THE RELATIONSHIP BETWEEN MYOFASCIAL TRIGGER POINTS, TOTAL WORK AND OTHER RECORDED MEASUREMENTS OF THE VASTUS LATERALIS AND VASTUS MEDIALIS, IN LONG-DISTANCE RUNNERS WITH PATELLOFEMORAL PAIN SYNDROME.

By

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

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

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DEDICATION

I would like to dedicate this work to my parents, Andy and Glynis Daly. It is thanks to your unconditional love and support that I have had the opportunity to reach my goals and dreams. Your generosity, words of encouragement and belief in me is greatly appreciated and will not be forgotten.

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ABSTRACT

Objectives: The aim of this study was to document the relationship between myofascial trigger points (active and latent) in the vastus lateralis and vastus medialis portion of the quadriceps femoris muscle, and total work in long distance runners suffering from PFPS. Furthermore this study also aimed at providing baseline graphs of vastus medialis and vastus lateralis with the use of a Cybex 700 Isokinetic Dynanometer activity in long distance runners suffering from PFPS and long distance runners with non-painful knees.

Methods: This was a quantitative, non-intervention clinical exploratory study. Fifty suitable participants were divided into two groups, Group A consisted of 40 long distance runners suffering from PFPS, and Group B consisted of 10 long distance runners that had non-painful knees. Both Group A and Group B were screened for vastus lateralis and vastus medialis trigger points and tested on the Cybex 700 Isokinetic Dynanometer. Subjective data was obtained from Group A using the Numerical Pain Rating Scale and the Patient Specific Functional Scale. Objective data was obtained from both Group A and Group B using the Algometer, Myofascial Diagnostic Scale, and the Cybex 700 Isokinetic Dynanometer. Descriptive analysis was achieved by frequency tabulations of categorical variables, box and whisker plots were used to display distributions graphically. Comparison of categorical and quantitative variables between independent groups were run using chi square or Fisher's exact tests and t-test or Mann-Whitney testing. Finally Spearman's correlation, multivariate generalized linear modelling and Repeated measures ANOVA were used where appropriate. All statistical analysis was completed at the 95% ($p<0.05$) level of confidence.

Results: There was a highly significant difference in number and severity of vastus lateralis and vastus medialis myofascial trigger points between the symptomatic (Group A) and asymptomatic (Group B) groups. The groups differed significantly with regards to total work measurements, as Group A had lower readings when compared to Group B. Futhermore, the total work values of the vastus lateralis were consistently higher than those of the vastus medialis.

Conclusion: With reference to this study, it is highly possible that a large proportion of the participants suffering with PFPS resulting in reduced total work readings of the VM muscle is due to reciprocal inhibition by the VL muscle.

GLOSSARY

1.1 Definitions related to Patellofemoral Pain Syndrome (PFPS)

- Patellofemoral Pain Syndrome (PFPS)

According to Wood (1998), patellofemoral pain syndrome (PFPS) refers to a syndrome that comprises of the following signs and symptoms: anterior knee pain, inflammation, imbalance, instability, or any combination thereof. PFPS is also referred to as patellagia, peripatella pain syndrome, patella tracking problem and anterior knee pain (Reid, 1992:349).

1.2 Definitions related to Myofascial Pain Syndrome (MPS)

- Myofascial Pain Syndrome (MPS)

A regional muscular disorder that results from both active and latent myofascial trigger points (Chaitow & Delany, 2002:124; and Hou et al. 2002:1411-1412).

- Myofascial trigger point (MFTrp's)

A hyperirritable spot in skeletal muscle that is associated with a hypersensitive palpable nodule in a taut band (Chaitow & Delany, 2000; and Travell, Simons & Simons, 1999). Compression of this hyperirritable spot causes pain and can give rise to characteristic referred pain and tenderness, and motor dysfunction (Travell, Simons & Simons, 1999). An active myofascial trigger point causes a clinical pain complaint, whilst a latent myofascial trigger point is clinically quiescent with respect to spontaneous pain and only causes pain on palpation (Travell, Simons and Simons, 1995:1-5).

- An active myofascial trigger point

A MFTrp that causes a clinical pain complaint. "It is a focus of hyperirritability in a muscle or it's fascia that is symptomatic with respect to pain; it refers to a pattern of pain at rest and/or at motion that is specific for the muscle. An active trigger point is always tender, prevents full lengthening of a muscle, weakens the muscle, usually refers pain on direct compression, mediates a local twitch response of the muscle fibers when adequately stimulated and often produces specific autonomic phenomena, generally in its referral zone" (Travell, Simons and Simons, 1999:1).

- A latent myofascial trigger point

"It is defined as a focus of hyperirritability in a muscle or it's fascia that is clinically quiescent with respect to spontaneous pain: it is only painful when palpated. A latent myofascial trigger point may have all the other clinical characteristics of an active trigger point, from which it is to be distinguished" (Travel, Simons and Simons, 1999:4).

1.3 Definitions related to Isokinetic Dynanometry:

- Total Work (TW): The total area under the torque curve with each repetition regardless of speed, range of motion or time (Davies,1992:p59) TW of the quadriceps demonstrates any "weakness" existing in the muscle (Davies, 1992:p59). For the purpose of this study TW will be measured in Joules (J), percentage of body weight (%BW) and total TW (set).

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CHAPTER ONE

INTRODUCTION

1.1 The problem and its setting:

The term Patellofemoral pain syndrome (PFPS) is descriptive, identifies the condition as a syndrome and is non assumptive (Meyer et al. 1990) and thus was chosen for this study.

In this respect PFPS refers to a syndrome that comprises of the following signs and symptoms: anterior knee pain, inflammation, imbalance, instability, or any combination thereof (Wood, 1998). PFPS is also referred to as patellagia, peripatella pain syndrome, patella tracking problem and anterior knee pain (Reid, 1992:349). The many names used for this syndrome, as well as the variety of proposed aetiological factors and different treatments, are an illustration of the complexity of the syndrome (Thomee et al. 1995).

Of all the knee problems presenting to a physician's office, the most common are disorders of the extensor mechanism (Walsh & Helzer-Julin, 1992, Powers, Landel & Perry, 1996), with PFPS being a common finding that affects a significant part of the population (Stakes, 2000). PFPS presents with localized peri- or retropatellar pain originating from the peripatellar tissue or the patellofemoral joint (Rowlands and Brantingham, 1999), and is aggravated by prolonged sitting, climbing stairs, kneeling and squatting (Powers, Landel, & Perry. 1996). This is supported by Rowlands and Brantingham (1999), who state that the prevalence of patellofemoral pain syndrome in the general population may be as high as 40% and may account for up to 25% of all running injuries for which medical attention is sought.

The cause of PFPS appears to be an enigma. Anatomical abnormalities, misalignments or anatomical predisposition (Walsh, 1994) or repetitive trauma (Davidson, 1993) are some of the possible aetiologies that have been cited in literature. The current trend in literature suggests an extensor mechanism dysfunction as the most probably aetiology (Juhn, 1999; and Post, 1998).

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

Gilleard et al. (1998) investigated the VM versus VL ratio and their role in the symptoms associated with PFPS. They found delayed activation of the VM to be present. However Powers, Landel & Perry (1996), demonstrated delayed onset of activity of the vastus medialis (VM) and vastus intermedialis (VI) during fast walking and descending ramps in individuals suffering from PFPS, this suggests that the preparation phase for initial contact may have been compromised.

The delayed activity may have been a result of anticipating a decreased muscular demand during loading due to a quadriceps femoris avoidance gait pattern (Powers, Landel & Perry, 1996). Powers, Landel & Perry (1996), propose that a quadriceps femoris muscle avoidance gait pattern would lead to generalised quadriceps femoris (QF) weakness and symptoms associated with PFPS. According to Travell, Simons & Simons (1999:1), myofascial trigger points are reported to cause muscular weakness and dysfunction.

A study by Dippenaar (2003) indicated that 95% of the subjects with PFPS presented with active and / or latent myofascial trigger points of the quadriceps femoris muscle. It was shown that a significant amount of latent myofascial trigger points were located in the distal muscular portion of the vastus medialis muscle (Dippenaar, 2003). Furthermore, Dippenaar (2003) suggests that the presentation of vastus medialis signs and symptoms may be secondary to the development of the myofascial component of the vastus lateralis.

Thus by implication there are 2 hypotheses in the literature:

1. One in which the delayed activation of the VM is directly related to the VM muscle – i.e. myofascial trigger points (Travell, Simons & Simons, 1999:1), or other pathology related to the neuro-muscular functions of the VM (Powers, Landel & Perry, 1996).
2. Or the development of an inhibition mechanism (reciprocal inhibition), whereby the vastus lateralis is responsible for the inhibition of the firing mechanism of the VM (Hopkins and Ingersoll, 2000).

Resolution of this issue is important with regard to the treatment and rehabilitation of subjects suffering from PFPS. Callaghan and Oldham (1996) suggest that VM dominance may be a personal trait with inter-individual variance, and that further studies are needed to investigate differences in the ratio of VM:VL in patients suffering from PFPS.

1.2 Aims and Objectives:

The aim of this study was to document the association of myofascial trigger points (active and latent) in the vastus lateralis and vastus medialis portion of the quadriceps femoris muscle, in relationship to the isokinetic readings with the use of a Cybex 700 Isokinetic Dynanometer activity (Davies, 1992:62). Furthermore this study also aimed at providing baseline graphs of VM to VL with the use of a Cybex 700 Isokinetic Dynanometer activity (Davies, 1992:62) in long distance runners suffering from PFPS and long distance runners with non-painful knees.

The first objective:

To document the presence of myofascial trigger points (active and latent), in the VL and in the VM portion of the quadriceps muscle in long distance runners suffering from PFPS and those with non-painful knees.

The second objective:

To provide baseline graphs of the concentric-eccentric isokinetic testing of the thigh by the Cybex 700 Isokinetic Dynanometer with the thigh in the neutral position (to provide readings of the entire QF muscle), internally rotated position (to provide emphasis on the VL portion of the QF muscle) and externally rotated position (to provide emphasis on the VM portion of the QF muscle).

The third objective:

To correlate the results obtained in the first and second objectives.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction:

This chapter gives a review of the available literature concerning the clinical, aetiological and diagnostic aspects of both patellofemoral pain syndrome and myofascial pain syndrome and areas of overlap between them. The theoretic basis for the delayed activation of the vastus medialis (VM) muscle and its role in the symptoms associated with patellofemoral pain syndrome are also discussed.

2.1 Anatomy and Biomechanics of the Patellofemoral joint:

The patella is a triangular sesamoid bone with its apex pointing inferiorly and is embedded in the quadriceps femoris tendon with the patella ligament attaching it to the tibial tuberosity (Moore and Dalley, 1999:617).

The patella acts as a guide for the quadriceps mechanism, sliding between the femoral condyles, which hold it in place (Davidson, 1993). It also increases the efficiency of the quadriceps muscle in extending the knee (Davidson, 1993), with the main biomechanical function of the patella being to increase the effective lever arm of the quadriceps femoris muscle in affecting knee extension or resisting knee flexion (Hungerford and Barry, 1979).

The patellofemoral articulation consists of the facets of the patella in contact with the sulcus of the anterior femur (Moore and Dalley, 1999:617). The patella surface can include up to seven facets, three on the medial and lateral surfaces and an extra (odd) facet on the medial side (Tria et al. 1992). The medial retinaculum and the vastus medialis obliquus stabilize the patella medially, while the lateral retinaculum, iliotibial band and the vastus lateralis muscle stabilizes the patella laterally (Bose et al. 1980; Moore and Dalley, 1999:619).

The surface anatomy of each side of the patellofemoral articulation, the overall rotational anatomy of the entire lower limb and the relationship of the surrounding muscles affect the contact between the two surfaces (Tria et al. 1992).

According to Travell and Simons (1983:248-257), the quadriceps femoris muscle group is comprised of four component muscles; the vastus lateralis (VL), vastus medialis (VM), vastus intermedialis (VI) and rectus femoris (RF); which are innervated by the posterior divisions of the femoral nerve(L2, L3, L4) .

The anatomical origins:

- Vastus lateralis: Greater trochanter and the lateral lip of the linea aspera of the femur.
- Vastus medialis: Intertrochanteric line and medial lip of the linea aspera of the femur.
- Vastus intermedialis: anterior and lateral surfaces of the body of the femur.
- Rectus femoris: anterior inferior iliac spine and groove superior to the acetabulum.

These muscles insert into the patella proximally in a layered fashion.
(Travell and Simons, 1983:254-256; Moore and Dalley, 1999:534).

The common direction of pull of the muscle fibers:

- Vastus lateralis (VL): 12-15˚ laterally in the frontal plane
- Vastus medialis longus (VML): 15-18˚ medially in the frontal plane
- Vastus medialis obliquus (VMO): 50-55˚ medially in the frontal plane
- Rectus femoris (RF): 7-10˚ medially in t he frontal plane

(Lieb and Perry, 1968).

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

Two forces act on the patella during knee movement; the first is a patellofemoral compressive force, and the second is a quadriceps muscle tension force.

The patellofemoral compressive force is also known as the patellofemoral joint reaction force (PFJRF) and is the measure of the compression of the patella against the femoral condyles and depends on the angle of flexion of the knee and the muscle tension (Hungerford and Lennox, 1983).

Correct tracking of the patella during flexion and extension of the knee is influenced by the following forces (Davidson, 1993):

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

2.2 Introduction to Patellofemoral Pain Syndrome (PFPS):

Of all the knee problems presenting to a physician's office, the most common are disorders of the extensor mechanism (Walsh and Helzer-Julin, 1992; Powers, Landel and Perry, 1996).

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.

A common cited cause of PFPS is that of selective dysfunction or insufficiency of certain components of the quadriceps femoris muscle (LaBrier and O'Neil, 1993). Any abnormality of anatomical structure that may influence the movement of the patella can cause excessive pressure between the patella and the femoral condyles (Davidson, 1993) therefore increasing the PFJRF.

According to Stakes (2000), PFPS is a common finding that affects a significant part of the population. It has been referred to as a myth, mystical and frustrating, and an enigma that remains a difficult condition to treat (Reid, 1993).

2.2.1 Incidence and Prevalence of PFPS:

The patellofemoral joint is a major source of pain and dysfunction in both men and women and in the sedentary and athletic population alike (Walsh, 1992).

Dehaven and Linter (1986), report the incidence of PFPS to be 19.6% in female collegiate athletes and 7.4% amongst their male counterparts.

Salem and Powers (2001), also found these types of injuries significantly common in female athletes. Davidson (1993), attributes the higher incidence amongst women to the wider gynaecoid pelvic structure which in turn increases the Q-angle.

