stress tests (in extended and resting position), Lachman's, anterior draw, posterior sag sign, posterior draw, Slocum's (for anterolateral/ anteromedial rotary instability), Macintosh and Houghstons (posterolateral/ posteromedial rotary instability).
- Meniscal pathology- MacMurry, Anderson's Grind, bounce-Home and Apley's were performed.
- Plica tests- Mediopatellar plica, Houghston's Plica and Plica stutter.
- Swelling- Brush / stroke test and Patella tap test.
- Patellofemoral Pain Syndrome tests- Clarke's sign, Passive patella tilt, Waldron's test and Mcconnell's.

- Other tests performed- Wilson's test, Fairbank, test, Noble compression test and Quadriceps contusion test.

A neurological examination of the myotomes, dermatomes and reflexes were performed. The subjective, objective readings were also performed.

In addition to this motion palpation (MP) is one of the main assessment tools used in manipulative therapy, and motion palpation of the knee is an integral part of the diagnosis and continued assessment of PFPS (Schafer et al. 1989, Lewit et al. 1993).

The most commonly utilised motion palpation technique is that of Bergman's technique, which includes the assessment of the motion of the patella at full extension and at the resting position (15). The examiner grasps the patella between thumb and forefinger (of both hands), on all motions medial to lateral, lateral to medial, superior to inferior and inferior to superior. On all motion the quality of movement and direction of restriction is recorded (Schafer and Faye, 1989: 396).

Nevertheless Lewit et al. (1993) stated that motion palpation is subjective and not a reliable enough assessment tool. Studies on motion palpation of extremities since then (Brangtingham et al. 1997, Chesworth et al. 1998) have however shown significant inter- and intra-examiner reliability. Bezuidenhout (2002) conducted an inter- and intra-examiner reliability study on motion palpation of the patella in asymptomatic subjects, and suggested that future research into this topic should include symptomatic patients. Bezuidenhout (2002) recommended that further research include symptomatic individuals.

CHAPTER THREE:

MATERIAL AND METHODS

3.1 INTRODUCTION

This chapter gives a description of the specific method followed in the experimental procedure.

3.2 MEASUREMENTS AND OBSERVATIONS

3.2.1The Data

The data consisted of both primary and secondary data.

3.2.2 The Primary Data

The primary data consisted of the following:

- Standardized Case History (Appendix I)
- Abridged Physical Examination (Appendix J)
- Knee Regional Examination (Appendix K)
- Numerical Pain Rating Scale (Appendix D)
- Objective Pain Rating Scale for Patellofemoral Pain Syndrome (Appendix F)
- Mechanical Algometer Reading (Appendix E)
- Patellofemoral Joint Evaluation Scale (Appendix G(a) and G(b))
- Patella Motion Palpation Record Sheet (Appendix H)

3.2.3 The Secondary Data

The secondary data was obtained from various sources: journal articles, textbooks, periodicals and medical search engines on the Internet (Pubmed, Mantis, Medscape and Medline).

3.3. STUDY DESIGN

This study was a quantitative, non- intervention, clinical assessment.

3.4 THE PARTICIPANTS

The 60 participants consisted of volunteers suffering from Patellofemoral Pain Syndrome residing in Kwazulu-Natal Province in the Republic of South Africa.

3.4.1 Advertisement for participant recruitment

The public was informed of the study by advertising in local newspapers, advertisements placed at the Durban Institute of Technology, local campuses, gyms, sports clubs and postal drops.

The advert (Appendix L) asked for participants from the ages of 16 and 55 years of age suffering from pain in or around the knee. All prospective participants were interviewed telephonically by the examiner to exclude subjects that did not fit the inclusion criteria for the study.

3.4.2 Sampling and group allocation of Participants

Convenience sampling was used for the first 60 participants who met the inclusion criteria. The 60 participants were divided into three groups of 20. These groups being determined by the time they spend running per week. Group one consisted of individuals who ran less than 1 hour per week; group two one to six hours per week and group three those who ran greater than six hours per week.

The sampling was non-probability, purposive, convenience sampling. In this type of sampling procedure, there is a deliberate subjective choice in drawing a 'representative' sample, which can eliminate anticipated sources of distortion. However, there remains the risk of unrecognized sources of distortion and subjective bias (Barnett 1991).

All patients received a "Letter of Information" (Appendix B) and an "Informed Consent Form" (Appendix C) to read and sign, to protect their interests and to ensure that they understood the research completely.

3.4.3 Inclusion criteria for participants.

1. Only subjects aged 16 to 55 years were included (Devereaux 1984, Sandow et al. 1985, Meyer et al. 1990, Wilson 1990, Boucher et al. 1992, Davidson 1993, Thomee et al. 1995, Heng et al. 1996).
2. Only subjects suffering from PFPS as defined by Thomee et al. (1995) were included. Subjects must have had localized peri- or retropatella pain and say yes to at least 2 out of the following 5 questions (Powers et al. 1996). 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?

3.4.4 Exclusion criteria for participants, as defined by Maitland (1977), Wilson (1990) and Thomee et al. (1995):

1. Bilateral knee pain specific for PFPS.
2. A history of recurrent patellar subluxation or dislocation.
3. A history of intermittent or persistent knee joint swelling.
4. 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 fat pad syndrome.
5. Any systemic arthritide that may affect the knee e.g. Rheumatoid Arthritis and gout.
6. Having undergone any knee surgery within the past 2 years.
7. Participants may not receive any chiropractic, physiotherapy treatment, or massage until after the second assessment.
8. Breastfeeding/ pregnant patients in the last trimester could not be part of this study.

3.5 CLINICAL PROCEDURE

At the initial consultation the individuals underwent a Case History (Appendix I), an abridged Physical examination (Appendix J) and a Knee Regional Examination (Appendix K), all subjective and objective data, except the motion palpation findings, were then recorded by the researcher. At the second consultation, within one week of the first, the motion palpation, recorded on the motion palpation sheet (Appendix H) by five examiners using Bergmans technique, were then recorded. The individual examiners reviewed each individual in a random order.

3.6 SUBJECTIVE MEASUREMENTS

Subjective data was recorded using the Numerical Pain Rating Scale (NRS) (Jenson et al. 1986) (Appendix D). The NRS was used to record the level of pain intensity; the participant was feeling, at that moment, at the initial consultation.

The NRS operates by giving the participant a scale of zero to ten, zero being no pain and ten being the worst pain that the participant has ever experienced. Liggins (1989), states that the NRS is the most appropriate method of rating pain intensity without comparison. Jenson et al. (1986) found that the NRS was a practical and an accurate tool for the measurement of pain intensity, and was statistically sensitive in clinical trials.

3.7 OBJECTIVE MEASUREMENTS.

Objective data was recorded using the Objective Pain Rating Scale for Patellofemoral Pain Syndrome (OPRS) (Appendix F) and a mechanical algometer reading (Appendix E).

3.7.1. Objective Pain Rating Scale for Patellofemoral Pain Syndrome

The OPRS (Appendix F) consisted of orthopaedic examination (Reid 1996: 369, Magee 1997: 566), and stress tests for the pathognomonic signs of PFPS (myofascial component) (Thomee et al. 1995), pain being a positive indicator. Each positive answer was given a score of 1; a negative answer was given a score of 0. The greatest score the participant could achieve was 9.

3.7.2 Mechanical Algometer

A mechanical algometer reading, for pain tolerance, was taken at three points (Appendix E) on the infra-patella tendon (most tender point), and on the medial and lateral retinaculum (most tender point). Nussbaum et al. (1998) reported the reliability of clinical pressure pain algometric measurements. Reeves et al. (1986) and Fischer (1986 and 1987) showed the validity and reliability of the pressure algometer in measuring pressure (myofacial trigger) point sensitivity. A study by Antonaci et al. (1998) pain perception thresholds were assessed with a mechanical pressure algometer. Three readings were taken, at the medial and lateral retinaculum and infrapatella tendon, at the participant's pain tolerance, at each site and the average of each recorded. The mechanical algometer chosen for this study was a Wagner Instrument 4 star, FDK 20 model.

3.8 OBJECTIVE AND SUBJECTIVE MEASUREMENT.

Subjective and objective data was collected using the Patellofemoral Joint Evaluation Scale (Shea et al. 1992) (Appendix G (a) and G (b)).
The scale has both objective and subjective components. Yeoman (2000) stated that subjective tools quantify a patient's disability or functional capacity while objective tools or tests quantify a patient's functional losses or impairments.

The PJES is subjective and objective scale out of 65, where the functional results are:

- 55-65 excellent results,
- 45-54 good,
- 35-44 fair,
- less than 35 is poor.

3.9 MOTION PALPATION FINDINGS

The five examiners were given a workshop to standardize the motion palpation technique (Bergmans (Schafer and Faye, 1989: 396)); this was held over two days. The examiners were taught to evaluate the patellofemoral articulation for medial to lateral glide, lateral to medial glide, superior to inferior glide, and inferior to superior glide with the patient lying supine and the involved leg straight in passive knee extension. The borders of the patella were contacted with both thumbs and a stress was applied to the patella from

- medial to lateral (ML),
- lateral to medial (LM),

- superior to inferior (SI) and
- inferior to superior (IS),

feeling for a comparative amount of movement from side to side as well as a springing quality of movement. The examiners were introduced to the motion palpation record sheet (Appendix H) and were instructed on how to record their findings. There was a grading for general patella mobility and was recorded as normal mobility, mild/ moderate restricted and severely restricted. The grading of patella motion was recorded as normal mobility (A), mild/ moderate restricted (B) and severely restricted (C).

3.10 STATISTICAL ANALYSIS.

The clinical data was collected after the first consultation (subjective, objective and subjective and objective data) and second (motion palpation findings) consultation.

Statistical Analysis was conducted using the SPSS (version 9) software suite. This Statistical software program was manufactured by SPSS Inc, 444N. Michigan Avenue, Chicago, Illinois, USA.

Various Descriptive and Inferential Statistical techniques were used. The Descriptive procedures used were various tables and graphs and a few summary statistics including but not limited to means and proportions.

Inferential Statistics included various correlation testing techniques, included using ANOVA for age, with post-hoc Bonferroni and Chi Square for gender and race, Univariate ANOVA was used for NRS, Post Hoc Tests were used for group multiple comparisons.

Spearman's Rank Order Correlation (for all groups) was used for the nonparametric correlation between NRS and PJES, Algometer and OPRS and OPRS and PJES,

Pearson's Product Moment Correlation Coefficients (for all groups) was used for the parametric correlation between Algometer and OPRS, Algometer and PJES, OPRS and PJES.

All correlation tests used a type 1 error with a significance level of α = 0.05.