Callaghan and Oldham (1996), found that PFPS affects one in four of the general population and is amongst the most common complaints in athletes. This is supported by Paluska and Mckeag (1999), who stated that disorders of the patellofemoral joint are common in recreational as well as competitive athletes, which is congruent with the finding that the prevalence of patellofemoral pain syndrome in the general population may be as high as 40% and may account for up to 25% of all running injuries for which medical attention is sought (Rowlands and Brantingham, 1999).

2.2.2 Aetiology and Pathophysiology of PFPS:

The pathophysiology, although unclear, has been related to malalignment of the patella and the femoral trochlear, which is thought to be the cause of the characteristic anterior knee symptoms (Cherf and Paulos, 1990). This is supported by Gilleard et al. (1998), in which they stated that subjects with PFPS may have problems with the patella entering the trochlear of the femur.

The aetiology of PFPS is poorly understood (Kannus et al. 1999), as a variety of factors including abnormal lower limb mechanics, vastus medialis obliquus (VMO) insufficiency, tight lateral structures and tight anterior and posterior muscles may contribute to the cause of PFPS according to Felder and Leeson (2002).

According to Davidson (1993), repetitive microtrauma is one of the circumstances under which PFPS develops which occurs most commonly in “overzealous recreational athletes”. This is supported by Reid (1992), who suggests that repeated weight-bearing impact, particularly in runners, may be a contributing factor.

Gilleard et al. (1998) investigated the VM versus VL ratio and their role in the symptoms associated with PFPS. They found delayed activation of the VM to be present. However, Powers, Landel and Perry (1996) demonstrated delayed onset of activity of the VM and VI during fast walking and descending ramps in individuals suffering from PFPS, this suggests that the preparation phase for initial contact may have been compromised. The delayed activity may have been a result of anticipating a decreased muscular demand during loading due to a quadriceps femoris avoidance gait pattern (Powers, Landel and Perry, 1996).

According to LaBrier and O'Niel (1993), a commonly cited cause of PFPS is that of selective dysfunction or insufficiency of certain components of the quadriceps femoris muscle. This is supported by Suter et al. (1998) who stated that a common consequence of knee pathology is weakness of the knee extensor muscles. According to Powers, Landel and Perry (1996), there is little doubt of the importance of normal QF activity to the functional integrity of the knee joint.

2.2.3 Clinical evaluation of the patient:

The clinical history is of great importance to the diagnosis of PFPS (Tria et al. 1992). According to Juhn (1999), the patient with PFPS presents most often with peripatella or retropatella pain. The pain is usually of a dull and aching nature becoming sharp with patella compression activities including climbing or descending stairs, squatting or deep knee bends or sitting for prolonged periods of time with the knee flexed, known as a "movie-goers sign" (Davidson, 1993).

Powers, Landel and Perry (1996); Delee and Drez (1994), add kneeling, physical exercise and isometric QF contractions to the previous points as factors that aggravate the pain associated with PFPS.

With the presence of MFTrp's in the quadriceps femoris muscle, a structure contributing to the "extensor mechanism", symptoms include chiefly pain and weakness (Travell and Simons, 1983:248). A buckling knee can be caused by MFTrp's in the vastus medialis, while MFTrp's in the vastus lateralis may cause locking of the patella with the knee in the extended position (Travell and Simons, 1983:248-252).

Scrainge (1994) found that rest relieves the pain, especially when seated with the leg in an extended position as this enables the patella to disengage the femoral trochlea.

Walsh (1994), stated that patella mobility might be increased or decreased, although most literature suggests a tightened lateral retinaculum will restrict the medial glide of the patella (McConnel, 1986).

Post (1998), suggested that the iliotibial band, which is frequently tight in subjects with PFPS, may result in a patella restriction due to the iliotibial bands strong attachment to the patella through the lateral retinaculum.

In a study by Clifton (2003), using an isokinetic dynamometer, the presence of both concentric and eccentric QF weakness and the presence of hamstring weakness in participants with PFPS was confirmed.

The clinical diagnosis of PFPS was based on criteria by Powers, Landel and Perry (1996) and by Rowlands and Brantingham (1999), for the purpose of this study.

- Participants presented with retro- or peripatella pain
  (Rowlands and Brantingham, 1999).

- Participants presented with at least two of the following:
  Pain on prolonged sitting (movie-goers sign)
  Pain on climbing and/or descending stairs
  Pain on deep knee bends or squats
  Pain on kneeling
  (Powers, Landel and Perry, 1996).

According to Davidson (1993), the following three findings on examination are fairly specific for PFPS, and were used for the purpose of this study:

1. Tenderness of the medial and lateral facets on palpation.
2. Compression of the patella on the femoral condyles (Waldron's test) may cause discomfort.
3. When both sides of the patella are grasped while the patient contracts the QF muscle (Clarke's sign) the pressure of the patella against the femoral condyles may cause discomfort.

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2.2.4 Natural History of PFPS:

A study by Sandow and Goodfellow (1985) found that PFPS is a benign condition, which affects individuals for many years after the initial onset causing residual pain in most cases.
The pain tended to be less intense in nature and tended to occur less frequently in the majority of individuals when compared to the initial visit. Only a small percentage experienced an increase in pain, which may have severely restricted sporting activities in some cases.

Findings in a seven year follow up study by Kannus et al. (1999), suggest that the presence of patella abnormalities such as decrease in patella cartilage thickness, increase in the signal density of the patella cartilage or roughness of the patella surface were not common findings in the presentation of PFPS.

However, Kannus et al. (1999) state that only a 10-20 year follow up study will provide a clear picture of the natural history of this condition. With this in mind, the natural history of PFPS is a little obscure and the amount of time needed for this condition to resolve is unknown.

2.3 Introduction to Myofascial Pain Syndrome (MPS):

According to Gatterman (1990:287); Chaitow & Delany (2002:18-20), Myofascial Pain Syndrome (MPS) is an extremely common type of muscular condition that frequently presents to primary health care practitioners an is of a multi-factorial origin.

2.3.1 Incidence and Prevalence of MPS:

In a review article written by Han and Harrison (1997:90), found that myofascial pain appeared to be the most common phenomenon in the clinical setting with the incidence of MPS reported as high as 85% at certain American pain clinics.

According to Goldberg (1987); Gatterman (1990:287); and Travell, Simons and Simons (1999:1-12), latent MFTrp's are more common than active MFTrp's. However, active MFTrp's refer pain to the associated pain referral sites at rest and/or on motion that is specific for the involved muscle (Travell and Simons, 1983:1), creating a greater problem in the clinical presentation.

Travell, Simons and Simons (1999:1-13); and Han and Harrison (1997:90), suggest that individuals in their later years between the ages 30-49years are more likely to suffer from MPS, with a female prevalence twice that of the male counterpart in all ages (Han and Harrison ,1997:89).
Likewise, Dahaven and Linter (1986), report the prevalence of PFPS to be greater in the female population compared to the male counterparts.

2.3.2 Aetiology of MPS:

Several primary and secondary factors may result in the development or activation of MFTrp's (Travell, Simons and Simons; 1999).

Primary factors include: mechanical abuse, trauma, nerve compression, adverse environmental conditions, leaving the muscle in a shortened position for a period of time and systemic biochemical imbalances (Travell, Simons and Simons, 1999; and Chaitow and Delany, 2002).

Secondary factors include: compensating synergistic or antagonistic muscles, satellite MFTrp's and low oxygenation of tissues (Baldry, 1993).

More specifically, activation of MFTrp's in the quadriceps femoris muscle often occurs with trauma to the muscle (which commonly occurs in athletes with an increase in mileage training over a short period of time), during a fall or a misstep (Travell and Simons, 1983:248-249).

Perpetuating factors include: mechanical stresses, nutritional inadequacies, metabolic and endocrine inadequacies, chronic infection, psychological factors and miscellaneous factors such as fatigue and radiculopathies (Travell and Simons, 1999 1:110-112).

2.3.3 Natural History of MPS:

In the absence of perpetuating factors together with adequate rest, an active MFTrp may revert spontaneously to a latent state (Travell, Simons and Simons (1999:1-20). Reactivation of a MFTrp by exceeding the muscle's stress tolerance, as commonly occurs in athletes with a sudden increase in mileage over a short period of time, can account for a history of recurrent episodes of the same or similar pain over a period of years.

2.3.4 Presentation of MPS:

MPS typically presents as a regional persistent pain. The severity of the symptoms ranges from the agonising incapacitating pain caused by very active MFTrp's to the painless restriction of movement and distortion of posture due to latent MFTrp's (Travell, Simons & Simons, 1999:13).

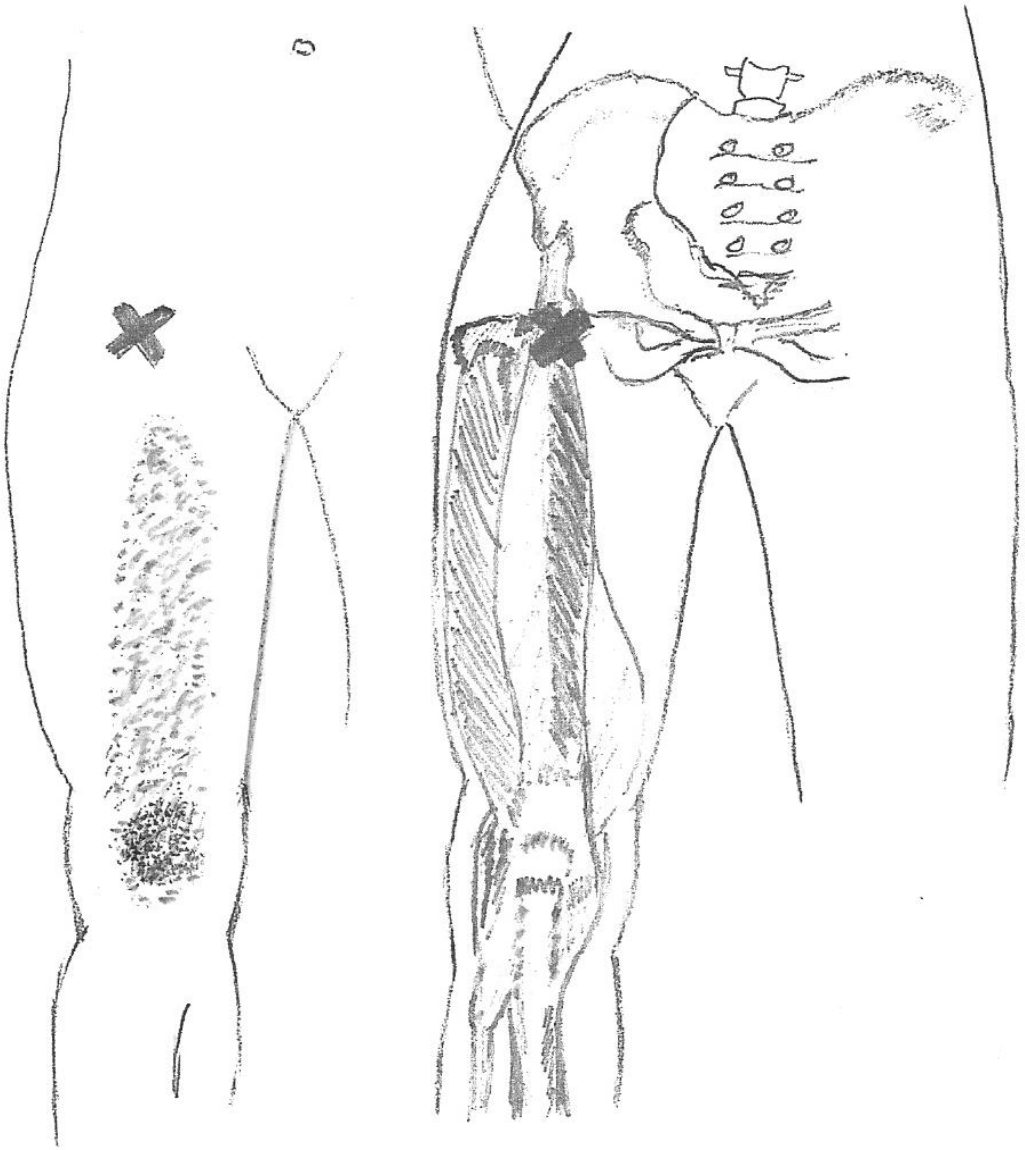
Motor disturbances may be experienced by the patient as described by Travell, Simons and Simons (1999:1-21), include muscle weakness, spasm of synergistic and/or antagonistic muscles and decrease in muscle power or work tolerance.

Presentation of the MFTrp's in the Quadriceps femoris muscle:

- Presentation of the MFTrp's in the Rectus femoris (RF) muscle

The first MFTrp is at hip level just below the anterior inferior iliac spine. The referred pain pattern for the first MFTp of the RF muscle is felt at the knee in and around the patella and occasionally deep within the joint. The second less common MFTrp is found at the lower end of the muscle just above the patella. Travell and Simons (1983:248-288) and Chaitow and Delany (2002:483-486).

Figure 2.3.4.1 (Daly, 2005)

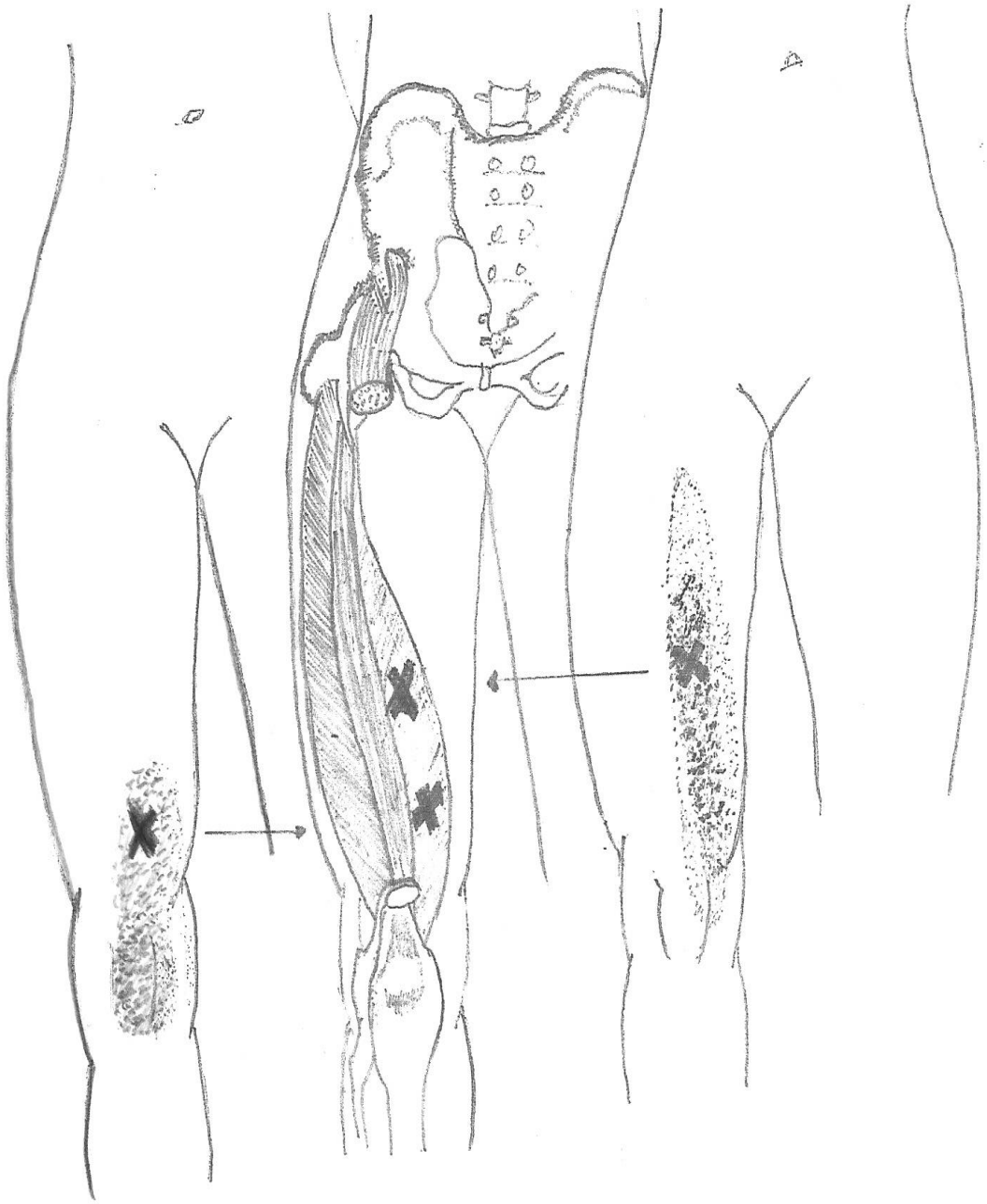


- Presentation of the MFTrp's in the vastus medialis (VM) muscle

The first and most common MFTrp is found in the distal muscle superomedial to the patella. Pain is referred to the anterior knee with some referral to the anteromedial aspect of the knee and some to deep within the knee joint. The second MFTrp is found proximal to the first at mid-thigh level. This may result in buckling of the knee.

Travell and Simons (1983:248-288); Baker (1989:129-131); Chaitow and Delany (2002:483-486).

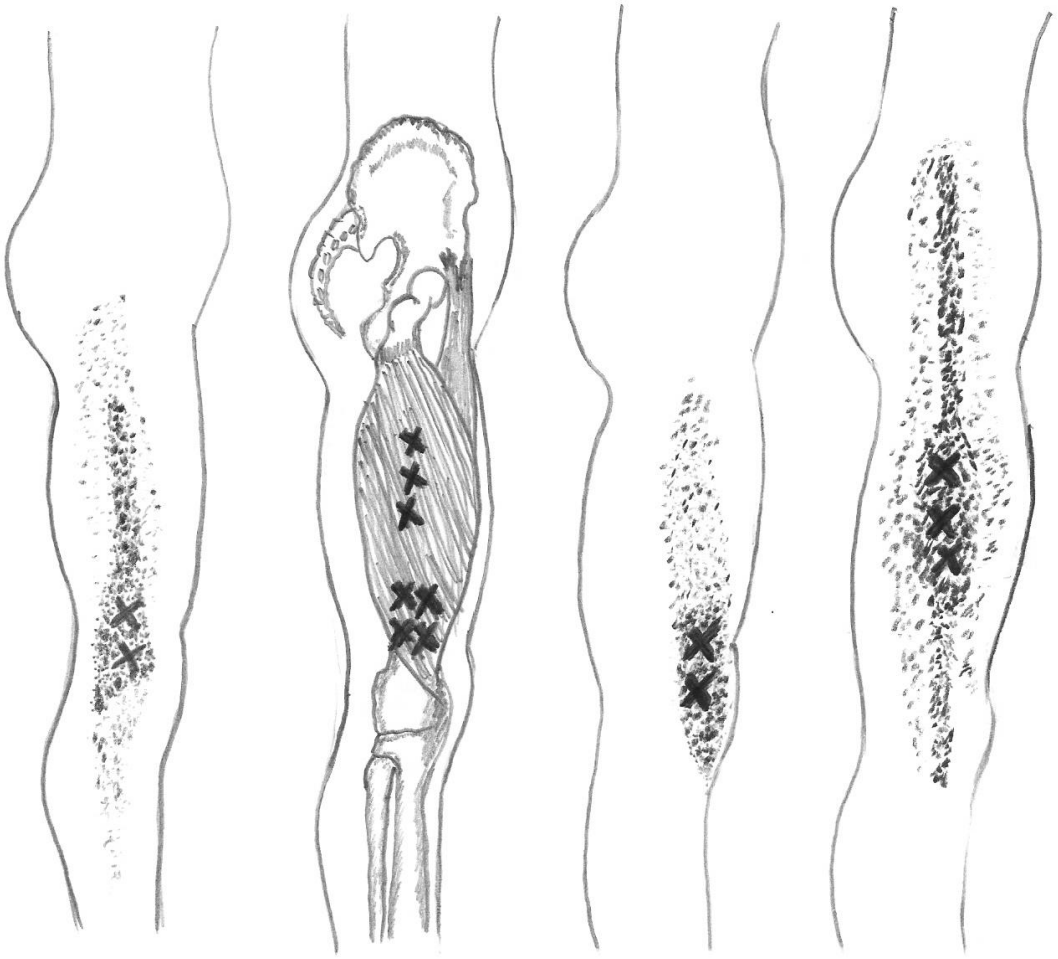
Figure 2.3.4.2 (Daly, 2005)



- Presentation of the MFTrp's in the vastus lateralis (VL) muscle

The five areas in which the MFTp's develop along the lateral aspect of the thigh spread along the length of the muscle. They refer pain throughout the full length of the muscle and to the lateral aspect of the patella. MFTrp's in the distal aspect of the muscle may cause a "stuck patella" or "locking" of the patella in combination with pain around the lateral border of the patella. Travell and Simons (1983:248-288); Chaitow and Delany (2002:483-486).

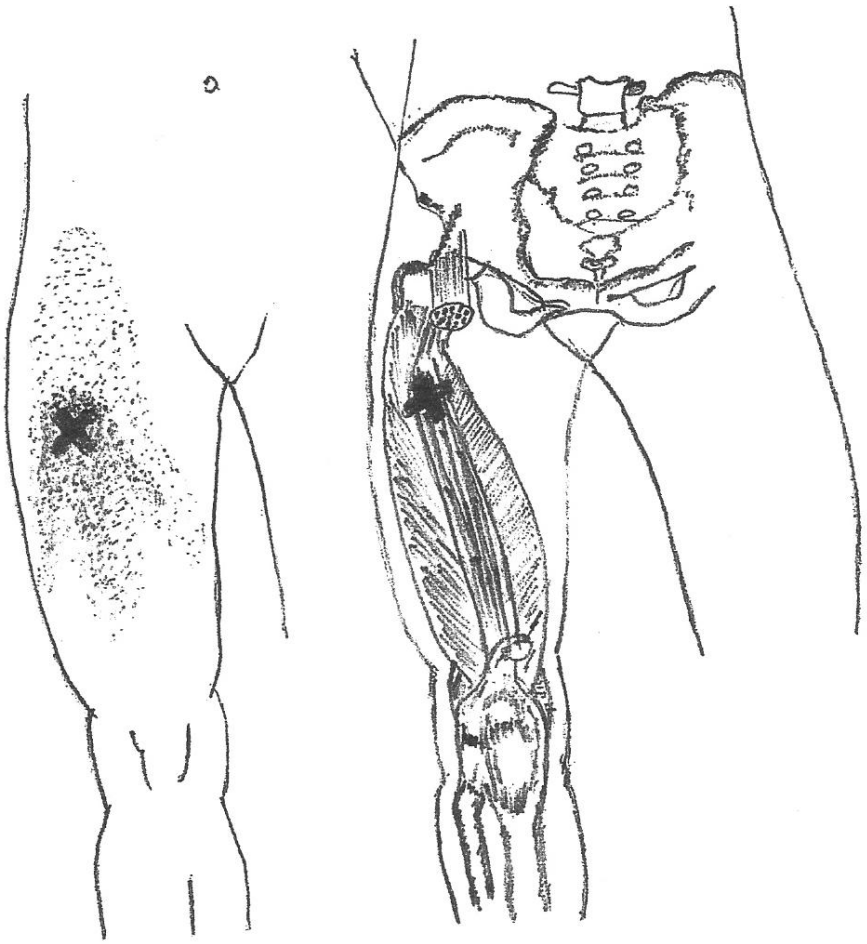
Figure 2.3.4.3 (Daly, 2005)



- Presentation of the MFTrp's in the vastus intermedialis (VI) muscle

A number of MFTrp's develop here, however they cannot be palpated directly as they are hidden by the RF muscle. They refer pain over the anterior thigh just superior to the knee. Travell and Simons (1983:248-288); Chaitow and Delany (2002:483-486).

Figure 2.3.4.4 (Daly, 2005)



According to Travell, Simons and Simons (1999), the presence of MFTrp's in the quadriceps femoris (QF) muscle could result in signs and symptoms including peri- and retropatellar pain, weakness of the QF muscle and loss of full lengthening. The above would result in inhibition of QF muscle activity and a resultant extensor mechanism dysfunction (Travell and Simons, 1983).

A study by Dippenaar (2003) shows a large overlap in the signs and symptoms of the two syndromes; patellofemoral pain syndrome (PFPS) and myofascial pain syndrome (MPS). "Both present with the following signs and symptoms:

- Peripatella or retropatella pain
- Pain on prolonged sitting
- Pain worsened with ascending or descending stairs
- Pain worsened with physical activity
- Pain on deep squats
- Pain on kneeling
- Pain on isometric quadriceps femoris contractions
- Patella mobility restriction"

(Dippenaar, 2003)

According to Travell and Simons (1983), the following referred pain pattern is produced with the presence of myofascial trigger points in the QF muscle:

- The anterior knee
- The medial aspect of the knee
- The lateral aspect of the knee
- Deep within the knee joint

This coincides, according to Woods (1998), with the classic peri- and retropatella pain pattern of PFPS.

Dippenaar (2003) concludes that there is a high degree of overlap between the presence of MDS and PFPS, when patients present with PFPS. "Thus it can be concluded that myofascial pain syndrome is a positive predictive factor in the development of Patellofemoral pain syndrome" (Dippenaar, 2003).

2.3 In Summary:

Powers, Landel and Perry (1996), propose that a quadriceps femoris muscle avoidance gait pattern would lead to generalised quadriceps femoris (QF) weakness and symptoms associated with PFPS. According to Travell, Simons and Simons (1999:1), myofascial trigger points are reported to cause muscular weakness and dysfunction.

Hence the study by Dippenaar (2003), which indicated that 95% of the subjects with PFPS presented with active and / or latent myofascial trigger points of the quadriceps femoris muscle. Furthermore, Dippenaar (2003) suggests that the presentation of vastus medialis signs and symptoms may be secondary to the development of the myofascial component of the vastus lateralis.

Thus by implication there are 2 hypotheses in the literature:

1. One in which the delayed activation of the VM is directly related to the VM muscle – i.e. myofascial trigger points (Travell, Simons and Simons, 1999:1), or other pathology related to the neuro-muscular functions of the VM (Powers, Landel and Perry, 1996).
2. Or the development of an inhibition mechanism (reciprocal inhibition), whereby the vastus lateralis is responsible for the inhibition of the firing mechanism of the VM (Hopkins and Ingersoll, 2000).

Resolution of this issue is important with regard to the treatment and rehabilitation of subjects suffering from PFPS. Callaghan and Oldham (1996) suggest that VM dominance may be a personal trait with inter-individual variance, and that further studies are needed to investigate differences in the ratio of VM:VL in runners suffering from PFPS.

CHAPTER THREE

MATERIALS AND METHODS

3.0 Introduction:

The aim of this study was to document the association of myofascial trigger points (active and latent) in the vastus lateralis and vastus medialis portion of the quadriceps femoris muscle, in relationship to the isokinetic readings with the use of a Cybex 700 Isokinetic Dynanometer activity (Davies, 1992:62). Furthermore this study also aimed at providing baseline graphs of VM to VL with the use of a Cybex 700 Isokinetic Dynanometer activity (Davies, 1992:62) in long distance runners suffering from PFPS and long distance runners with non-painful knees.

3.1 Design:

The design was that of a quantitative, non-intervention exploratory study.

3.2 Advertising:

The public was informed of the study by advertisements placed at local gymnasiums, athletic clubs, in local newspapers and on the Durban Institute of Technology (DIT) campus advertising for free participation in a research program being conducted on knee pain in long-distance runners (Appendix 1).

3.3 Sample:

The sample consisted of 40 volunteer long-distance runners suffering from PFPS, allocated to group A, and 10 volunteer long-distance runners with non-painful knees, allocated to group B, residing in the Kwa-Zulu Natal province.

Upon reply all participants were required to undergo a cursory telephonic discussion with the examiner to exclude subjects that did not fit the criteria for the study (Appendix 2).

An initial consultation was scheduled during which a case history (Appendix 3), physical examination (Appendix 4) and knee regional examination (Appendix 5) were completed.

Acceptance of the participant was dependant on whether or not they met the specific inclusion criteria indicated below:

Inclusion Criteria:

Participants were between the ages of 18 and 60 years (Rowlands and Brantingham, 1999).

Participants were long-distance runners (Running an average of two hours per week)

Participants allocated to Group A presented with patellofemoral pain syndrome:

In diagnosing PFPS, emphasis was placed on case history and physical findings as opposed to specific orthopaedic tests, as these have not yet been proven reliable.

Participants allocated for Group A presented with at least three of the following:

- Retro- or peripatella pain (Rowlands and Brantingham, 1999).
- Pain on prolonged sitting (movie-goers sign)
- Pain on climbing and descending stairs
- Pain on deep knee bends or squats
- Pain on kneeling

  (Powers, Landel, Perry, 1996).