This associational testing process (between the severity of PFPS and patella mobility) was conducted by each location. Spearman's and Pearson's correlational testing techniques were applied to numerous sets of data. These tests were applied to individual and grouped pain and functional measurement values.

CHAPTER FOUR:

RESULTS AND DISCUSSION

This chapter involves the discussion of the demographic data (age, race and gender) and the results after statistical analysis of the data obtained from the subjective (NRS) and objective (Algometer readings, Objective Pain Rating Scale for Patellofemoral Pain Syndrome and Motion Palpation results). Subjective and objective data were collected using the Patellofemoral Joint Evaluation Scale. Problems encountered through the course of this study are also discussed in this chapter.

The results will be discussed in two parts:

- Demographic data
- Correlation comparisons

4.1 Demographic Data.

The following tests were used: ANOVA for age, and post-hoc Bonferroni and Chi Square for gender and race.

4.1.1 AGE

Table 1: Mean age for groups 1, 2 and 3

GROUP	Mean	N	Std. Deviation
1	33.15	20	8.177
2	27.65	20	8.975
3	33.75	20	8.843
Total	31.52	60	8.962

The 60 participants were placed in three groups of 20, depending on the amount of training they underwent per week. Group 1 consists of individuals who were sedentary (who ran less than 1 hour per week). Their mean age was 33.15

years. Group 2 consisted of individuals who ran 1 to 6 hours per week. Their mean age was 27.65 years. Group 3 consisted of individuals who ran more than 6 hours per week. Their mean age was 33.75 years. Literature suggests that PFPS is a common knee problem, affecting adolescents, especially females, young adults and sports men and women (Devereaux 1984, Sandow et al. 1985, Meyer et al. 1990, Wilson 1990, Boucher et al. 1992, Davidson 1993, Thomee et al. 1995, Heng et al. 1996), which is frequently seen in young adults with individuals mostly between the ages of 10-20 years (Kannus et al. 1999).

In this study the younger ages were taken into consideration starting at 16 and up to and including 55. The mean age of the sample population (N = 60) was 31.52 years, this is older than the age range of greatest frequency as suggested by Kannus et al. 1999. This could be due to the specific constraints, group 1 being sedentary and groups 2 and 3 being runners. Group 2 was aimed at middle distant runners and group 3 at marathon and ultra distant runners.

4.1.2 Gender

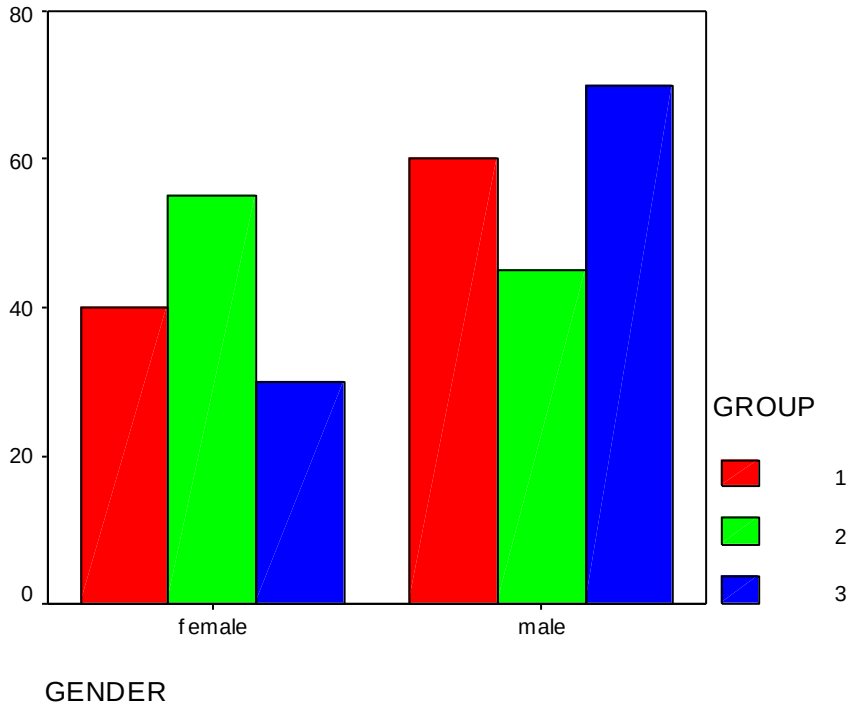

Fig. 1: Gender distribution in sample population.

There was greater male participation in Groups 1 and 3, while females were the majority in group 2. In the literature females have a greater predisposition to PFPS than males (Devereaux 1984, Sandow et al. 1985, Meyer et al. 1990, Wilson 1990, Boucher et al. 1992, Davidson 1993, Thomee et al. 1995, Heng et al. 1996). In later statistical findings in this study, this is supported, in that group 2 appear to be more clinically congruent with PFPS in terms of the NRS, OPRS, PJES and Algometer.

The possibility may be that men delay in seeking treatment for their condition, which therefore increases the chances of a worsened clinical presentation, as the condition may develop into an AMI. The higher percentage of males participating in this study does however correlate with findings in other South African studies on PFPS (Stakes 2000, Clifton 2003, Dippenaar 2003).

4.1.3 Race

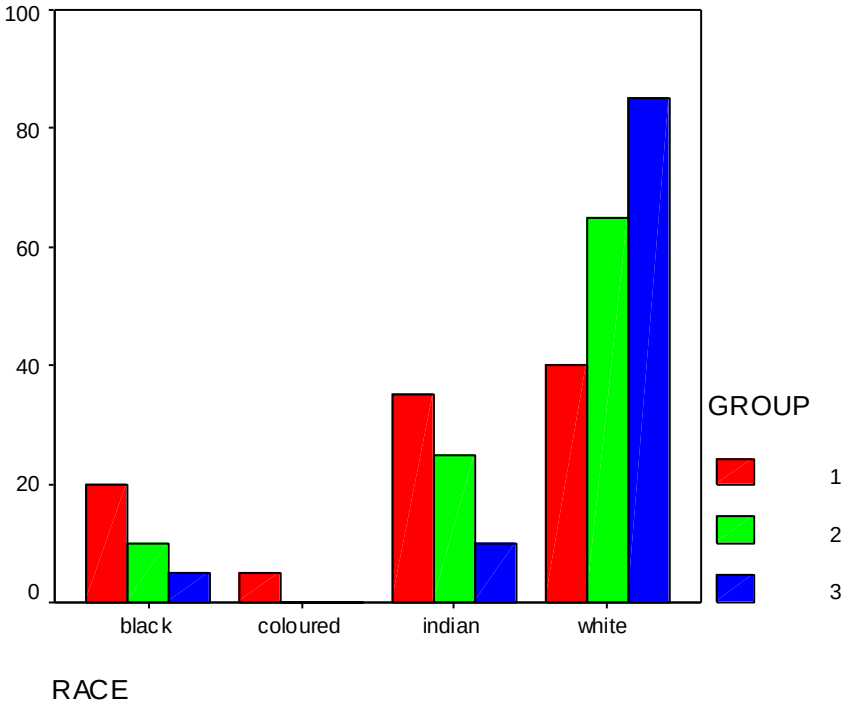

Fig. 2: Race distribution.

There was a majority of white participants in all three groups, followed by indians and then blacks. There was no correlation with the distribution of race, with the demographics of race in South Africa. This could be accounted for in that the selection of individuals was by means of consecutive convenience sampling, which relied on patient self selection for the research. Furthermore the process was specific for runners (particularly in groups 2 and 3), which resulted in a defined subgroup of the South African' population participating in the study. Therefore the population was not representative of the demographics of the South African population, but may be representative of the patient population of the Durban Institute of Technology Chiropractic Clinic or the population group under study (runners); which can only be verified through further research.

4.2 Correlation Data.

4.2.1 Correlation between Motion Palpation (MP) and the NRS, Algometer, PJES, OPRS and General Motion and Motion Palpation

4.2.1.1 Correlation between NRS and MP

Table 2: Tests of Between-Subjects Effects (Dependent Variable: NRS)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	152.484(a)	29	5.258	2.149	.021
Intercept	768.421	1	768.421	314.000	.000
GROUP	42.825	2	21.412	8.750	.001
Average general motion	3.696	2	1.848	.755	.479
Average superior to inferior	.326	1	.326	.133	.718
Average inferior to superior	.896	1	.896	.366	.550
Average medial to lateral	.032	1	.032	.013	.910
Average lateral to medial	.009	1	.009	.004	.952
Error	73.416	30	2.447		
Total	2107.500	60			
Corrected Total	225.900	59			

a R Squared = .675 (Adjusted R Squared = .361)

Only group was significantly influenced by NRS. There was no association between MP variables and NRS after controlling for group.

4.2.1.2 Correlation between Algometer and MP

Table 3: Tests of Between-Subjects Effects (Dependent Variable: Infrapatella tendon)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	53.871(a)	29	1.858	.499	.968
Intercept	888.202	1	888.202	238.357	.000
group	1.994	2	.997	.268	.767
Average general motion	6.818	2	3.409	.915	.411
Average superior to inferior	.046	1	.046	.012	.912
Average inferior to superior	.308	1	.308	.083	.776
Average medial to lateral	2.956	1	2.956	.793	.380
Average lateral to medial	.244	1	.244	.066	.800
Error	111.791	30	3.726		
Total	2365.080	60			
Corrected Total	165.662	59			

a R Squared = .325 (Adjusted R Squared = -.327)

The infrapatella tendon algometer reading was not associated with group

Table 4: Dependent Variable: Medial retinaculae algometer reading

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	73.010(a)	29	2.518	.725	.805
Intercept	626.656	1	626.656	180.510	.000
group	2.825	2	1.412	.407	.669
Average general motion	7.660	2	3.830	1.103	.345
Average superior to inferior	.479	1	.479	.138	.713
Average inferior to superior	4.255	1	4.255	1.226	.277
Average medial to lateral	.024	1	.024	.007	.934
Average lateral to medial	6.388	1	6.388	1.840	.185
Error	104.148	30	3.472		
Total	1703.069	60			
Corrected Total	177.158	59			

a R Squared = .412 (Adjusted R Squared = -.156)

There was nothing associated with medial retinaculae algometer reading

Kruskal-Wallis Test – Nonparametric test

Table 5: Mean rank in total population for the lateral retinaculae algometer reading.

Ranks

	group	N	Mean Rank
lateral	1	20	25.18
	2	20	30.80
	3	20	35.53
	Total	60	

Table 6: Test statistics for lateral retinaculae algometer reading

Test Statistics[a,b]

	lateral
Chi-Square	3.522
df	2
Asymp. Sig.	.172

a. Kruskal Wallis Test

b. Grouping Variable: group

Nonparametric were done as there were less than 20 individuals and not normally distributed. The lateral retinaculae algometer reading was not associated with group. Multivariate tests could not be done as the lateral retinaculae algometer reading is non parametric data.

Based on the non parametric test / Kruskal-Wallis test (which is the equivalent of the ANOVA) and the univariate ANOVA, it was found that the respective group results yielded no relationship between the 2 clinical outcomes of pain (as measured by the algometer) and the motion palpation findings which where denoted as direction (average SI, IS, ML and LM) and severity of the restriction(s) found by the examiners.

This supports the assertion that the algometer reading of the retinacular / infrapatella tendon is either not a suitable tool for measuring the pain of PFPS or alternatively that the pain also has an origin away from the retinacular / infrapatella tendon.

4.2.1.3 Correlation between PJES and MP

Table 7: Tests of Between-Subjects Effects (Dependent Variable: PJES)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2912.243(a)	29	100.422	1.263	.265
Intercept	50970.567	1	50970.567	640.828	.000
group	502.918	2	251.459	3.161	.057
Average general motion	11.151	2	5.576	.070	.932
Average superior to inferior	187.195	1	187.195	2.354	.135
Average inferior to superior	46.030	1	46.030	.579	.453
Average medial to lateral	62.533	1	62.533	.786	.382
Average lateral to medial	.400	1	.400	.005	.944
Error	2386.157	30	79.539		
Total	145852.000	60			
Corrected Total	5298.400	59			

a R Squared = .550 (Adjusted R Squared = .114)

There was no statistical significance between MP and PJES

No correlation exists with the exception of PJES for the total group when compared to restrictions noted. This could possibly be due to the fact that PJES measures functional ability and motion palpation measures one factor that could affect the functional ability of the individual.

4.2.1.3.1 Correlation between PJES and Oneway Direction (Medial to Lateral)

Table 8: ANOVA: Correlation between PJES and medial to lateral motion

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	588.833	2	294.417	3.563	.035
Within Groups	4709.567	57	82.624		
Total	5298.400	59			

PJES is significantly statistically different between the Medial to Lateral motion groups, A, B and C (restriction description). Post hoc tests were not performed for PJES because at least one group has fewer than two cases. These figures were interpreted with caution.

Restriction description

A = Normal mobility

B = Mild to moderate restriction

C = Severe restriction

4.2.1.4 Correlation between OPRS and MP

Table 9: Correlation between OPRS and MP: in all groups

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	97.669(a)	29	3.368	1.424	.170
Intercept	615.800	1	615.800	260.450	.000
Group	20.528	2	10.264	4.341	.022
Average general motion	2.997	2	1.499	.634	.538
Average superior to inferior	17.277	1	17.277	7.307	.011
Average inferior to superior	.000	1	.000	.000	.989
Average medial to lateral	9.737	1	9.737	4.118	.051
Average lateral to medial	5.341	1	5.341	2.259	.143
Error	70.931	30	2.364		
Total	1854.000	60			
Corrected Total	168.600	59			

a R Squared = .579 (Adjusted R Squared = .173)

After controlling for group, there was a significant association between average SI and OPRS (p = 0.011) and a borderline association between average ML and OPRS.

For all individuals participating in this study, where total group (N = 60), there was a significant statistical association between motion palpation and the OPRS (p = 0.022) per group to which the individuals where allocated. No statistically significant relationship exists between the direction or degree of restriction and OPRS findings

This implies that motion palpation restrictions of all groups were highly correlated to the OPRS reading, which is congruent with:

- PFPS playing a role in limiting patella motion (Rowlands, 1999)
- Myofascial / muscular pain syndromes restricting the motion of the patella (4.2.3, 4.2.5),

as per the previous hypotheses which link OPRS and PFPS and OPRS and myofascial / muscular pain syndromes.

In addition to and support of the above and after controlling for group, there was a further significant association between:

- average SI and OPRS (p = 0.011):
  - The correlation supports the assertion that there seems to be a pull of the patella into a superior position (without being a patella alta). This could be as a result of
    - The pull of the quadriceps femoris muscle superiorly, as a result of muscle hypertonicity as could be associated with the presence of a myofascial / muscular pain syndrome.

4.2.1.4.1 Correlation between OPRS and MP: T-Test: group 1

Table 10: group statistics

Group Statistics

	average SI	N	Mean	Std. Deviation	Std. Error Mean
OPRS	A	11	4.455	1.1282	.3402
	B	9	5.778	1.4814	.4938

Table 11: Independent sample test

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
OPRS	Equal variances assumed	2.344	.143	-2.270	18	.036	-1.3232	.5830	-2.5480	-.0984
	Equal variances not assumed			-2.207	14.739	.044	-1.3232	.5996	-2.6032	-.0432

Group 1: OPRS is statistically significantly higher in average SI B (mild /moderate restriction) group than A (normal mobility) group.

- In furtherance of the above hypothesis, group one exhibited:
  - Mild to moderate restriction of the patella which was highly significant when compared to normal motion of the patella, which was not present for groups 2 and 3.
  - IS restrictions which correlated with average general mobility (although the interpretation and extent of the correlation was

questioned due to statistical limitation)

Restriction description

A = Normal mobility

B = Mild to moderate restriction

C = Severe restriction

These results suggest that group 1 individuals have a higher degree of restriction, which is most likely in the SI direction as compared to groups 2 and 3 which reported direction, but no correlation to the degree of restriction. It is therefore implied that group one has factors related to it that make it different in terms of the pathomechanics of the relevant syndrome (either PFPS or myofascial / muscular pain syndromes) than groups 2 and 3, which could be

- Due to lifestyle (sedentary)
- Erratic exercise patterns ("weekend warrior") leading to lack of conditioning, muscular strength and tone, as well as the possibility of an imbalance between hamstring and quadriceps femoris muscles,

as these are associated with myofascial / muscular pain syndromes due to muscle overload, fatigue or tension (Travell and Simons 1983). This therefore supports the assertion that group 1 has a greater myofascial / muscular pain syndrome as a component of or precursor to PFPS.

A borderline association:

- between average ML and OPRS (p = 0.051)
  - From the literature this correlation is supported by the fact that PFPS has as part of the syndrome, the imbalance between the VMO and VL muscles.

    The imbalance creates differing pull forces on the patella placing the patella in a position that is outside of its normal / congruent position in the intercondylar groove, thereby limiting either ML or LM movement of the patella.

4.2.1. 5 Correlation between average General mobility and average Direction of Restriction

The following tables have been cross tabulated, with the average general mobility and with the average SA, IS, ML and LM which has been stratified by group. Chi square tests are given for each crosstab for each group. Fisher's exact tests are given for 2 by 2 tables and have been used in preference to Chi sq where appropriate.

Table 12: Average general mobility * average SI * for Group

GROUP				average SI		Total
				A	B	
1	Average general mobility	1	Count	3	2	5
			% within Average general mobility	60.0%	40.0%	100.0%
		2	Count	8	7	15
			% within Average general mobility	53.3%	46.7%	100.0%
	Total		Count	11	9	20
			% within Average general mobility	55.0%	45.0%	100.0%
2	Average general mobility	1	Count	8	2	10
			% within Average general mobility	80.0%	20.0%	100.0%
		2	Count	3	6	9
			% within Average general mobility	33.3%	66.7%	100.0%
		3	Count	0	1	1
			% within Average general mobility	.0%	100.0%	100.0%
	Total		Count	11	9	20
			% within Average	55.0%	45.0%	100.0%

			general mobility			
3	Average general mobility	1	Count	5	0	5
			% within Average general mobility	100.0%	.0%	100.0%
		2	Count	8	7	15
			% within Average general mobility	53.3%	46.7%	100.0%
	Total		Count	13	7	20
			% within Average general mobility	65.0%	35.0%	100.0%

Table 13: Chi-Square Tests

GROUP		Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
1	Pearson Chi-Square	.067(b)	1	.795		
	Continuity Correction(a)	.000	1	1.000		
	Likelihood Ratio	.068	1	.795		
	Fisher's Exact Test				1.000	.604
	Linear-by-Linear Association	.064	1	.800		
	N of Valid Cases	20				
2	Pearson Chi-Square	5.455(c)	2	.065		
	Likelihood Ratio	6.060	2	.048		
	Linear-by-Linear Association	5.138	1	.023		
	N of Valid Cases	20				
3	Pearson Chi-Square	3.590(d)	1	.058		
	Continuity Correction(a)	1.832	1	.176		
	Likelihood Ratio	5.170	1	.023		
	Fisher's Exact Test				.114	.083
	Linear-by-Linear Association	3.410	1	.065		

	N of Valid Cases	20				

a Computed only for a 2x2 table

b 2 cells (50.0%) have expected count less than 5. The minimum expected count is 2.25.

c 5 cells (83.3%) have expected count less than 5. The minimum expected count is .45.

d 2 cells (50.0%) have expected count less than 5. The minimum expected count is 1.75.

Group 1: no statistical association between average general mobility and average SI (p = 1.000)

Group 2: Borderline statistical significant (p = 0.065)

Group 3: Not statistically significant (p = 0.114)

Table 14: Average General Mobility * Average IS * GROUP

GROUP				Average IS		Total
				A	B	
1	Average general mobility	1	Count	4	1	5
			% within Average general mobility	80.0%	20.0%	100.0%
		2	Count	9	6	15
			% within Average general mobility	60.0%	40.0%	100.0%
	Total		Count	13	7	20
			% within Average general mobility	65.0%	35.0%	100.0%
2	Average general mobility	1	Count	9	1	10
			% within Average general mobility	90.0%	10.0%	100.0%
		2	Count	2	7	9
			% within Average general mobility	22.2%	77.8%	100.0%
		3	Count	0	1	1
			% within Average general mobility	.0%	100.0%	100.0%
	Total		Count	11	9	20
			% within Average general mobility	55.0%	45.0%	100.0%
3	Average general mobility	1	Count	4	1	5
			% within Average general mobility	80.0%	20.0%	100.0%
		2	Count	12	3	15
			% within Average general mobility	80.0%	20.0%	100.0%
	Total		Count	16	4	20

	% within Average general mobility	80.0%	20.0%	100.0%

Table 15: Chi-Square Tests

GROUP		Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
1	Pearson Chi-Square	.659(b)	1	.417		
	Continuity Correction(a)	.073	1	.787		
	Likelihood Ratio	.703	1	.402		
	Fisher's Exact Test				.613	.406
	Linear-by-Linear Association	.626	1	.429		
	N of Valid Cases	20				
2	Pearson Chi-Square	10.079(c)	2	.006		
	Likelihood Ratio	11.489	2	.003		
	Linear-by-Linear Association	9.059	1	.003		
	N of Valid Cases	20				
3	Pearson Chi-Square	.000(d)	1	1.000		
	Continuity Correction(a)	.000	1	1.000		
	Likelihood Ratio	.000	1	1.000		
	Fisher's Exact Test				1.000	.718
	Linear-by-Linear Association	.000	1	1.000		
	N of Valid Cases	20				

a Computed only for a 2x2 table

b 2 cells (50.0%) have expected count less than 5. The minimum expected count is 1.75.

c 5 cells (83.3%) have expected count less than 5. The minimum expected count is .45.

d 3 cells (75.0%) have expected count less than 5. The minimum expected count is 1.00.