Participants allocated to Group B did not present with patellofemoral pain syndrome:

In excluding the diagnosis of PFPS, emphasis was placed on case history and physical findings as opposed to specific orthopaedic tests, as these have not yet been proven reliable.

All participants received a letter of information (Appendix 6) and were required to sign an informed consent form (Appendix 7) before participation in the study commenced.

Exclusion Criteria:

Participants were excluded if they had a history of one or more of the following:

- any neurological involvement that influenced their gait.
- had undergone knee surgery within the past two years.
- traumatic patella dislocation.

  (Rowlands and Brantingham, 1999).
- trauma and / or surgery of the involved knee.

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

- bursitis, patella tendonitis, fat pad syndrome
- any systemic arthritide that affected the knee.
  (Powers, Landel and Perry. 1996).
- evidence of a meniscal tear
- ligamentous instability (pathological or trauma induced)
- abnormalities indicative of osteoarthritis, osteochondritis dessicans or loose bodies
- pregnant or breast-feeding subjects.
  (Kannus et al. 1999)

Participants presenting with acute, severe PFPS who experienced pain that prevented them from completing the isokinetic test were excluded from the study.

Participants were excluded if they received any form of therapy (Poul et al. 1993), for their patellofemoral pain syndrome during the course of this research period.

Participants who had not signed the informed consent form were excluded from this study.

All the relevant data required to diagnose PFPS was collected at the initial consultation. At the second consultation familiarization testing on the Cybex 700 Isokinetic Dynanometer was performed. Relevant subjective and objective data was gathered at the third consultation prior to the actual testing on the Cybex 700 Isokinetic Dynanometer.

Diagnosis of Myofascial trigger points:

Once the participant had been included in the study they were screened for myofascial trigger points. It is the opinion of Travell, Simons and Simons (1999:34-35) that no one diagnostic examination alone is a satisfactory criterion for the identification of a trigger point. According to Travell and Simons (1983:12-16) the signs of a trigger point are as follows:

- Referred pain in the zone of reference
- Local twitch response
- Palpable taut band and
- Focal tenderness

3.4 Measurement tools:

Both group A and group B were screened for VL and VM myofascial trigger points (Figures 2.3.4.1 – 2.3.4.4) and tested on the Cybex 700 Isokinetic Dynanometer.

Subjective and objective measurements were taken on the third consultation using the following scales:

Subjective data:

Obtained from group A only.

1. Numerical Pain Rating Scale (NRS) (Jenson et al. 1986). (Appendix 8).

The NRS 10 assesses the patient's perception of their pain intensity. The questionnaire consists of a numerical scale of eleven points with 10 representing pain at it's worst and 0 representing no pain. The NRS has been found to be a reliable and valid method to record subjective data relating to the patients level of pain (Jensen, et al. 1986:125).

2. Patient Specific Functional Scale (PSFS) (Chatman et al. 1997). (Appendix 9).

Chatman et al. (1997), found the PSFS to be time efficient and an appropriate tool for assessing changes in disability. The study by Chatman et al. (1997), showed that for knee dysfunction at the individual activity level a change in 3 or more PFPS points provides reliability at a 90% confidence interval, and that validity in terms of with-in patient decision making exists.

Objective data:

Obtained from group A and Group B.

1. Algometer (Appendix 10).

The pocket-sized pressure Algometer has been widely used to document the tenderness of myofascial trigger points (Fischer, 1986). Nussbaum and Downes (1998) reported reliability of clinical pressure pain algometeric measurements. Reeves et al. (1986) and Fischer (1987:207) demonstrated the reliability and validity of the pressure algometer in measuring myofascial trigger point sensitivity.

2. Myofascial diagnostic scale (MDS) (Chettiar, 2001). (Appendix 8).

The purpose of this scale is to determine the extent to which a patient suffers from myofascial trigger points (Chettiar, 2001). The scale is rated out of 17 points, a score of 9 or above is considered indicative of an active trigger point while a score below 9 is indicative of a latent trigger point.

In order to determine whether myofascial trigger points occur more commonly in the vastus medialis, vastus lateralis, vastus intermedialis or rectus femoris of the quadriceps femoris muscle, measurements were taken and recorded as to the specific location of the myofascial trigger points in quadriceps femoris muscle at the third consultation, prior to the actual test on the Cybex 700. More specifically the association with myofascial trigger points, both active and latent, found in the vastus lateralis and vastus medialis portions of the quadriceps femoris muscle were noted. The MDS was then used to assess the severity of present myofascial trigger points.

3. Cybex 700 Isokinetic Dynanometer at King's Park Sports Medical Centre under the supervision of Mr J. Wright HonsB (Biokinetics).

Davies (1992:p362) states that it is possible to isolate knee extensor muscle groups using an Isokinetic Dynanometer. According to Davies (1992:p62), one of four factors that appear to be most specific in demonstrating "weakness" existing in a muscle is the Total Work (TW) of the quadriceps. Callaghan et al. (2000) stated that researches should have confidence in using a multi-joint device (i.e.: Cybex 700, when testing patients with PFPS). Evidence suggests that this type of measurement is considered the most appropriate tool as a direct indicator of functional status.

Two test sessions were performed on the Cybex 700, the first of which was for participant familiarization and the second for the actual test. These two tests were performed 7days apart (Wright, 2004).

Methodology with the use of the Cybex 700 Isokinetic Dynanometer, as recommended by Wright (2004), included:

- 5 minute warm-up on an exercise bicycle
- Quadriceps and Hamstring stretches for 15 seconds repeated 3 times.
- 4 – 6 Sub-maximal warm-up repetitions on the Cybex 700 Isokinetic Dynanometer in order to customize the participant to the machine.
- Actual test consisted of 6 maximum efforts where an average of the 6 repetitions was taken for the entire quadriceps muscle, the VL and the VM individually.

The Cybex 700 Isokinetic Dynamomter to be used was calibrated weekly for the duration of the study.

3.5 Statistical Analysis:

Data were exported into SPSS version 12 (SPSS inc. Chicago, Ill) for analysis.

Descriptive analysis was achieved by frequency tabulations of categorical variables and calculation of means, medians and standard deviations in the case of quantitative variables. Box and whisker plots were used to display distributions graphically.

Interferential Statistical analysis

Comparison of categorical variables between independent groups: chi square or Fisher's exact tests where appropriate.

Comparison of quantitative variables between two independent groups: t-test or Mann-Whitney test where appropriate

Pearson's or Spearman's correlation coefficients were calculated to assess correlation between two quantitative variables where appropriate.

Multivariate generalized linear modeling was used to examine relationships between many quantitative dependant variables and several factors and covariates.

Repeated measures ANOVA was used to compare the two muscle components with regard to quantitative outcomes of total work, controlling for between subjects factor of group.

Hypothesis testing decision rule: a two tailed p value of <0.05 was considered statistically significant.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Introduction:

This chapter tabulates the results and discusses these results obtained from the statistical analysis of the primary data collected over the duration of the study.

The measurements criteria included:

- Numerical Pain Rating Scale (subjective)
- Patient Specific Functional Scale (subjective)
- Algometer readings (objective)
- Myofascial Diagnostic Scale (objective)
- Cybex 700 Isokinetic Dynanometer (objective)

The age, gender, and distance run per week (measured in kilometers) are tabulated.

Criteria Governing the Admissibility of Data:

Data was collected only from those patients who met the research criteria and who participated for the full duration of the research program. Only subjective pain perception data and the Patient Specific Functional Scale that was completed by the participants under supervision of the researcher were utilized. Only objective algometer readings, Myofascial Diagnostic Scale readings, location of MFTrp's readings and Cybex 700 Isokinetic Dynanometer measurements taken by the researcher were utilized.

4.1. Demographics:

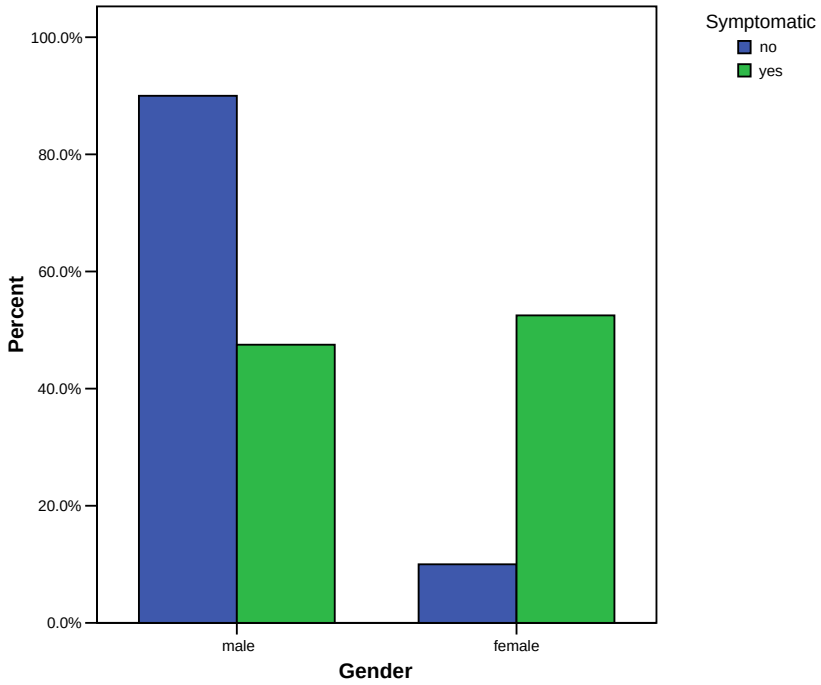


Figure 4.1.1: Distribution of gender by group (n=50)

There were 50 subjects in the study: 40 (80%) symptomatic (Group A) and 10 (20%) asymptomatic (Group B). The majority (90%) of Group B were male, while 47.5% of Group A were male. Thus there was a statistically significantly unequal distribution of male and female participants by group (p = 0.029). This is shown in Figure 4.1.1.

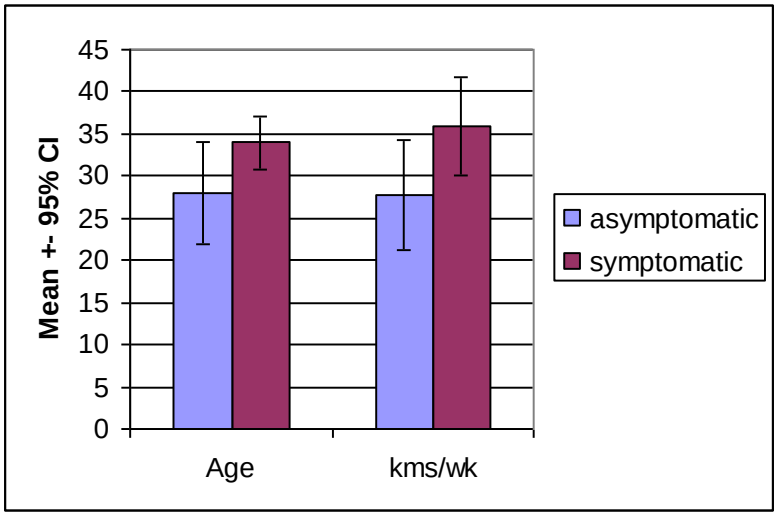


Figure 4.1.2: Mean and 95% confidence interval for age and kilometers run per week by group

Figure 4.1.2 shows the mean and 95% confidence interval for age and number of kms run per week by group. Participants in Group A were slightly older than those in Group B and ran more kilometers per week.

Table 4.1.1: Independent samples t-test for difference between Group A and Group B by age and kms/week

	t	df	p (2-tailed)
Age	1.707	14.340	.109
kms/wk	1.287	48	.204

There was no significant difference between mean age of participants by group (p=0.109), or mean number of kilometers run per week by group (p = 0.204). This is shown in Table 4.1.1. It can also be seen in Figure 4.1.2 that the 95% CI overlapped between the groups, indicating that the means were not significantly different.

4.2. VL trigger points

4.2.1. Type and number of VL trigger points by group

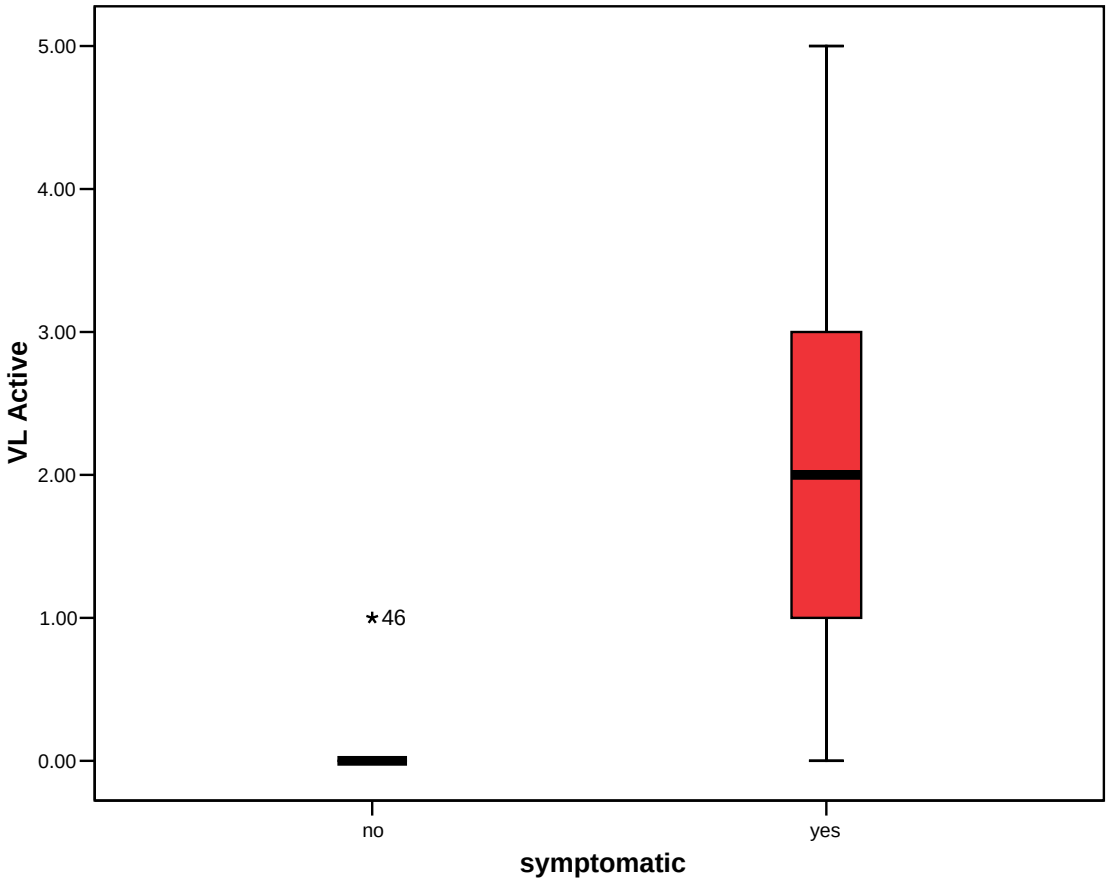


Figure 4.2.1: boxplot of number of active VL trigger points by group

The median number of active VL trigger points in Group B was 0 (range 0-1), while the median in Group A was 2 (range 0-5). This is shown in Figure 4.2.1. There was a significant difference in median number of active VL trigger points by group (p <0.001). Results of the Mann-Whitney test are shown in Table 4.2.1.