Group 1: not statistically significant (p = 0.613)

Group 2: statistically significant (p = 0.006) (interpret with caution)

Group 3: not statistically significant (p =1.000)

Table 16: Average general mobility * Average ML * GROUP

GROUP				Average ML			Total
				A	B	C	
1	Average general mobility	1	Count	5	0		5
			% within Average general mobility	100.0%	.0%		100.0%
		2	Count	3	12		15
			% within Average general mobility	20.0%	80.0%		100.0%
	Total		Count	8	12		20
			% within Average general mobility	40.0%	60.0%		100.0%
2	Average general mobility	1	Count	10	0		10
			% within Average general mobility	100.0%	.0%		100.0%
		2	Count	2	7		9
			% within Average general mobility	22.2%	77.8%		100.0%
		3	Count	0	1		1
			% within Average general mobility	.0%	100.0%		100.0%
	Total		Count	12	8		20
			% within Average general mobility	60.0%	40.0%		100.0%
3	Average general mobility	1	Count	5	0	0	5
			% within Average general mobility	100.0%	.0%	.0%	100.0%

		2	Count	3	11	1	15
			% within Average general mobility	20.0%	73.3%	6.7%	100.0%
	Total		Count	8	11	1	20
			% within Average general mobility	40.0%	55.0%	5.0%	100.0%

Table 17: Chi-Square Tests

GROUP		Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
1	Pearson Chi-Square	10.000(b)	1	.002		
	Continuity Correction(a)	6.944	1	.008		
	Likelihood Ratio	11.908	1	.001		
	Fisher's Exact Test				.004	.004
	Linear-by-Linear Association	9.500	1	.002		
	N of Valid Cases	20				
2	Pearson Chi-Square	13.519(c)	2	.001		
	Likelihood Ratio	17.386	2	.000		
	Linear-by-Linear Association	12.052	1	.001		
	N of Valid Cases	20				
3	Pearson Chi-Square	10.000(d)	2	.007		
	Likelihood Ratio	11.908	2	.003		
	Linear-by-Linear Association	8.170	1	.004		
	N of Valid Cases	20				

a Computed only for a 2x2 table

b 2 cells (50.0%) have expected count less than 5. The minimum expected count is 2.00.

c 4 cells (66.7%) have expected count less than 5. The minimum expected count is .40.

d 4 cells (66.7%) have expected count less than 5. The minimum expected

count is .25.

Group 1: statistically significant (p = 0.004)

Group 2: statistically significant (p = 0.001) (interpreted with caution)

Group 3: statistically significant (p = 0.007) (interpreted with caution)

Table 18: Average general mobility * Average LM * GROUP

GROUP				Average LM		Total
				A	B	
1	Average general mobility	1	Count	5	0	5
			% within Average general mobility	100.0%	.0%	100.0%
		2	Count	8	7	15
			% within Average general mobility	53.3%	46.7%	100.0%
	Total		Count	13	7	20
			% within Average general mobility	65.0%	35.0%	100.0%
2	Average general mobility	1	Count	10	0	10
			% within Average general mobility	100.0%	.0%	100.0%
		2	Count	5	4	9
			% within Average general mobility	55.6%	44.4%	100.0%
		3	Count	1	0	1
			% within Average general mobility	100.0%	.0%	100.0%
	Total		Count	16	4	20
			% within Average general mobility	80.0%	20.0%	100.0%
3	Average general mobility	1	Count	5	0	5
			% within Average	100.0%	.0%	100.0%

			general mobility			
		2	Count	9	6	15
			% within Average general mobility	60.0%	40.0%	100.0%
	Total		Count	14	6	20
			% within Average general mobility	70.0%	30.0%	100.0%

Table 19: Chi-Square Tests

GROUP		Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
1	Pearson Chi-Square	3.590(b)	1	.058		
	Continuity Correction(a)	1.832	1	.176		
	Likelihood Ratio	5.170	1	.023		
	Fisher's Exact Test				.114	.083
	Linear-by-Linear Association	3.410	1	.065		
	N of Valid Cases	20				
2	Pearson Chi-Square	6.111(c)	2	.047		
	Likelihood Ratio	7.651	2	.022		
	Linear-by-Linear Association	2.768	1	.096		
	N of Valid Cases	20				
3	Pearson Chi-Square	2.857(d)	1	.091		
	Continuity Correction(a)	1.270	1	.260		
	Likelihood Ratio	4.244	1	.039		
	Fisher's Exact Test				.260	.129
	Linear-by-Linear Association	2.714	1	.099		
	N of Valid Cases	20				

a Computed only for a 2x2 table

b 2 cells (50.0%) have expected count less than 5. The minimum expected count is 1.75.

c 4 cells (66.7%) have expected count less than 5. The minimum expected count is .20.

d 3 cells (75.0%) have expected count less than 5. The minimum expected count is 1.50.

Group 1: not statistically significant (p =0.114).

Group 2: statistically significant (p =0.047) (interpreted with caution)

Group 3: not statistically significant (p = 0.091)

4.2.1.6 NRS distribution for all groups

Univariate ANOVA was used for NRS because there was a normal distribution to the reported pain rating, with the mean pain rating being 5.60. Post Hoc Tests are used for group multiple comparisons.

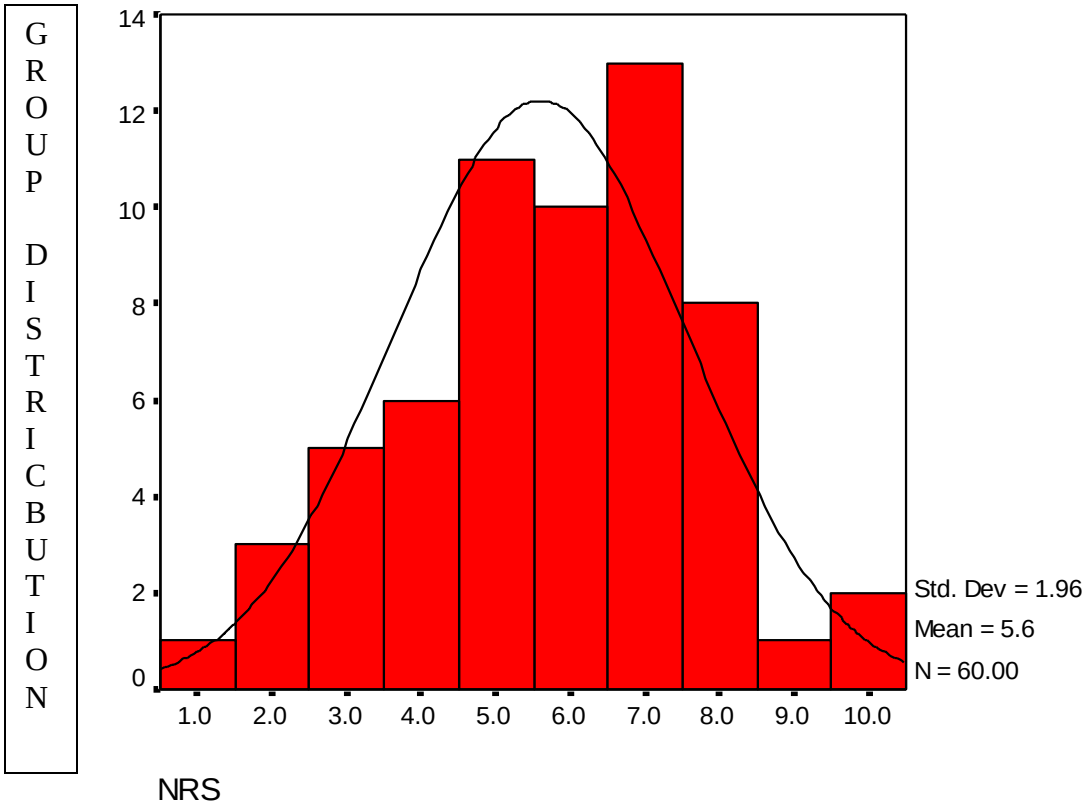

Fig. 3: Histogram of NRS.

The reported pain rating was recorded using a NRS. This subjective scale consists of numbers from zero to ten; with zero being no pain and ten being the worst pain that the individual had experienced with their condition. On the first consultation the individuals were asked to complete the NRS to indicate their pain rating prior to objective evaluation of the individual by the researcher. There was an even distribution within the entire sample population (N = 60).

4.2.2 Groups multiple comparisons for NRS.

Table 20: Bonferroni (Dependent Variable: NRS)

GROUP	GROUP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	.60	.495	.704	-.65	1.85
	3	3.15(*)	.495	**.000**	1.90	4.40
2	1	-.60	.495	.704	-1.85	.65
	3	2.55(*)	.495	**.000**	1.30	3.80
3	1	-3.15(*)	.495	**.000**	-4.40	-1.90
	2	-2.55(*)	.495	**.000**	-3.80	-1.30

Based on observed means. * The mean difference is significant at the .05 level.

Post Hoc tests for the groups show that group 3 is different (in terms of the subjective NRS reading) to group 1 and 2 but 1 and 2 were not different (in terms of the subjective NRS reading) to each other. Group 3 are the group that runs greater than 6 hours a week (e.g. those who train for marathons and ultra marathons).

<u>The group differences could have been attributed to:</u>

- The experienced runners could have developed mechanisms to avoid, adapt and control situations in which pain may arise during a marathon / run (Price 1998, Leach 1994).
- Their increased mileage and distance they run leads to increased release of natural opoids and results decreased pain (Price 1988). Thus their pain tolerance could be increased (Melzack and Wall 1965, Price 1988).
- Increased musculoskeletal development (tone, muscle strength and co-ordination) in terms of running with appropriate physiological adaptation, thereby resulting in decreased severity or decreased injury rates.

These reasons would be in support of group 3 being significantly different from groups 1 and 2.

4.2.3 Correlation between NRS and Algometer.

4.2.3.1 Correlations: Group 1

Table 21: Correlation between NRS and Algometer.