Table 4.2.1: Mann-Whitney tests for difference in median number of VL active trigger points by group

	symptomatic	N	Mean Rank	Sum of Ranks	p (2 tailed)
VL Active	No (Group B)	10	8.20	82.00	<0.001
	Yes (Group A)	40	29.83	1193.00	
	Total	50			

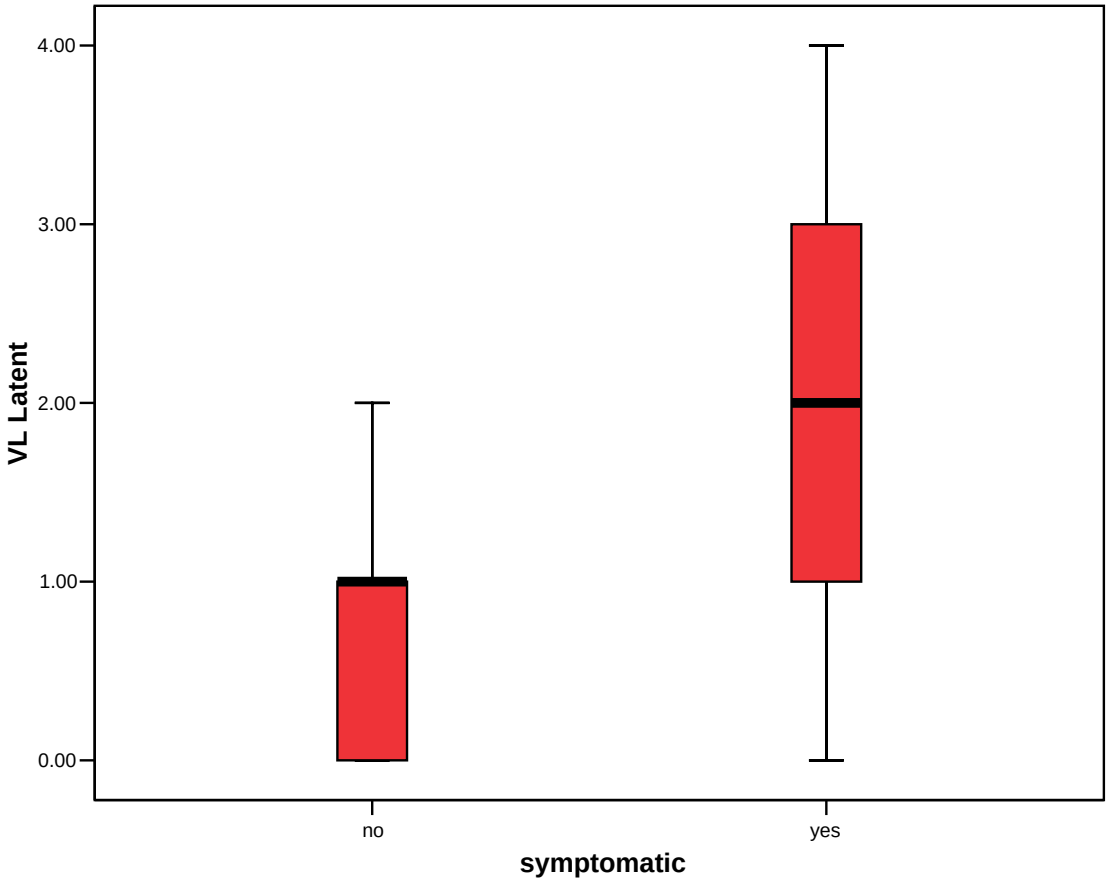


Figure 4.2.2: boxplot of the number of latent VL trigger points by group

The median number of latent VL trigger points in Group B was 1 (range 0-2) and in Group A was 2 (range 0-4). Figure 4.2.2 shows this graphically. Table 4.2.2. shows that this difference was statistically significant (p=0.014).

Table 4.2.2.: Mann-Whitney tests for difference in median number of VL latent trigger points by group

	Symptomatic	N	Mean Rank	Sum of Ranks	p (2 tailed)
VL Latent	No (Group B)	10	15.55	155.50	0.014
	Yes (Group A)	40	27.99	1119.50	
	Total	50			

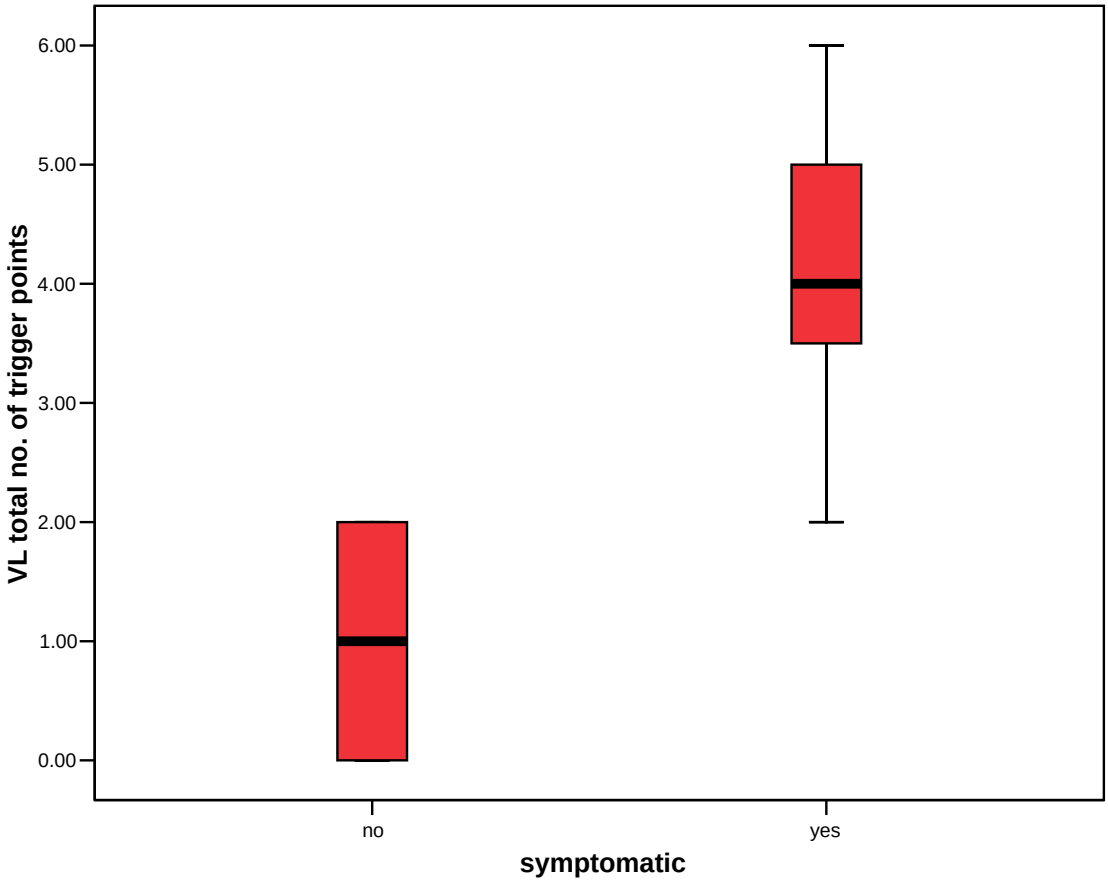


Figure 4.2.3.: boxplot of total VL trigger points by group

The median number of total VL trigger points in Group B was 1(range 0-2) and in Group A was 4 (range 2-6). This is shown in Figure 4.2.3. There was a highly statistically significant difference between Group A and Group B with regard to total number of VL trigger points ($p<0.001$). Table 4.2.3 shows this.

Table 4.2.3: Mann-Whitney tests for difference in median number of total VL trigger points by group

	Sympto-matic	N	Mean Rank	Sum of Ranks	p (2 tailed)
VL total number	No (Group B)	10	6.10	61.00	<0.001
	Yes (Group A)	40	30.35	1214.00	
	Total	50			

4.2.2. Severity of VL trigger points by group
Severity was measured by NRS, Algometer and MDS.

4.2.2.1. NRS:

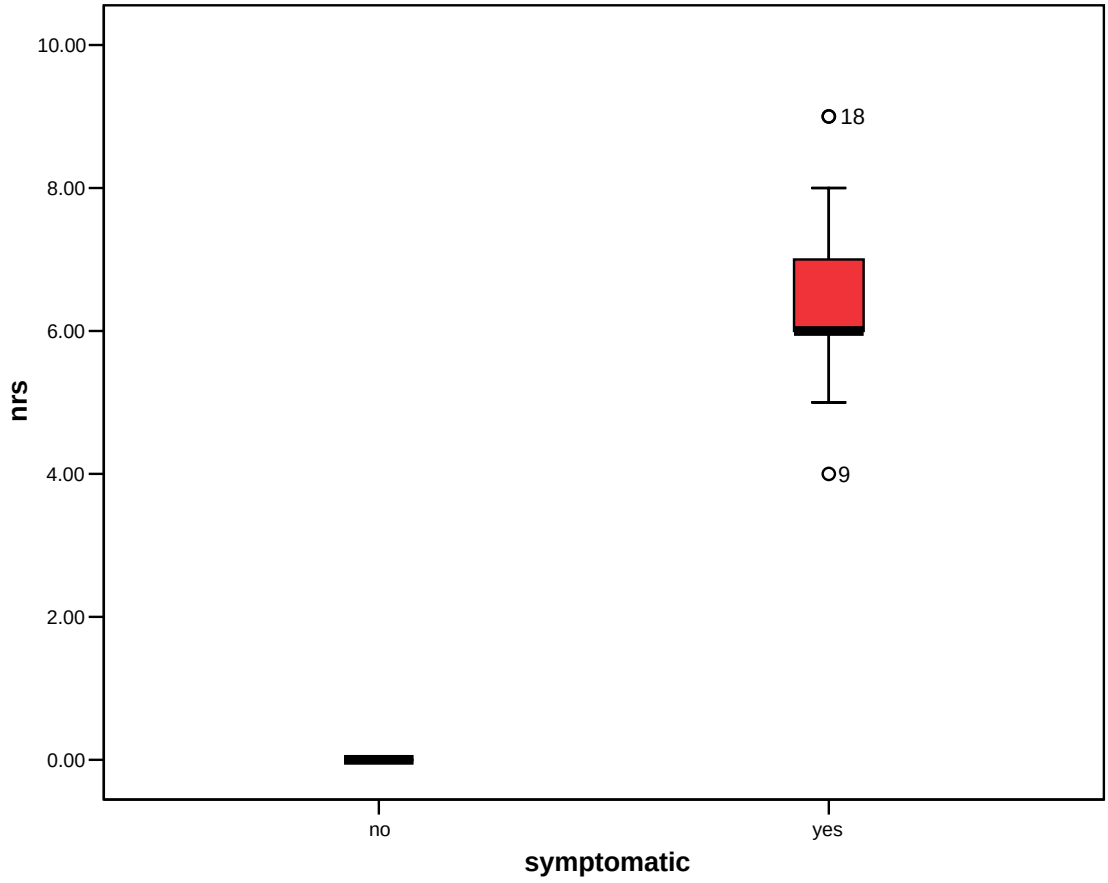


Figure 4.2.4: boxplot of NRS score by group

Participants in Group B all scored 0 for NRS. Participants in Group A had a median NRS score of 6 (range 4-9). This is shown in Figure 4.2.4. There was thus a highly significant difference between Group A and Group B with regard to NRS (p<0.001). The results of the Mann-Whitney test are shown in Table 4.2.4.

Table 4.2.4: Mann-Whitney test for NRS between the groups

Sympto matic	N	Mean Rank	Sum of Ranks	p (2 tailed)
No (Group B)	10	5.50	55.00	<0.001
Yes (Group A)	40	30.50	1220.00	
Total	50			

4.2.2.2. Algometer reading:

Table 4.2.5: T-test for the difference between total algometer readings between the groups

	t	df	p (2-tailed)
Total algometer reading for VL	4.400	48	<0.001

The sum of the algometer readings for each patient for each of the 7 possible VL trigger points was calculated and compared between Group A and Group B participants using a t-test. Group A had a significantly higher mean algometer reading than Group B (p<0.001) (see Table 4.2.5). The distribution of algometer scores between the groups are shown in Figure 4.2.5.

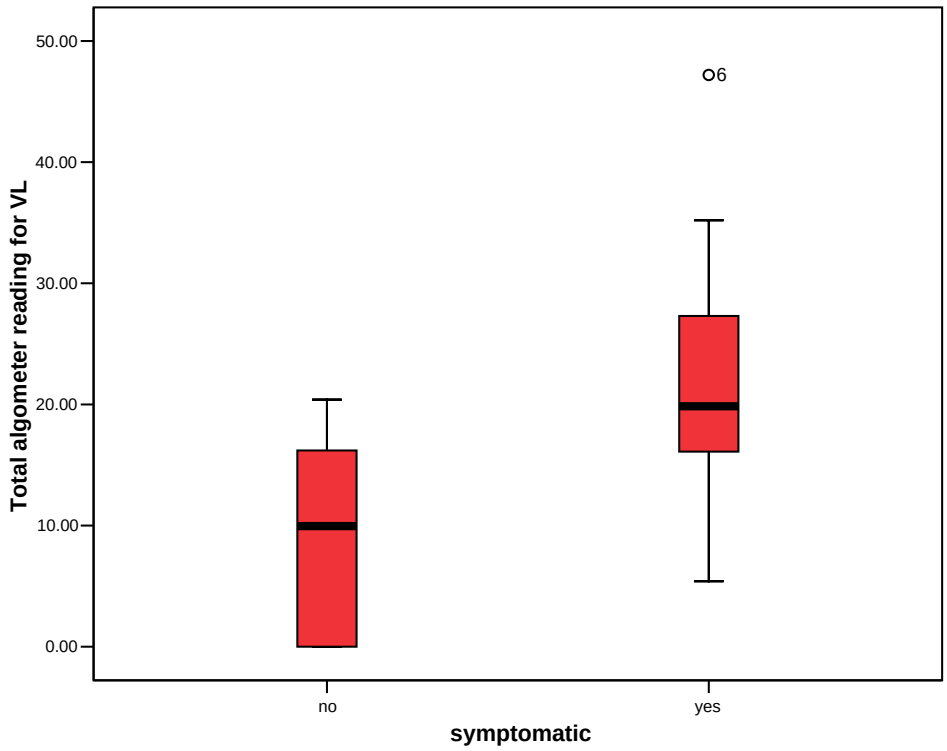


Figure 4.2.5: boxplot of the distribution of total algometer readings between the groups

4.2.2.3. MDS:

Table 4.2.6: T-test for the difference in MDS readings between the groups

	t	df	p (2-tailed)
total MDS reading for VL	11.947	32.618	<0.001

The sum of the MDS readings for each of the 7 possible VL trigger points was calculated for each participant and compared between the groups. The distribution of this measurement for each group is shown in Figure 4.2.6. There was a highly statistically significant difference in mean MDS score by group (p<0.001). The t-test results are shown in Table 4.2.6.