		NRS	Infrapatella tendon algometer reading	Medial retinaculum algometer reading	Lateral retinaculum algometer reading
NRS	Pearson Correlation	1	-.155	.217	-.193
	Sig. (2-tailed)		.513	.358	.415
	N	20	20	20	20
Infrapatella tendon algometer reading	Pearson Correlation	-.155	1	.587(**)	.467(*)
	Sig. (2-tailed)	.513		.006	.038
	N	20	20	20	20
Medial retinaculum algometer reading	Pearson Correlation	.217	.587(**)	1	.560(*)
	Sig. (2-tailed)	.358	.006		.010
	N	20	20	20	20
Lateral retinaculum algometer reading	Pearson Correlation	-.193	.467(*)	.560(*)	1
	Sig. (2-tailed)	.415	.038	.010	
	N	20	20	20	20

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

From the above table the following can be deduced from Group 1 of individuals with PFPS:

- There was no statistical significance between the subjective NRS and the objective algometer readings as taken in individuals with PFPS, whether it is on the medial (p=0.358) or lateral (p=0.415) retinaculum or over the

infrapatella tendon (p=0.513).

- It is interesting to note that there is a positive relationship between NRS and medial retinaculum (p=0.358) algometer readings, which indicates that with an increased pain tolerance in the algometer readings, there is also an increase in the subjective reported pain readings (NRS). This suggests that medial retinaculum tenderness as measured by the algometer is not clearly associated with the severity of PFPS symptoms in this group. This is in contrast to the expectation that pain reported increases as a result of retinacular compromise (Reid 1992: 393) as often seen in PFPS which should result in a decrease of the algometer reading due to increased local sensitivity. Thus, it stands to reason, that the individuals are reporting pain that is of a non-retinacular origin. This indicates that the pain is of a referred nature (for example that of myofascial or muscular pain syndrome).

- In addition to this, the infrapatella tendon algometer reading has a significant statistical relationship with the medial (p=0.006) and the lateral (p=0.038) retinaculum algometer readings but has a stronger relationship with the medial retinaculum reading. This indicates that when the infrapatella tendon reading reports increased tenderness (decrease algometer reading), that there is a corresponding increase in tenderness over the medial retinaculum. This could be the result of :
    - Inflammatory processes that affect both the retinaculum and the infrapatella tendon concurrently within the context of PFPS (Davidson 1993).
    - Due to biomechanical changes in the lower extremity, whereby there is increased joint gapping on the medial aspect (medial hypopressure syndrome / medial facet syndrome) with associated increase in stressors that pass through the infrapatella tendon as the quadriceps femoris attempts to stabilize the knee (Reid 1992; 355, 361-3).

In respect of group one, the former hypothesis seems more appropriate because they tend to be “weekend warriors” (see discussion 4.2.3.1) having periods of excessive stress placed on the knee by unconditioned quadriceps femoris musculature interspersed with periods of inactivity. This profile supports the development of infrapatella tendonitis (acute) / or a more repetitive tendonosis, as opposed to the second hypothesis which implies a period of time of development of the syndrome; as time, excessive use and repetitive microtrauma are the associated inducing factors related to the development of retincular laxity as found in medial hypopressure syndrome / medial facet syndrome (Reid 1992: 355).

- The lateral retinaculum algometer reading has a significant statistical relationship with the medial retinaculum (p=0.010) and infrapatella tendon (p=0.038) algometer readings but has a stronger relationship with the medial retinaculum reading.

  This relationship may indicate that there is a relationship between the 2 retinacular structures within the knee. This relationship is supported by authors (Reid 1992: 354/5) who indicate that an inverse relationship exists between the 2 retinaculae in that:

  - Hypermobility in one retinaculum is associated with hypomobility in the other retinaculum (Reid 1992: 354/5). Pain or inflammation in the one retinaculum easily affects both retinaculae simultaneously as they have a common infrapatella tendon between them as well as attachment to a common joint capsule, (Lumley 1987, Delee 1994, Scuderi 1995).
  - Furthermore current literature suggests an extensor mechanism disorder as the most probable etiology. The term “extensor mechanism”, according to Walsh and Helzer-Julin (1992) encompasses several anatomical structures: the quadriceps

musculature, the quadriceps tendon attachment to the patella, the patella and corresponding trochlear surface of the femur, the patella tendon, and the associated soft tissues.

- According to Voight and Wieder (1991), the pull of the vastus medialis obliquus (VMO) and vastus lateralis (VL) provides dynamic patella stability. Lieb and Perry (1968) and Felder and Leeson (2002) concluded that the function of the VMO is to maintain patella alignment and stability, in congruence with Gilleard et al. (1998) who suggested that inadequate medial control from the VMO muscle may result in lateral displacement of the patella.

  This supports only the hypothesis that there is a relationship between the VMO and the VL, but does not necessarily account for the presence of infrapatella tendon tenderness, unless it is explained as a consequence of the derangement of mechanics between VMO and VL (Post, 1998, Juhn, 1999).

- It is interesting to note that latent myofascial trigger points (MTrp's) only have a significance for latent MTrp's in the VL, followed by an increase in the development of active MTrp's in the VL and concomitant with the VM. Therefore the implication that arises is that the presentation of VM signs and symptoms may actually be secondary to the development of the myofascial component of the VL. Although myofascial trigger points were found in all four-component muscles of the quadriceps, the most common location of active myofascial trigger points was the mid belly and the distal muscular portion of the vastus lateralis (Dippenaar 2003).

In addition to this Papagelopoulos and Sim (1997), Blond and Hansen (1998) and Post (1998), state that a tight lateral retinaculum may result in abnormal patella tracking.

This hypothesis may explain why there is a stronger relationship between the medial retinaculum and lateral retinaculum algometer readings, than any other combination. Furthermore this hypothesis would support the assertion that referred pain from the VMO, which results in infrapatella pain, could be responsible for the strong and significant link between medial and infrapatella pain (Travel and Simmons 1992: 250/1).

In support of the findings it would seem that the first correlation, with a combination of the third and fourth correlation is more probable as the relationship between the infrapatella tendon and the lateral retinaculum is not as strong or significant as the relationship between the infrapatella tendon and the medial retinaculum.

However it is not possible to state from the above statistics (table 21) whether these hypotheses occur simultaneously or result in a sequence of changes in the pathomechanics associated with PFPS.

4.2.3.2 Correlations: group 2

Table 22: Correlation between NRS and Algometer.

		nrs	Infrapatella tendon algometer reading	Medial retinaculum algometer reading	lateral retinaculum algometer reading
nrs	Pearson Correlation	1	-.211	.023	-.170
	Sig. (2-tailed)		.373	.923	.473
	N	20	20	20	20
Infrapatella tendon algometer reading	Pearson Correlation	-.211	1	.700(**)	.525(*)
	Sig. (2-tailed)	.373		.001	.018
	N	20	20	20	20
Medial retinaculum algometer reading	Pearson Correlation	.023	.700(**)	1	.509(*)
	Sig. (2-tailed)	.923	.001		.022
	N	20	20	20	20
lateral retinaculum algometer reading	Pearson Correlation	-.170	.525(*)	.509(*)	1
	Sig. (2-tailed)	.473	.018	.022	
	N	20	20	20	20

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

From the above table the following can be deduced:

- NRS – algometer relationship in group 2, indicates that as the subjective reported pain (NRS) increases the algometer readings decrease, indicating a negative relationship between infrapatella tendon objectively reported algometer and NRS (p = -0.211) and lateral retinculum objectively reported algometer readings and NRS (p = -0.170).

- Therefore it seems in group 2, that as the reported pain increases the objective algometer decreases, indicating that this group has a possible inflammatory process occurring in the region of the infrapatella tendon and lateral retinculum, which would decrease the algometer readings.

  This supports the assertion that individuals with PFPS have increased possibility of medial hypopressure syndrome / medial facet syndrome in association with a infrapatella tendonitis and / or tendonosis as a result of a biomechanical derangement in the lower extremity during the course of their running (Reid, 1992: 364, 449, 486 and Fithian et al. 2004)

- There is a strong relationship between the infrapatella tendon algometer reading and the medial retinaculum algometer reading ($p = 0.700$), as was found in the previous group (group 1) and which supports the assertions made and discussed previously (4.2.3. 1 Group 1).

- In addition, it would also seem plausible, with the lateral retinaculum algometer reading having a strong relationship with the medial retinaculum algometer reading ($p = 0.509$), that there is a high likelihood of a VMO and VL relationship, endorsing the relationship as in the previous group (group 1). This relationship could further be linked by the fact that both the VMO and VL are supplied by the same nerve roots (L2, L3 and L4) (Moore, 1999:534). This could result in a situation where through pain or dysfunction, the VMO or VL inhibit the antagonist muscle, resulting in the development of myofascial trigger points in the agonist, due to inactivity or a patella tracking anomaly because the agonist muscle becomes relatively stronger in its pull of the patella.

These hypotheses raise the following question as pertaining to PFPS:
“Could there be increased tension in the VMO and laxity of the VL?”

4.2.3.3 Correlations: group 3

Table 23: Correlations between NRS and Algometer readings.

		NRS	Infrapatella tendon algometer reading	Medial retinaculum algometer reading	lateral retinaculum algometer reading
NRS	Pearson Correlation	1	.272	.041	-.014
	Sig. (2-tailed)		.246	.863	.954
	N	20	20	20	20
Infrapatella tendon algometer reading	Pearson Correlation	.272	1	.515(*)	.376
	Sig. (2-tailed)	.246		.020	.102
	N	20	20	20	20
Medial retinaculum algometer reading	Pearson Correlation	.041	.515(*)	1	.412
	Sig. (2-tailed)	.863	.020		.071
	N	20	20	20	20
Lateral retinaculum algometer reading	Pearson Correlation	-.014	.376	.412	1
	Sig. (2-tailed)	.954	.102	.071	
	N	20	20	20	20

* Correlation is significant at the 0.05 level (2-tailed).

From the above table the following can be deduced:

- NRS has no association with the algometer readings, as found in the previous 2 groups (groups 1 and 2); although an inverse relationship exists between NRS and the lateral retinaculum algometer reading (pearsons = -0.014). This indicates that with an increase in the NRS (pain reported) there is a concomitant decrease in the algometer reading (kg's per cm).

  Thus the pain reported by the individual corresponds with pain originating from the lateral retinculum. Therefore this group may have a greater degree of biomechanical derangement (true PFPS) or degenerative disease of the knee (indicated as joint pain under the retinaculum giving a possible false algometer reading).

- Lateral retinaculum algometer reading has hardly any relation with the medial retinaculum algometer (p=0.71) and infrapatella tendon algometer (p=0.102) readings.

4.2.4 Correlation between NRS and OPRS

Pearson correlation was utilized to assess the correlations between NRS and OPRS in all individuals and within groups. Univariate Analysis of Variants (ANOVA) was utilized for assessing NRS within the groups; with OPRS as a covariate.