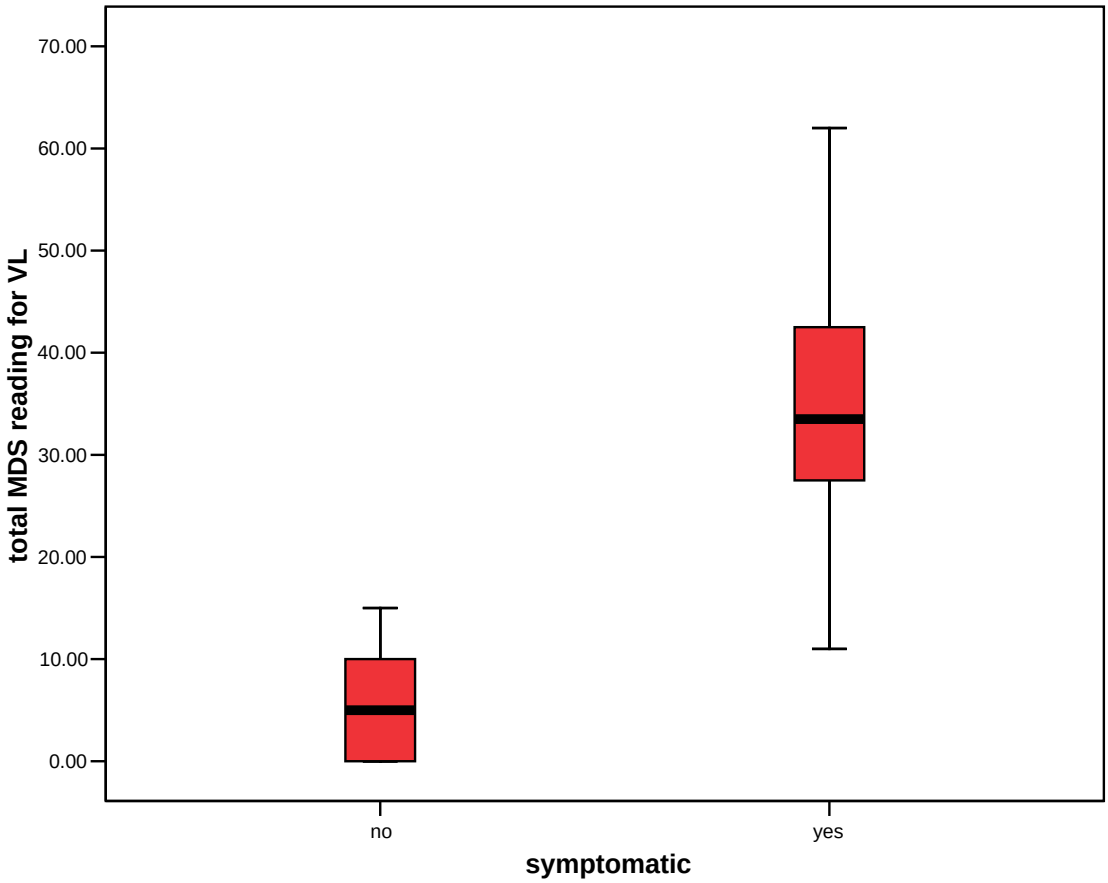


Figure 4.2.6: boxplot of distribution of MDS measurements by group

4.2.2.4. Correlation between the three severity measurements for VL trigger points:

Table 4.2.7: Spearman's correlation between severity measurements for VL trigger points

Spearman's rho		nrs	Mean algometer reading for VL	Mean MDS reading for VL
nrs	Correlation Coefficient	1.000	-.136	.646(**)
	Sig. (2-tailed)	.	.345	.000
	N	50	50	50
Mean algometer reading for VL	Correlation Coefficient	-.136	1.000	-.126
	Sig. (2-tailed)	.345	.	.384
	N	50	50	50
Mean MDS reading for VL	Correlation Coefficient	.646(**)	-.126	1.000
	Sig. (2-tailed)	.000	.384	.
	N	50	50	50

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

Spearman's correlation coefficients for NRS, mean algometer readings and mean MDS scores are shown in Table 4.2.7. NRS was significantly positively correlated with mean MDS score (rho = 0.646, p <0.001). Mean algometer readings were negatively correlated with NRS and MDS scores, although these correlations were not very high nor statistically significant.

4.2.2.5. Correlation between number and severity of VL trigger points:

Table 4.2.8: Spearman's correlation between number of VL trigger points and severity measurements for VL trigger points

Spearman's rho		Number of VL trigger points
NRS	Correlation Coefficient	.525(**)
	p (2-tailed)	<0.001
	N	50
Total algometer reading for VL	Correlation Coefficient	.570(**)
	p (2-tailed)	<0.001
	N	50
total MDS reading for VL	Correlation Coefficient	.903(**)
	p (2-tailed)	<0.001
	N	50

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

Total number of VL trigger points was significantly correlated with NRS, algometer and MDS readings. The correlation coefficient was particularly high for MDS (rho= 0.903, p<0.001). (See Table 4.2.8)

4.2.2.6. Correlation between number of VL trigger points and age and distance run per week

Table 4.2.9: Spearman's correlation between age and distance run per week, and number of VL trigger points

			Age	kms/wk
Spearman's rho	VL no	Correlation Coefficient	.058	.020
		p (2-tailed)	.688	.888
		N	50	50
	VL Latent	Correlation Coefficient	.009	.215
		p (2-tailed)	.953	.134
		N	50	50
	VL Active	Correlation Coefficient	.110	-.120
		p (2-tailed)	.445	.405
		N	50	50

Neither age, nor distance run per week was correlated with number of VL trigger points, whether active, latent or in total. This is shown in Table 4.2.9.

4.2.2.7. Association between number of VL trigger points and gender

Table 4.2.10: Mann-Whitney test for number of VL trigger points by gender

	Gender	N	Mean Rank	Sum of Ranks	p (2 tailed)
VL Active	male	28	23.61	661.00	0.289
	female	22	27.91	614.00	
	Total	50			
VL Latent	male	28	23.20	649.50	0.194
	female	22	28.43	625.50	
	Total	50			
VL no	male	28	22.52	630.50	0.092
	female	22	29.30	644.50	
	Total	50			

There was no significant association between number of VL trigger points and gender. This is shown in Table 4.2.10

4.2.2.8. Correlation between number of VL trigger points and PSFS scores

Table 4.2.11: Spearman's correlation between number of VL trigger points and PSFS scores

			VL Active	VL Latent	VL no
Spearman's rho	PSFS Running	Correlation Coefficient	.549(**)	.056	.490(**)
		p (2-tailed)	.000	.702	.000
		N	50	50	50
	PSFS Prolonged Sitting	Correlation Coefficient	.323(*)	-.114	.186
		p (2-tailed)	.022	.432	.197
		N	50	50	50
	PSFS Squatting	Correlation Coefficient	.212	.097	.162
		p (2-tailed)	.139	.504	.260
		N	50	50	50
	PSFS Kneeling	Correlation Coefficient	.320(*)	.138	.399(**)
		p (2-tailed)	.023	.340	.004
		N	50	50	50
	PSFS Stair Climbing	Correlation Coefficient	.149	.358(*)	.351(*)
		p (2-tailed)	.301	.011	.012
		N	50	50	50
	PSFS Other	Correlation Coefficient	.238	-.149	.109
		p (2-tailed)	.096	.303	.450
		N	50	50	50

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

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

Table 4.2.11 shows the Spearman's correlation between number of VL trigger points and PSFS scores on all 50 subjects. The PSFS scores for all factors in Group B were 0. Thus there was a high and significant positive correlation between running and active VL trigger points and between running and total VL trigger points. The more trigger points the participant had, the higher their PSFS score for running was. Prolonged sitting was positively correlated with number of active VL trigger points. Kneeling was also positively correlated with number of active and total VL trigger points. Stair climbing was positively correlated with number of latent trigger points and total VL trigger points.

4.3. VM trigger points

4.3.1. Type and number of VM trigger points by group

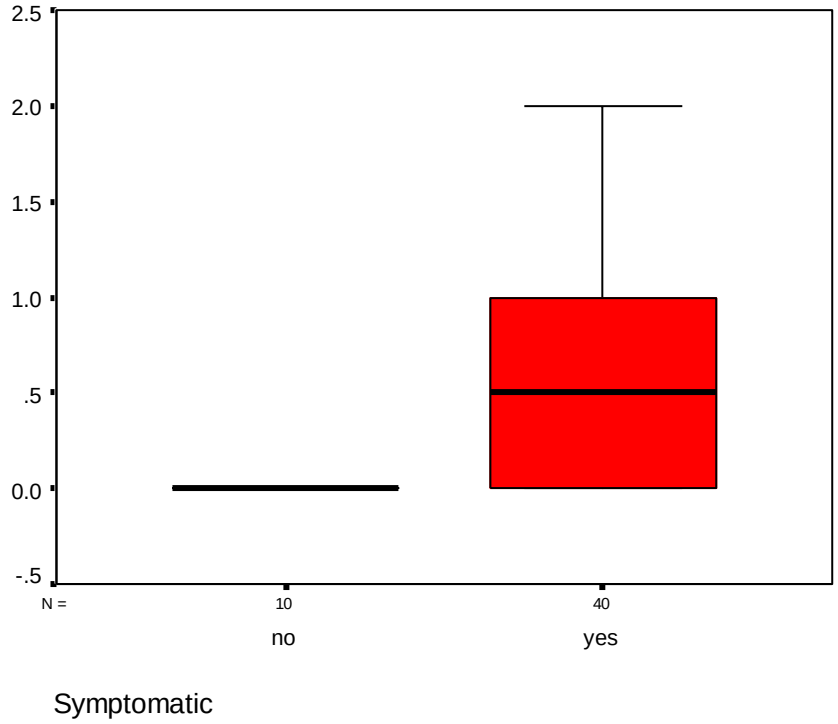


Figure 4.3.1: Boxplot of number of active VM trigger points by group

None of the participants in Group B had any active VM trigger points, while the median in Group A was 0.5 (range 0-2). This is shown in Figure 4.3.1. There was a significantly higher median number of active VL trigger points in Group A (p =0.014). Results of the Mann-Whitney test are shown in Table 4.3.1.

Table 4.3.1: Mann-Whitney tests for difference in median number of VM active trigger points by group

	Symptomatic	N	Mean Rank	Sum of Ranks	p(2 tailed)
VM Active	No (Group B)	10	15.50	155.00	0.014
	Yes (Group A)	40	28.00	1120.00	
	Total	50			

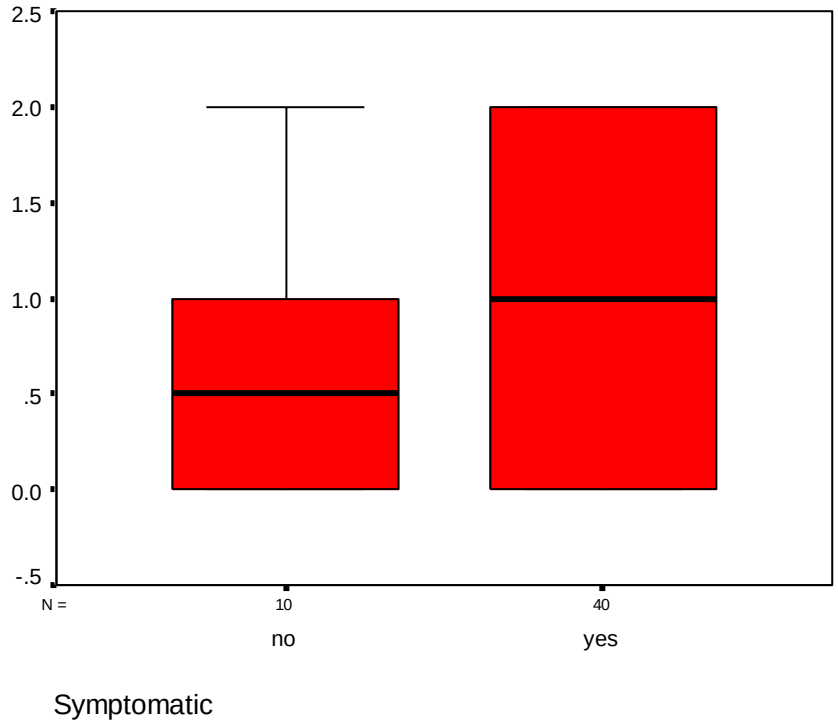


Figure 4.3.2: boxplot of number of latent VM trigger points by group

The median number of latent VM trigger points in Group B was 0.5 (range 0-2) while that in Group A was 1 (range 0-2). This difference in medians was not statistically significant (p =0.181). This is shown in Figure 4.3.2 and Table 4.3.2.