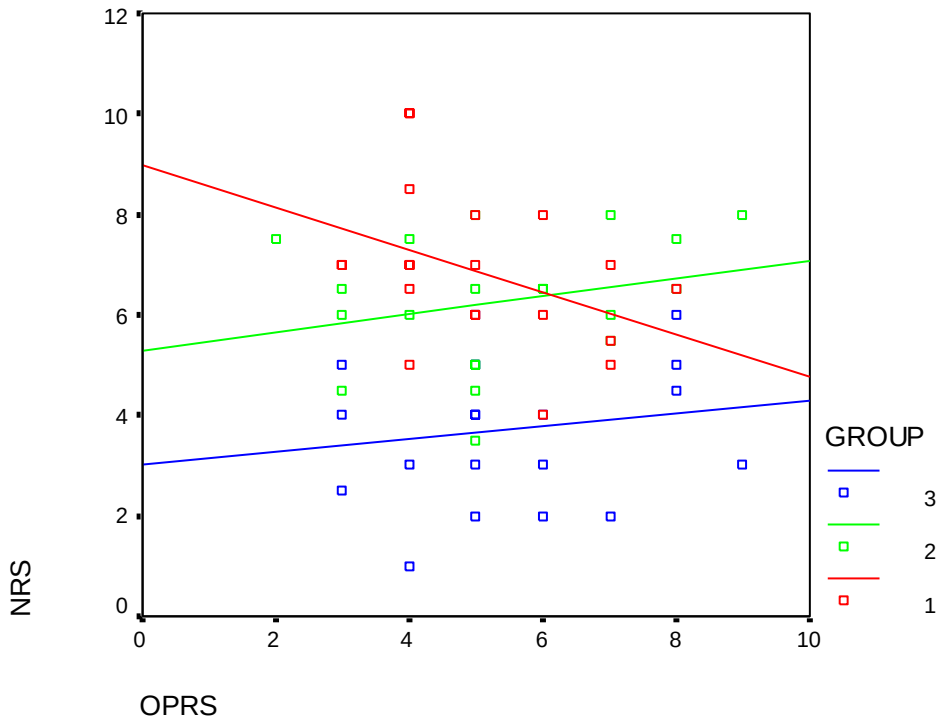

Fig. 4: Scattergram of correlation between NRS and OPRS.

4.2.4.1 Correlations: Group 1

Table 24: Correlation between NRS and OPRS

		NRS	OPRS
NRS	Pearson Correlation	1	-.393
	Sig. (2-tailed)	.	.087
	N	20	20
OPRS	Pearson Correlation	-.393	1
	Sig. (2-tailed)	.087	.
	N	20	20

Group 1: There is an almost significant negative correlation between NRS and OPRS (p = 0.087).

From the above scattergram (indicated in red) and table the following can be deduced:

- The OPRS (Appendix F) as correlated with the NRS indicates an insignificant relationship; however it is significant to note that this relationship is nonetheless a negative relationship.

It is therefore evident that one of 2 processes were occurring here:

1. The individual's reporting of the pain does not correspond with the objective evaluation of the patient by the researcher, as a result of the 2 measures (NRS and OPRS) possibly measuring different entities (e.g. PFPS versus a myofascial / muscular pain syndrome of the quadriceps femoris).
2. Individuals that have PFPS have significantly different phases within the PFPS pathogenesis that are either distinct diagnoses or phases involving different tissues (e.g. myofascial / muscular pain syndrome more prevalent in initial stages (group 1), and degenerative complaints more prevalent in the later stages (group 3)).

This is supported by the fact that group one as a whole led a more sedentary lifestyle and tended to be “weekend warriors”, thereby overloading muscles that are not toned, strengthened and / or lack the co-ordination to cope with the excessive demands placed on them over the short periods of intense activity. This would support a myofascial / muscular overload theory as proposed by Travel and Simmons (1992: 265). Thus these individuals may have reported a high NRS and an inverse reading on the OPRS, which technically measures PFPS (Thomee et al. 1995, Reid 1992 and Magee 1997), but has components within its structure that could measure a myofascial / muscular pain syndrome (Shea et al. 1992), by virtue of the question structure which could measure myofascial / muscular pain syndrome (Travell and Simons 1983: 265):

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

The question arises as to whether these individuals should therefore be treated symptomatically as a myofascial / muscular pain syndrome case or rather from a mechanical dysfunction perspective (strapping / orthotics) for PFPS (Reid 1992: 377, 383/9)? In furtherance to this point, does a myofascial / muscular pain syndrome precede or exist concomitantly with the mechanical dysfunction of a Patellofemoral Pain Syndrome?

4.2.4.2 Correlations: group 2

Table 25: Correlation between NRS and OPRS

		NRS	OPRS
NRS	Pearson Correlation	1	.263
	Sig. (2-tailed)	.	.263
	N	20	20
OPRS	Pearson Correlation	.263	1
	Sig. (2-tailed)	.263	.
	N	20	20

Group 2: There were no correlations found in table 7 between NRS and OPRS.

4.2.4.3 Correlations: group 3

Table 26: Correlation between NRS and OPRS

		NRS	OPRS
NRS	Pearson Correlation	1	.159
	Sig. (2-tailed)	.	.503
	N	20	20
OPRS	Pearson Correlation	.159	1
	Sig. (2-tailed)	.503	.
	N	20	20

Group 3: There were no correlations found in table 8 between NRS and OPRS.

From Fig. 4 above (green – group 2 / blue – group 3) and tables (7 and 8) the following can be deduced:

Groups 2 and 3 indicate (although insignificant), that there is a positive relationship between the NRS and the OPRS. This indicates that the NRS and the OPRS are more likely to measure the same clinical entity, as opposed to group 1. This could be because the individuals are reporting the pain as related to a mechanical dysfunction as reported by the OPRS. It is further noted that the individuals in groups 2 and 3 correlate more closely with the predisposing factor (e.g. group 2 had the most females) and profile of the true PFPS patient.

This also lends credence to the researcher's hypothesis that PFPS is part of a pathomechanical process that seems to begin with a myofascial syndrome and progress to a more mechanical clinical dysfunction with time, as the athletes adapt to their running styles, increase tone, strength and co-ordination; even though this may be happening with an underlying pathomechanical process developing.

4.2.5 Correlation between NRS and PJES.

Table 27: Nonparametric Correlations: group 1

			NRS	PJES
Spearman's rho	NRS	Correlation Coefficient	1.000	-.239
		Sig. (2-tailed)	.	.310
		N	20	20
	PJES	Correlation Coefficient	-.239	1.000
		Sig. (2-tailed)	.310	.
		N	20	20

Group 1: no statistically significant correlations between NRS and PJES.

Table 28: Nonparametric Correlations: group 2

			NRS	PJES
Spearman's rho	NRS	Correlation Coefficient	1.000	-.430
		Sig. (2-tailed)	.	.058
		N	20	20
	PJES	Correlation Coefficient	-.430	1.000
		Sig. (2-tailed)	.058	.
		N	20	20

Group 2: borderline statistical significant correlation between NRS and PJES.

Table 29: Nonparametric Correlations: group 3

			NRS	PJES
Spearman's rho	NRS	Correlation Coefficient	1.000	-.144
		Sig. (2-tailed)	.	.546
		N	20	20
	PJES	Correlation Coefficient	-.144	1.000
		Sig. (2-tailed)	.546	.
		N	20	20

Group 3: no statistically significant correlation between NRS and PJES.

The PJES (Appendix G (a) and G (b)) was composed of both subjective and objective portions. The NRS (Appendix D) reported only subjective pain as indicated by the individual.

From the above tables 8, 9, and 10 the following can be deduced:

- There is a negative correlation between the NRS and PJES for all groups (group 1 Spearmans rho=-0.239, group 2 Spearmans rho=-0.430 and group 3 Spearmans rho=-0.144). There is no statistical significance in group 1 (Spearmans rho=-0.239 and p=0.310), group 2 (Spearmans rho=-0.430 and p=0.058) and group 3 (Spearmans rho=-0.144 and p=0.546) between NRS and PJES.

This indicates that as the NRS increases (increased pain), PJES decreases (or decreased functional ability) (or the inverse) in its score value in group 2:

- Therefore it would seem that as the individuals functional ability decreased (e.g. increased degenerative changes, increased myofascial / muscular pain syndrome), the pain reported subjectively increased.

This is supported due to the following reasons:

- PJES categorizes activity according to a functional scale testing for
  - functional activity (limp, stair climbing, need for assistive devices, crepitation or clicking of the knee),
  - instability (or giving way) and
  - swelling,

which may be due to muscle, ligament and / or tendon dysfunction.

Without the PJES scale differentiating muscle, disc, menisci, cartilage, ligament and / or tendon dysfunction (by patient activity), it is difficult to assess whether the reported pain (NRS) is truly related to PFPS or pain from another cause.

For example, the above categories instability or “giving way” and stair climbing could be related to PFPS or a myofascial / muscular pain syndrome. This could explain why a negative relationship exists between the NRS and the PJES in groups 1 and 3 as well as group 2.

In group 1, the researcher has previously linked the PFPS syndrome to a myofascial / muscular pain syndrome picture (4.2.4), which is reported under the functional activity portion of the PJES.

Whereas in group 3, with the possible presence of a more degenerative process, the PJES would report more on:

- Swelling or the need for assistive devices and crepitus could be related to degenerative joint pathology.

Thus it would seem that the PJES is a non specific PFPS scale that does not isolate a true PFPS, with all its permutations. This is supported by the fact that the true PFPS group seems to be group 2 (from other findings: 4.2.3, 4.2.4, 4.2.6, 4.2.7, 4.2.8) and there is a borderline statistical significance; however the negative association between the PJES and the groups is maintained throughout.

4.2.6 Correlations between Algometer and OPRS.

Table 30: Correlation between Algometer and OPRS

		Infrapatella tendon algometer reading	Medial retinaculum algometer reading	Lateral retinaculum algometer reading	OPRS
Infrapatella tendon algometer reading	Pearson Correlation	1	.627(**)	.476(**)	-.222
	Sig. (2-tailed)		.000	.000	.089
	N	60	60	60	60
Medial retinaculum algometer reading	Pearson Correlation	.627(**)	1	.487(**)	-.265(*)
	Sig. (2-tailed)	.000		.000	.041
	N	60	60	60	60
Lateral retinaculum algometer reading	Pearson Correlation	.476(**)	.487(**)	1	-.080
	Sig. (2-tailed)	.000	.000		.543
	N	60	60	60	60
OPRS	Pearson Correlation	-.222	-.265(*)	-.080	1
	Sig. (2-tailed)	.089	.041	.543	
	N	60	60	60	60

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 31: Partial correlation between Algometer and OPRS

Control Variables			Infrapatella tendon algometer reading	Medial retinaculum algometer reading	Lateral retinaculum algometer reading	OPRS
group	Infrapatella tendon algometer reading	Correlation	1.000	.623	.466	-.241
		Significance (2-tailed)	.	.000	.000	.066
		df	0	57	57	57
	Medial retinaculum algometer reading	Correlation	.623	1.000	.480	-.278
		Significance (2-tailed)	.000	.	.000	.033
		df	57	0	57	57
	Lateral retinaculum algometer reading	Correlation	.466	.480	1.000	-.096
		Significance (2-tailed)	.000	.000	.	.469
		df	57	57	0	57
	OPRS	Correlation	-.241	-.278	-.096	1.000
		Significance (2-tailed)	.066	.033	.469	.
		df	57	57	57	0

Controlling for group medial retinaculum algometer reading and OPRS still correlated (p = 0.033)

From the above tables 30 and 31 the following can be deduced

- For all individuals there is a significant negative correlation between OPRS and medial retinaculum algometer measurement (p = 0.041). This means that the algometer reading decreases (pain increases) as the OPRS increases.
- A negative (although insignificant) relationship exists between OPRS and lateral retinaculum and infrapatella algometer readings. This means that the algometer reading decreases (pain increases) as the OPRS increases.

Therefore if we assume that the OPRS is assessing PFPS,

- From the literature (Thomee et al. 1995, Reid 1996: 369, Magee 1997: 566), it would be reasonable to assume that the algometer reading of the lateral retinaculum would decrease as pain reported increases and the OPRS increases.

- This assumption would support the previously reported finding where group 2 was identified as the true PFPS group (4.2.3, 4.2.4, 4.2.5) indicating that the presentation of PFPS should be in congruence with the measured outcomes (algometer and OPRS).

The preceding conclusions as applicable to group 2 are however not applicable to groups 1 and 3, as no significant negative relationship can be reported from the data gathered in this study.

4.2.6.1 Correlations between Algometer and OPRS: group 1

Table 32: Correlations between Algometer and OPRS: group 1

		Infrapatella tendon algometer reading	Medial retinaculum algometer reading	lateral retinaculum algometer reading	OPRS
Infrapatella tendon algometer reading	Pearson Correlation	1	.587(**)	.467(*)	.311
	Sig. (2-tailed)		.006	.038	.182
	N	20	20	20	20
Medial retinaculum algometer reading	Pearson Correlation	.587(**)	1	.560(*)	.017
	Sig. (2-tailed)	.006		.010	.943
	N	20	20	20	20
Lateral retinaculum algometer reading	Pearson Correlation	.467(*)	.560(*)	1	.158
	Sig. (2-tailed)	.038	.010		.506
	N	20	20	20	20
OPRS	Pearson Correlation	.311	.017	.158	1
	Sig. (2-tailed)	.182	.943	.506	
	N	20	20	20	20

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 33: Nonparametric Correlations between Algometer and OPRS: group 1

			Infrapatella tendon algometer reading	Medial retinaculum algometer reading	lateral retinaculum algometer reading	OPRS
Spearman's rho	Infrapatella tendon algometer reading	Correlation Coefficient	1.000	.254	.208	.347
		Sig. (2-tailed)	.	.279	.380	.134
		N	20	20	20	20
	Medial retinaculum algometer reading	Correlation Coefficient	.254	1.000	.407	.129
		Sig. (2-tailed)	.279	.	.075	.587
		N	20	20	20	20
	Lateral retinaculum algometer reading	Correlation Coefficient	.208	.407	1.000	-.009
		Sig. (2-tailed)	.380	.075	.	.970
		N	20	20	20	20
	OPRS	Correlation Coefficient	.347	.129	-.009	1.000
		Sig. (2-tailed)	.134	.587	.970	.
		N	20	20	20	20

4.2.6.2 Correlations between Algometer and OPRS: group 2

Table 34: Correlations between Algometer and OPRS: group 2

		Infrapatella tendon algometer reading	Medial retinaculum algometer reading	lateral retinaculum algometer reading	OPRS
Infrapatella tendon algometer reading	Pearson Correlation	1	.700(**)	.525(*)	-.599(**)
	Sig. (2-tailed)		.001	.018	.005
	N	20	20	20	20
Medial retinaculum algometer reading	Pearson Correlation	.700(**)	1	.509(*)	-.436
	Sig. (2-tailed)	.001		.022	.055
	N	20	20	20	20
Lateral retinaculum algometer reading	Pearson Correlation	.525(*)	.509(*)	1	-.250
	Sig. (2-tailed)	.018	.022		.288
	N	20	20	20	20
OPRS	Pearson Correlation	-.599(**)	-.436	-.250	1
	Sig. (2-tailed)	.005	.055	.288	
	N	20	20	20	20

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Group 2: There was a significant negative correlation between the infrapatella tendon algometer reading and OPRS (p = 0.005).

Table 35: Nonparametric Correlations between Algometer and OPRS: group 2

			Infrapatella tendon algometer reading	Medial retinaculum algometer reading	Lateral retinaculum algometer reading	OPRS
Spearman's rho	Infrapatella tendon algometer reading	Correlation Coefficient	1.000	.743(**)	.805(**)	-.543(*)
		Sig. (2-tailed)	.	.000	.000	.013
		N	20	20	20	20
	Medial retinaculum algometer reading	Correlation Coefficient	.743(**)	1.000	.759(**)	-.446(*)
		Sig. (2-tailed)	.000	.	.000	.049
		N	20	20	20	20
	Lateral retinaculum algometer reading	Correlation Coefficient	.805(**)	.759(**)	1.000	-.438
		Sig. (2-tailed)	.000	.000	.	.053
		N	20	20	20	20
	OPRS	Correlation Coefficient	-.543(*)	-.446(*)	-.438	1.000
		Sig. (2-tailed)	.013	.049	.053	.
		N	20	20	20	20

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

4.2.6.3 Correlations between Algometer and OPRS: group 3

Table 36: Correlations between Algometer and OPRS: group 3

		Infrapatella tendon algometer reading	Medial retinaculum algometer reading	Lateral retinaculum algometer reading	OPRS
Infrapatella tendon algometer reading	Pearson Correlation	1	.515(*)	.376	-.103
	Sig. (2-tailed)		.020	.102	.666
	N	20	20	20	20
Medial retinaculum algometer reading	Pearson Correlation	.515(*)	1	.412	-.301
	Sig. (2-tailed)	.020		.071	.197
	N	20	20	20	20
Lateral retinaculum algometer reading	Pearson Correlation	.376	.412	1	-.035
	Sig. (2-tailed)	.102	.071		.883
	N	20	20	20	20
OPRS	Pearson Correlation	-.103	-.301	-.035	1
	Sig. (2-tailed)	.666	.197	.883	
	N	20	20	20	20

* Correlation is significant at the 0.05 level (2-tailed).

Table 37: Nonparametric Correlations between Algometer and OPRS: group 3

			Infrapatella tendon algometer reading	Medial retinaculum algometer reading	Lateral retinaculum algometer reading	OPRS
Spearman's rho	Infrapatella tendon algometer reading	Correlation Coefficient	1.000	.524(*)	.417	-.087
		Sig. (2-tailed)	.	.018	.067	.717
		N	20	20	20	20
	Medial retinaculum algometer reading	Correlation Coefficient	.524(*)	1.000	.260	-.338
		Sig. (2-tailed)	.018	.	.268	.145
		N	20	20	20	20
	Lateral retinaculum algometer reading	Correlation Coefficient	.417	.260	1.000	-.004
		Sig. (2-tailed)	.067	.268	.	.987
		N	20	20	20	20
	OPRS	Correlation Coefficient	-.087	-.338	-.004	1.000
		Sig. (2-tailed)	.717	.145	.987	.
		N	20	20	20	20

* Correlation is significant at the 0.05 level (2-tailed).

Group 3: nothing statistically significant was found

Thus based on the preceding 6 tables (32, 33, 34, 35, 36, 37), if we are to assume that the OPRS could be assessing a myofascial / muscular pain syndrome (either as a component or precursor to PFPS);

- It would be reasonable to assume that an increase in the algometer readings, with an associated decrease in pain would result in an increase in the OPRS. This is based on the work of Travel and Simons (1999:265-266) where they indicate that:
    - stair ascent and descent,
    - pain during squatting,
    - pain during isometric contraction of the quadriceps,
    - prolonged immobilization (e.g. sitting),

may irritate the component muscles of the quadriceps femoris, generating myofascial / muscular pain syndrome and thereby generating a positive relationship between the OPRS and NRS.

We could therefore conclude that the *significant negative relationship between the algometer reading and OPRS* could be associated with the first correlation (PFPS), whereas the s*ignificant positive relationship between the algometer reading and OPRS* could be applied to the second correlation (myofascial / muscular pain syndrome).

4.2.7 Correlation between the Algometer and PJES.

Table 38: Correlations between the Algometer and PJES: group 2

		Infrapatella tendon algometer reading	Medial retinaculum algometer reading	Lateral retinaculum algometer reading	PJES
Infrapatella tendon algometer reading	Pearson Correlation	1	.700(**)	.525(*)	.494(*)
	Sig. (2-tailed)		.001	.018	.027
	N	20	20	20	20
Medial retinaculum algometer reading	Pearson Correlation	.700(**)	1	.509(*)	.439
	Sig. (2-tailed)	.001		.022	.053
	N	20	20	20	20
Lateral retinaculum algometer reading	Pearson Correlation	.525(*)	.509(*)	1	.132
	Sig. (2-tailed)	.018	.022		.580
	N	20	20	20	20
PJES	Pearson Correlation	.494(*)	.439	.132	1
	Sig. (2-tailed)	.027	.053	.580	
	N	20	20	20	20

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

From table 38 the following can be deduced:

In Group 2 there was a positive correlation between PJES (decreases) and the objective algometer (decreases) readings (i.e. pain increases); giving strong evidence that group 2 is a true PFPS group as compared to groups 1 and 3. This implies that with decreased functional ability, the patient has increased pain. However the scale does not differentiate the type of functional inability, which could be due to multiple causes. The reason for implying that it therefore indicates a true PFPS is based on the following discussion:

Group 1: Negative correlation between PJES and algometer readings, indicating that with a decrease in the PJES there is an increase in the

algometer reading (decrease pain). This implies that with functional ability decreased, there is an associated decrease in pain.

Group 3: There where a mixture of reported findings with 2 negative and 1 positive correlation. Therefore the implications are unclear.