Table 4.3.2: Mann-Whitney test of median number of VM latent trigger points by group

	Symptomatic	N	Mean Rank	Sum of Ranks	p(2 tailed)
VM Latent	No (Group B)	10	19.90	199.00	0.181
	Yes (Group A)	40	26.90	1076.00	
	Total	50			

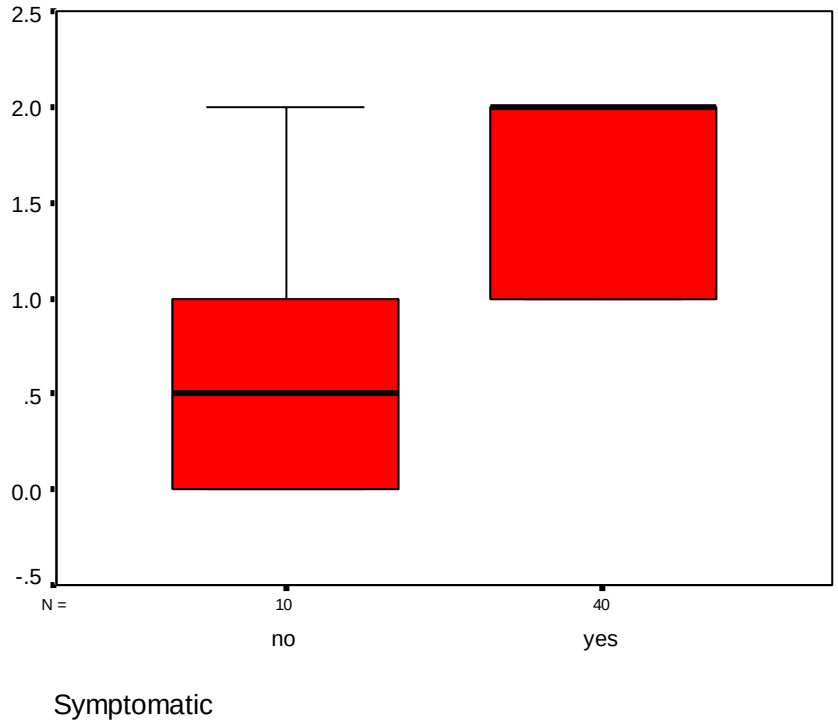


Figure 4.3.3: boxplot of total number of VM trigger points by group

In terms of total VM trigger points, the median number in Group B was 0.5 (range 0-2) while in Group A the median number was 2 (range 1-2). This difference was statistically significant ($p<0.001$). These results and distributions are shown in Figure 4.3.3 and Table 4.3.3.

Table 4.3.3: Mann-Whitney test of median number of total number of VM trigger points by group

	Symptomatic	N	Mean Rank	Sum of Ranks	p (2 tailed)
VM total number	No (Group B)	10	10.75	107.50	<0.001
	Yes (Group A)	40	29.19	1167.50	
	Total	50			

4.3.2. Severity of VM trigger points by group

4.3.2.1. Algometer readings:

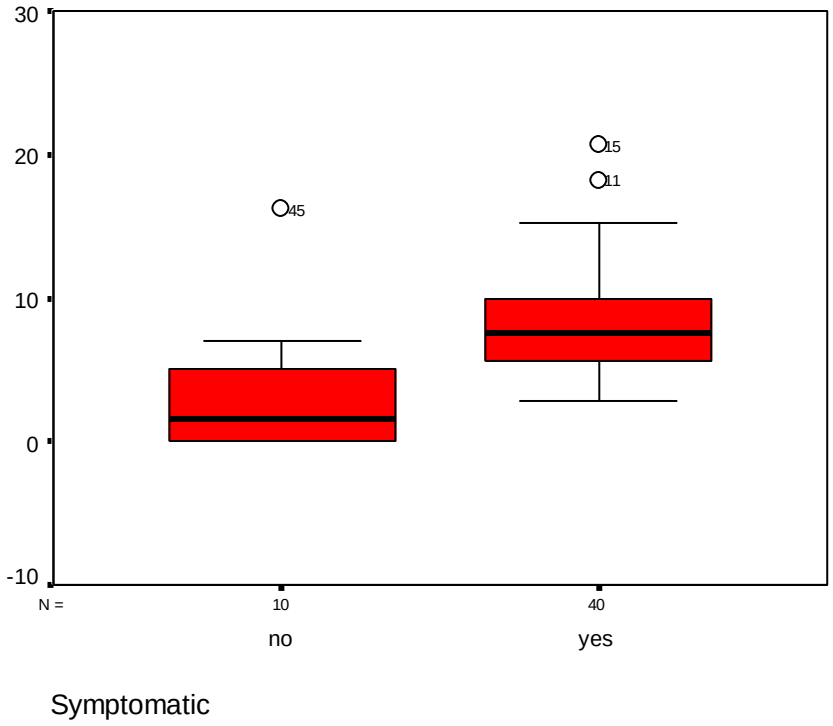


Figure 4.3.4: Boxplot of the distribution of algometer scores for total VM trigger points by group

Participants in Group A had a significantly higher mean Algometer reading than those in Group B (p=0.003). The results of the t-test are shown in Table 4.3.4. The distribution of Algometer readings between the groups is shown in Figure 4.3.4.

Table 4.3.4: T-test for the comparisons of mean total algomoter readings for VM trigger points by group

	t	df	p (2-tailed)
Total algometer reading for VM	-3.140	48	.003

4.3.2.2. MDS Score

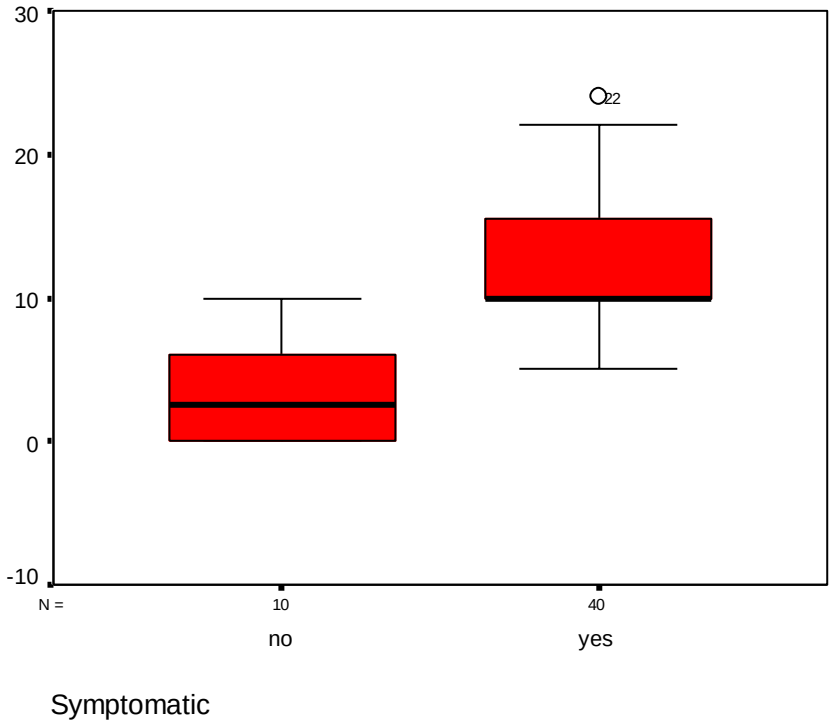


Figure 4.3.5: Boxplot of distribution of MDS readings for VM trigger points by group

There was a highly significant difference between the mean MDS score for Group A participants and for Group B participants ($p<0.001$). The scores were higher in the symptomatics, as shown in Table 4.3.5 and Figure 4.3.5.

Table 4.3.5: T-test for comparison of mean MDS score for VM trigger points by group

	t	df	p (2-tailed)
Total MDS reading for VM	-5.044	48	<0.001

4.3.2.3. Correlation between the three severity measures for VM

Table 4.3.6: Spearman's correlation between NRS, Algometer and MDS measurements for VM

Spearman's rho		nrs	Mean algometer reading for VM	Mean MDS reading for VM
nrs	Correlation Coefficient	1.000	.316(*)	.394(**)
	Sig. (2-tailed)	.	.026	.005
	N	50	50	50
Mean algometer reading for VM	Correlation Coefficient	.316(*)	1.000	.050
	Sig. (2-tailed)	.026	.	.731
	N	50	50	50
Mean MDS reading for VM	Correlation Coefficient	.394(**)	.050	1.000
	Sig. (2-tailed)	.005	.731	.
	N	50	50	50

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

There was a fairly high positive and statistically significant correlation between mean MDS score and NRS severity measurement (rho = 0.394, p =0.005). However, there was no correlation between mean algometer reading and mean MDS score (rho =0.05, p = 0.731) for VM. There was an unexpected significant positive correlation between mean algometer reading and NRS (rho = 0.316, p = 0.026). This could possibly be explained by 5 of the participants in Group B (all with NRS score =0) reporting a mean algometer score of 0. This is shown in Table 4.3.6.

4.3.2.4. Correlation between number and severity of VM trigger points:

Table 4.3.7: Spearman's correlation between number of VM trigger points and severity of VM trigger points

Spearman's rho		VM total number
NRS	Correlation Coefficient	.395(**)
	p (2-tailed)	.005
	N	50
Total algometer reading for VM	Correlation Coefficient	.734(**)
	p (2-tailed)	.000
	N	50
Total MDS reading for VM	Correlation Coefficient	.832(**)
	p (2-tailed)	.000
	N	50

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

Total number of VM trigger points was significantly correlated with NRS, algometer and MDS readings. The correlation coefficient was particularly high for MDS (rho= 0.832, p<0.001). (See Table 4.3.7)

4.3.2.5. Correlation between number of VM trigger points and age and distance run per week

Table 4.3.8: Spearman's correlation between age, distance run per week and total number of VM trigger points.

Spearman's rho		AGE	kms/wk
VM Active	Correlation Coefficient	-.052	-.096
	p. (2-tailed)	.722	.505
	N	50	50
VM Latent	Correlation Coefficient	.231	.054
	p (2-tailed)	.107	.712
	N	50	50
VM total number	Correlation Coefficient	.248	-.028
	p (2-tailed)	.083	.846
	N	50	50

There was no correlation between age or distance run per week and total number of VM trigger points. This is shown in Table 4.3.8.

4.3.2.6. Association between gender and number of VM trigger points

Table 4.3.9: Mann-Whitney test for comparison of median number of VM trigger points between genders

	GENDER	N	Mean Rank	Sum of Ranks	p (2 tailed)
VM Active	male	28	25.38	710.50	0.938
	female	22	25.66	564.50	
	Total	50			
VM Latent	male	28	21.86	612.00	0.034
	female	22	30.14	663.00	
	Total	50			
VM total number	male	28	21.68	607.00	0.018
	female	22	30.36	668.00	
	Total	50			

VM active trigger points did not differ by gender, but VM latent and total VM trigger points were significantly different in males compared with females. They were both higher in females. The results of the Mann-Whitney test are shown in Table 4.3.9.

4.3.2.7. Correlation between VM trigger points and PSFS scores

Table 4.3.10: Spearman's correlation between number of VM trigger points and PSFS scales

Spearman's rho		VM Active	VM Latent	VM total number
PSFS Running	Correlation Coefficient	.216	.102	.290(*)
	p (2-tailed)	.132	.483	.041
	N	50	50	50
PSFS Prolonged sitting	Correlation Coefficient	.342(*)	-.088	.219
	p (2-tailed)	.015	.543	.127
	N	50	50	50
PSFS Squatting	Correlation Coefficient	.146	.176	.323(*)
	p (2-tailed)	.313	.222	.022
	N	50	50	50
PSFS Kneeling	Correlation Coefficient	.173	.045	.198
	p. (2-tailed)	.230	.758	.168
	N	50	50	50
PSFS Stair Climbing	Correlation Coefficient	.070	.045	.087
	p. (2-tailed)	.627	.755	.548
	N	50	50	50
PSFS Other	Correlation Coefficient	.183	.026	.286(*)
	p (2-tailed)	.204	.860	.044
	N	50	50	50

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

Number of VM active trigger points was positively correlated with prolonged sitting. Latent trigger points were not correlated with any PSFS scores, and total VM number of trigger points was correlated with running, squatting, and other. The correlation coefficients were not very high, although they were statistically significant. Shown in Table 4.3.10.

4.4. Normal ranges in Group B

There were 10 asymptomatic participants, allocated to Group B, on which the normal ranges were calculated.

4.4.1.Neutral position

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Table 4.4.1: Mean, standard deviation and range of values in Group B for neutral position (n=10)

	Total Work (Joules)	Total Work (%)	Total Work (Set)
N	10	10	10
Mean	204.4000	258.1500	1144.4000
Std. Deviation	46.91884	45.04702	267.93830
Minimum	122.00	188.80	701.00
Maximum	302.00	322.30	1718.00

Mean, SD and ranges are shown for total work (Joules), total work (%/BW) and set total work in Table 4.4.1 for the neutral position

4.4.2. Vastus Lateralis (VL) position

Table 4.4.2: Mean, standard deviation and range of values in Group B for vastus lateralis position (n=10)

	Total Work (Joules)	Total Work (%)	Total Work (Set)
N	10	10	10
Mean	175.5000	223.5300	979.3000
Std. Deviation	39.79740	46.89795	234.02092
Minimum	115.00	142.30	647.00
Maximum	259.00	289.40	1445.00

Mean, SD and ranges are shown for total work (Joules), total work (%/BW) and set total work in Table 4.4.2 for the vastus lateralis position.

4.4.3. Vastus medialis (VM) position

Table 4.4.3: Mean, standard deviation and range of values in Group B for vastus medialis position (n=10)

	Total Work (Joules)	Total Work (%)	Total Work (Set)
N	10	10	10
Mean	172.0000	218.3300	927.6000
Std. Deviation	47.76563	48.97131	286.16359
Minimum	118.00	141.10	614.00
Maximum	287.00	305.70	1627.00

Mean, SD and ranges are shown for total work (Joules), total work (%) and set total work in Table 4.4.3 for the vastus medialis position.

4.5. Ranges in Group A

4.5.1. Neutral position

Table 4.5.1: Mean, standard deviation and range of values in Group A for neutral position (n=40)

	Total Work (Joules)	Total Work (%)	Total Work (Set)
N	40	40	40
Mean	124.8000	182.1775	677.5250
Std. Deviation	52.86422	54.49422	299.47510
Minimum	35.00	58.90	171.00
Maximum	241.00	321.80	1387.00

Mean, SD and ranges are shown for total work (Joules), total work (%/BW) and set total work in Table 4.5.1for the neutral position in 40 symptomatic participants, allocated to Group A..

4.5.2. Vastus Lateralis (VL) position

Table 4.5.2: Mean, standard deviation and range of values in Group A for vastus lateralis position (n=40)

	Total Work (Joules)	Total Work (%)	Total Work (Set)
N	40	40	40
Mean	114.1500	166.6825	626.8250
Std. Deviation	45.82495	45.04525	255.04177
Minimum	47.00	78.90	239.00
Maximum	207.00	259.40	1184.00

Mean, SD and ranges are shown for total work (Joules), total work (%BW) and set total work in Table 4.5.2 for the vastus lateralis position in Group A.