From the above it can therefore be hypothesized that the PJES is not in any way related to the pain presentation over the measured retinaculae and infrapatella tendon. However it does lend credence in terms of the observed trends that group 1 has a myofascial / muscular pain syndrome as a predominant syndrome, group 2 a PFPS and group 3 either has a combination of the preceding two syndromes or a degenerative process occurring.

This assertion carries greater validity when the trends of the NRS readings are read in conjunction with the algometer and PJES readings, in group 2, where there was a reported significant decrease in PJES when compared to NRS which increased.

4.2.8 Correlation between OPRS and PJES.

Table 39: Correlations between OPRS and PJES for all groups

		OPRS	PJES
OPRS	Pearson Correlation	1	-.515(**)
	Sig. (2-tailed)	.	.000
	N	60	60
PJES	Pearson Correlation	-.515(**)	1
	Sig. (2-tailed)	.000	.
	N	60	60

** Correlation is significant at the 0.01 level (2-tailed).

There was a statistically significant negative correlation overall between OPRS and PJES ($p<0.001$)

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

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

The total group correlation between PJES and OPRS indicated that there was a significant negative correlation, which implies that as the PJES decreases (functional ability decreases), the OPRS increases.

This is in congruence with the current literature (OPRS as in Thomee et al. 1995; Reid 1992 and Magee 1997; and PJES as in Shea et al. 1992, for the scales), whereby the one scale measures the individual's ability (PJES) and the other the degree of pathology associated with PFPS (OPRS).

4.2.8.1 Correlations: group 1

Table 40: Correlations between OPRS and PJES: group1

		OPRS	PJES
OPRS	Pearson Correlation	1	-.255
	Sig. (2-tailed)	.	.278
	N	20	20
PJES	Pearson Correlation	-.255	1
	Sig. (2-tailed)	.278	.
	N	20	20

Table 41: Nonparametric Correlations between OPRS and PJES: group 1

			OPRS	PJES
Spearman's rho	OPRS	Correlation Coefficient	1.000	-.229
		Sig. (2-tailed)	.	.331
		N	20	20
	PJES	Correlation Coefficient	-.229	1.000
		Sig. (2-tailed)	.331	.
		N	20	20

Group 1: There was no correlation between OPRS and PJES

4.2.8.2 Correlations between OPRS and PJES: group 3

Table 42: Correlations between OPRS and PJES: group 3

		OPRS	PJES
OPRS	Pearson Correlation	1	-.525(*)
	Sig. (2-tailed)	.	.017
	N	20	20
PJES	Pearson Correlation	-.525(*)	1
	Sig. (2-tailed)	.017	.
	N	20	20

* Correlation is significant at the 0.05 level (2-tailed).

Table 43: Nonparametric Correlations between OPRS and PJES: group 3

			OPRS	PJES
Spearman's rho	OPRS	Correlation Coefficient	1.000	-.553(*)
		Sig. (2-tailed)	.	.011
		N	20	20
	PJES	Correlation Coefficient	-.553(*)	1.000
		Sig. (2-tailed)	.011	.
		N	20	20

* Correlation is significant at the 0.05 level (2-tailed).

Group 3: There was a statistically significant correlation between OPRS and PJES

The correlations in these groups between the OPRS and the PJES indicate that, they (group 1 and 3) follow the same trend as the total group picture, with group 3 having a significant correlation at p = 0.05.

The above trend indicates that there is incongruency between the OPRS and PJES measures in group 1, as a result of a confounding variable. This is in congruence with the assertions made previously (4.2.3, 4.2.5), where it was stated that there is a high probability that group 1 has a higher likelihood of a myofascial / muscular pain syndrome as a precursor to PFPS or associated with PFPS.

In addition to this when group 3 is compared with group 2 below, it becomes apparent that the group significance differs greatly and lends credence to the assertions that in group 3 there is either an underlying degenerative process or alternatively a myofascial / muscular pain syndrome. From this research the process cannot be accurately defined in this group although from literature it would seem most probable that there is a degenerative process (Reid, 1992:348; Scuderi, 1995: 60-61)

4.2.8.3 Correlations between OPRS and PJES: group 2

Table 44: Correlations between OPRS and PJES: group 2

		OPRS	PJES
OPRS	Pearson Correlation	1	-.825(**)
	Sig. (2-tailed)	.	.000
	N	20	20
PJES	Pearson Correlation	-.825(**)	1
	Sig. (2-tailed)	.000	.
	N	20	20

** Correlation is significant at the 0.01 level (2-tailed).

Table 45:Nonparametric Correlations between OPRS and PJES: group 2

			OPRS	PJES
Spearman's rho	OPRS	Correlation Coefficient	1.000	-.843(**)
		Sig. (2-tailed)	.	.000
		N	20	20
	PJES	Correlation Coefficient	-.843(**)	1.000
		Sig. (2-tailed)	.000	.
		N	20	20

** Correlation is significant at the 0.01 level (2-tailed).

Group 2: There was a statistically significant correlation between OPRS and PJES

4.3 Summary

The initial ***hypotheses*** (chapter 1) will be discussed here in the light of the findings and discussions in this chapter.

4.3.1 There is a relationship between the severity of PFPS and the objective clinical findings which is significant.

In group 2 there is a significant relationship (negative correlation) between the Algometer readings and the PJES (being both objective and subjective) indicating that there is a strong correlation between the two tests giving the indication of PFPS.

In group 1 there is a positive correlation showing that with a decrease pain (increased Algometer reading) there is still a decrease in the PJES, indicating a greater myofascial / muscular pain syndrome

In group 3 the Algometer readings are different:

- At the infrapatella tendon there is decrease in the Algometer (increase in pain) but there is an increase in the PJES indicating a possible PFPS or more likely an AMI due to a degenerative process.
- At the medial and lateral retinaculum reading there is a decreased Algometer reading (increase in pain) and a decreased PJES indicates a myofascial / muscular pain syndrome.

In group 2 and 3 there is a negative correlation with the Algometer readings and the OPRS. The Algometer decreases (increased pain) and there is an increase in the OPRS. The OPRS, having a higher (6) myofascial scale than the orthopedic (3) tests, increases in scale with the correlation of an increased pain. This indicates that there is a high myofascial / muscular pain syndrome and PFPS indication.

In group 1 there is a positive relationship with an increase in the Algometer (decreased pain) and an increase in the OPRS. This indicates a high myofascial / muscular pain syndrome.
There was no correlation between PJES and OPRS, in group 1.

Therefore the hypothesis is accepted for group 2 and rejected for groups 1 and 3.

4.3.2 There is a relationship between the severity of PFPS and the subjective clinical findings which is significant.

The NRS was correlated in varying degrees with the objective tests (Algometer, OPRS and PJES) thus indicating that the perceived severity of PFPS is not a reliable measure.

Therefore the hypothesis that severity of PFPS is related to the subjective clinical outcomes cannot be accepted for the entire population in this study and therefore cannot be extrapolated to the general population, as the results varied in significance and association dependant on the particular presentation as has previously been associated with each group.

4.3.3 There is a relationship between the severity of PFPS and patella motion (the degree and direction of restriction).

It was found that the relationship between the restrictions of the patella and the OPRS ($p = 0.022$) was significant for the total group (60 individuals).

Furthermore restrictions noted in individual directions seemed to show preference for a particular designated group (viz. SI in group 1) or a particular objective measurement tool (viz. SI and OPRS; ML and OPRS),

with no preference found to exist with the exception of PJES for the total group when compared to restrictions noted.

Therefore, the hypothesis as stated above, is rejected as the incidence and strength of the relationships are sporadic and limited either by group or by correlation with an assessment modality, and therefore no generalized statements can be made.

CHAPTER FIVE:

CONCLUSION AND RECOMMENDATIONS OF THE RESULTS

5.1 Conclusions.

The aim of this research was to assess the associations between the severity (degree of clinical dysfunction) of PFPS (in terms of the objective and subjective clinical measures) and patella mobility (direction of mobility loss and degree of motion loss). The PJES and the associated algometer reading was the most closely correlated / sensitive test for PFPS. The OPRS seemed to be an indicator for more of a myofascial / muscular pain syndrome than a scale for PFPS. The NRS was found not to be a reliable indicator for perceived pain in PFPS; this may be due to its subjective testing nature. There was a relationship between the OPRS and the general restrictions of the patella, but only for group.

Therefore this research shows that PFPS does not seem to be a defined clinical entity, but refers to a pathogenic process that evolves over time. However it must also be remembered that the patients may also be presenting with an acute exacerbation of PFPS upon a chronic pathogenic process, as a result of a sudden increase in mileage (as an example).

The above would explain that patients present with the classic signs and symptoms as measured in this study, but have varying degrees of significance between the variables, or have tendencies towards indicating different portions of the pathogenic process, indicating that Patellofemoral Pain Syndrome appears to refer to an evolving syndrome with pathognomonic signs and symptoms of PFPS. This is indicated by individuals tending towards a myofascial / muscular

pain syndrome in group 1, with evolution to a defined PFPS (group 2) to a PFPS with possible degenerative or long terms changes in group 3. This is supported by the results that indicate that Group 2 appears to be the most definable example of PFPS, where individuals meet the criteria as defined by the tests, signs and symptoms recorded in true PFPS.

In this light the researcher therefore recommends that patients with PFPS need to be holistically evaluated and treated for PFPS, including nutritional and supplement programs, correct stretching and toning exercises and correct foot wear and running techniques.

5.2 Recommendations.

- Methodological recommendations:
    - There is a need for a more defined clinical picture (age, ethnicity, aggravating factors (e.g. sport, occupation) and clinical presentation) of PFPS, as the norms applied in the literature where not congruent in every respect to the results of this research.
    - A specific outcomes evaluation sheet (similar to OPRS and PJES) needs to be defined for PFPS in order to minimize the ambiguity that arose in this study, where the outcomes evaluation sheet seems to have measured more than just PFPS as a condition.
    - 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.
    - Utilization of a digital Algometer to more accurately record the readings from this measurement.
    - 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.

- The degree of hypermobility should have been assessed in addition to the degree of hypomobility and normal mobility of the patella as assessed in this study.
- In further studies on motion palpation of the patella, the examiners should not be limited by predetermined planes / directions of movement.
- Limiting individual subjective input (e.g. NRS or clinical history questions) prior to the objective evaluation of the individual (viz. Hawthorne Effect (Mouton, 1996:152)).

- Further research directions based on this study.
  - Use of the individual groups that where represented in this study, with increased participant numbers in order to verify the findings of this study.
  - The primary involvement seems to be related to the involvement of VL (active or latent myofascial / muscular pain dysfunction); therefore further research should look at whether the VMO results from a secondary effect (viz. AMI) or becomes shortened due to latent myofascial / muscular pain dysfunction within itself.

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