4.5.3. Vastus medialis (VM) position

Table 4.5.3: Mean, standard deviation and range of values in Group A for vastus medialis position (n=40)

	Total Work (Joules)	Total Work (%)	Total Work (Set)
N	40	40	40
Mean	103.8500	151.1250	559.4250
Std. Deviation	45.65509	46.78364	256.01591
Minimum	36.00	67.90	191.00
Maximum	200.00	278.40	1153.00

Mean, SD and ranges are shown for total work (Joules), total work (%/BW) and set total work in Table 4.5.3 for the vastus medialis position in Group A.

4.6. Comparison of mean total work in neutral position between Group A and Group B

Table 4.6.1: T-test for comparison of mean total work in neutral position between Group A and Group B

	t	df	p (2-tailed)
Total Work (Joules)	-4.346	48	<0.001
Total Work (%)	-4.066	48	<0.001
Total Work (Set)	-4.494	48	<0.001

Results of t-tests comparing mean total work in Joules and % and set total work between Group A and Group B for the neutral position are shown in Table 4.6.1. There was a highly significant difference in mean work between Group A and Group B ($p<0.001$ for all measurements).

4.7. Comparison of mean total work in vastus lateralis position between Group A and Group B

Table 4.7.1: T-test for comparison of mean total work in vastus lateralis position between Group A and Group B

	t	df	p (2-tailed)
Total Work (Joules)	-3.877	48	<0.001
Total Work (%)	-3.542	48	0.001
Total Work (Set)	-3.968	48	<0.001

Results of t-tests comparing mean total work in Joules and %/BW and set total work between Group A and Group B for the vastus lateralis position are shown in Table 4.7.1. There was a highly significant difference in mean work between the two groups.

4.8. Comparison of mean work in vastus medialis position between Group A and Group B

Table 4.8.1: T-test for comparison of mean total work in vastus medialis position between Group A and Group B

	t	df	p (2-tailed)
Total Work (Joules)	-4.185	48	<0.001
Total Work (%)	-4.027	48	<0.001
Total Work (Set)	-3.976	48	<0.001

Results of t-tests comparing mean total work in Joules and %/BW and set total work between Group A and Group B for the vastus medialis position are shown in Table 4.8.1. There was a highly significant difference in mean work between the two groups ($p<0.001$) for all measurements.

4.9. The effect of number of trigger points and PFPS on total work

The dependant variables of work measured in Joules, %/BW and set, with the thigh in the neutral, internally rotated and externally rotated position were examined for the effect of number of VL and VM trigger points, controlling for group (symptomatic/asymptomatic) using Multivariate General Linear Modeling.

4.9.1. VL trigger points:

Table 4.9.1a: Multivariate tests for total work and number of VL trigger points

Effect		Value	F	Hypothesis df	Error df	p
Intercept	Wilks' Lambda	.264	12.050	9.000	39.000	.000
Number of VL trigger points	Wilks' Lambda	.767	1.315	9.000	39.000	.261
Group A /Group B	Wilks' Lambda	.619	2.672	9.000	39.000	.016

Number of VL trigger points did not significantly affect the total work variables, after controlling for group ($p=0.261$). However, the group of the subject did significantly affect the total work variables ($P=0.016$). This is shown in Table 4.9.1 a and b. Between subjects effects tests showed that only VL total work (joules) ($p=0.061$) and % ($p=0.063$) were not significantly associated with group.

Table 4.9.1b: Tests of Between-Subjects Effects for each dependant variable for group

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	p
Group A /Group B	Neutral TW (J)	17497.656	1	17497.656	6.390	.015
	Neutral TW (P)	18598.503	1	18598.503	6.520	.014
	Neutral TW (S)	590966.231	1	590966.231	6.711	.013
	VL TW (J)	7495.175	1	7495.175	3.694	.061
	VL TW (P)	7584.413	1	7584.413	3.614	.063
	VL TW (S)	277588.886	1	277588.886	4.328	.043
	VM TW (J)	12634.633	1	12634.633	5.838	.020
	VM TW (P)	16169.296	1	16169.296	7.114	.010
	VM TW (S)	285131.425	1	285131.425	4.097	.049

4.9.2. VM trigger points:

Table 4.9.2a: Multivariate tests for total work and number of VM trigger points

Effect		Value	F	Hypothesis df	Error df	p
Intercept	Wilks' Lambda	.189	18.595	9.000	39.000	.000
Number of VM trigger points	Wilks' Lambda	.784	1.195	9.000	39.000	.325
Group A /Group B	Wilks' Lambda	.744	1.493	9.000	39.000	.185

Neither number of VM trigger points nor group significantly affected work variables overall. This is shown in Table 4.9.2a . However, individually some of the work variables were affected by group and number of VM trigger points. This is shown in Table 4.9.2 b.

Table 4.9.2b: Tests of Between-Subjects Effects for each dependant variable for number of VM trigger points and group

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	p
Number of VM trigger points	NTW(J)	8929.715	1	8929.715	3.501	.068
	NTW(P)	4138.045	1	4138.045	1.497	.227
	NTW(S)	302869.517	1	302869.517	3.706	.060
	VLTW(J)	7921.161	1	7921.161	4.220	.046
	VLTW(P)	3627.267	1	3627.267	1.789	.188
	VLTW(S)	226397.575	1	226397.575	3.796	.057
	VMTW(J)	2296.668	1	2296.668	1.085	.303
	VMTW(P)	89.584	1	89.584	.039	.844
	VMTW(S)	121665.723	1	121665.723	1.803	.186
Group A/ Group B	NTW(J)	12523.565	1	12523.565	4.910	.032
	NTW(P)	15231.721	1	15231.721	5.509	.023
	NTW(S)	434133.757	1	434133.757	5.312	.026
	VLTW(J)	5755.986	1	5755.986	3.066	.086
	VLTW(P)	7154.298	1	7154.298	3.528	.067
	VLTW(S)	210405.158	1	210405.158	3.528	.067
	VMTW(J)	13686.624	1	13686.624	6.463	.014
	VMTW(P)	19498.516	1	19498.516	8.576	.005
	VMTW (S)	329817.518	1	329817.518	4.888	.032

4.10. The effect of severity of trigger points and PFPS on work

Since there was a high degree of correlation amongst the Algometer readings and MDS scores, and MDS scores were very highly correlated with number of trigger points, MDS scores were used to represent severity of trigger points.

4.10.1. VL trigger points

Table 4.10.1a: Multivariate tests for total work and severity of VL trigger points

Effect		Value	F	Hypothesis df	Error df	p
Intercept	Wilks' Lambda	.184	19.243	9.000	39.000	.000
MDS score for VL trigger points	Wilks' Lambda	.812	1.004	9.000	39.000	.453
Group A /Group B	Wilks' Lambda	.636	2.483	9.000	39.000	.024

There was no association between severity of VL trigger points and total work overall (p=0.453). There was a significant association between group (symptomatic/asymptomatic) and work (p = 0.024).

Table 4.10.1b: Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	p
Group A /Group B	NTW(J)	23395.569	1	23395.569	8.539	.005
	NTW(P)	22091.075	1	22091.075	7.748	.008
	NTW(S)	816731.777	1	816731.777	9.267	.004
	VLTW(J)	9930.694	1	9930.694	4.875	.032
	VLTW(P)	7666.016	1	7666.016	3.666	.062
	VLTW(S)	358560.823	1	358560.823	5.575	.022
	VMTW(J)	14023.986	1	14023.986	6.483	.014
	VMTW(P)	13788.532	1	13788.532	6.067	.017
	VMTW(S)	347133.355	1	347133.355	4.981	.030

4.10.2. VM trigger points:

Table 4.10.2a: Multivariate tests for work and severity of VM trigger points

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Wilks' Lambda	.132	28.433	9.000	39.000	.000
MDS score for VM trigger points	Wilks' Lambda	.877	.610	9.000	39.000	.781
Group A /Group B	Wilks' Lambda	.729	1.608	9.000	39.000	.147

There was no significant association between severity of VM trigger points and total work overall, nor between the group and total work overall (0.147). However, all the work variables were significantly associated individually with group (Table 4.10.2 b).

Table 4.10.2b: Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	p
Group A /Group B	NTW(J)	23484.883	1	23484.883	8.732	.005
	NTW(P)	18844.573	1	18844.573	6.800	.012
	NTW(S)	787495.671	1	787495.671	9.138	.004
	VLTW(J)	12299.444	1	12299.444	6.172	.017
	VLTW(P)	8971.742	1	8971.742	4.423	.041
	VLTW(S)	416165.416	1	416165.416	6.619	.013
	VMTW(J)	21344.793	1	21344.793	9.879	.003
	VMTW(P)	21504.695	1	21504.695	9.464	.003
	VMTW(S)	571487.727	1	571487.727	8.209	.006

Summary

The group significantly determines the work in all 3 positions. The number and severity of trigger points does not influence work after controlling for group. This may be because number and severity of trigger points was significantly associated with group, thus confounding was present, and controlled for in the multivariate analysis.

4.11. Comparison of VL and VM positions

Table 4.11.1a: Multivariate between and within subjects tests for total work

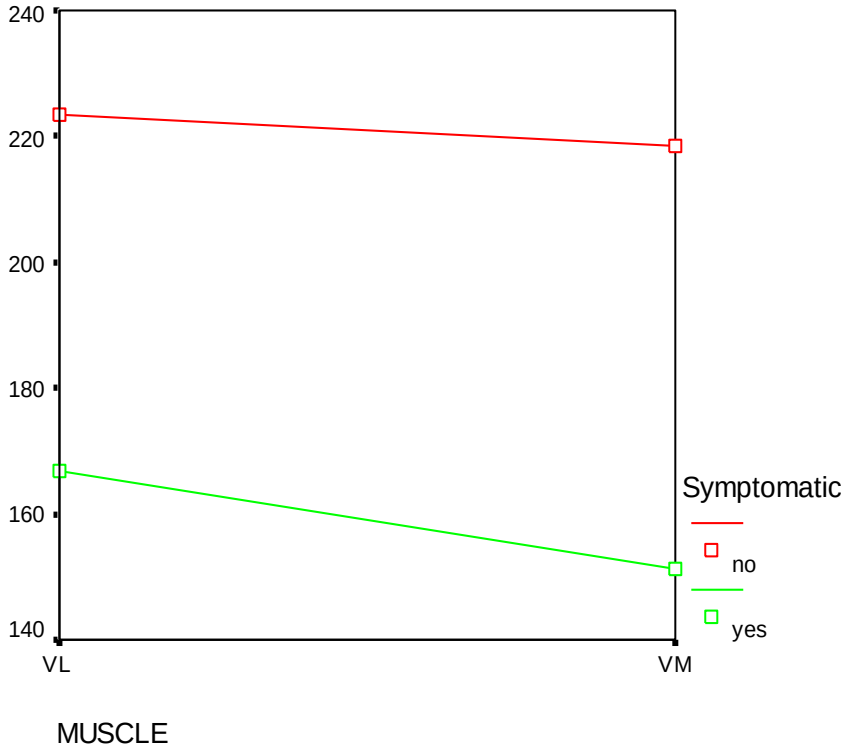
Effect			Value	F	p
Between Subjects	Intercept	Wilks' Lambda	.069	208.476	.000
	Group A vs. Group B	Wilks' Lambda	.723	5.886	.002
Within Subjects	MUSCLE (VL vs. VM)	Wilks' Lambda	.795	3.947	.014
	MUSCLE * Group A	Wilks' Lambda	.956	.701	.556

Multivariate repeated measures ANOVA was used to compare the VM and VL positions with regard to the work outcomes (joules, percent and set), whilst controlling for group. There was a significant difference between the two muscle components overall (p = 0.014) Table 4.11.1a. This was only statistically significant in set work (p=0.009) (Table 36b). Figures 4.11.1-4.11.3 show that for all work measures and both VL and VM muscle components, the scores in Group A were lower than those in Group B. The VM measurements were slightly lower than the VL measurements, and only significant for set total work.

Table 4.11.1b: Tests of Within-Subjects Contrasts

Source	Measure	Type III Sum of Squares	df	Mean Square	F	p
MUSCLE	JOULES	761.760	1	761.760	2.789	.101
	PERCENT	1723.495	1	1723.495	3.370	.073
	SET	56739.240	1	56739.240	7.366	.009
MUSCLE * Group A	JOULES	184.960	1	184.960	.677	.415
	PERCENT	429.111	1	429.111	.839	.364
	SET	985.960	1	985.960	.128	.722

Figure 4.11.1: Mean total work (Joules) by muscle component and group



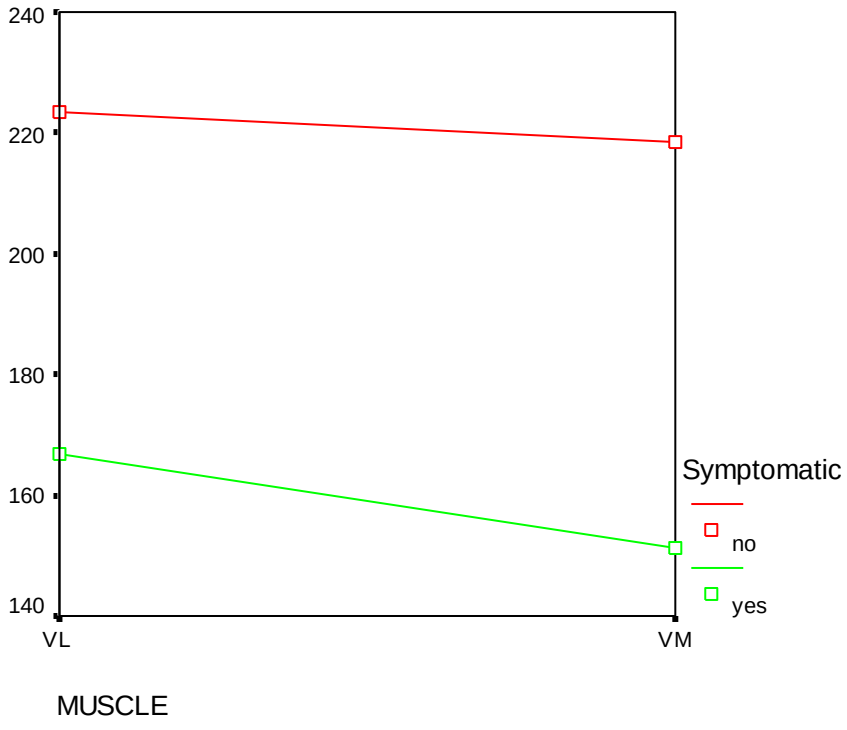


Figure 4.11.2: Mean work (Percent) by muscle component and group

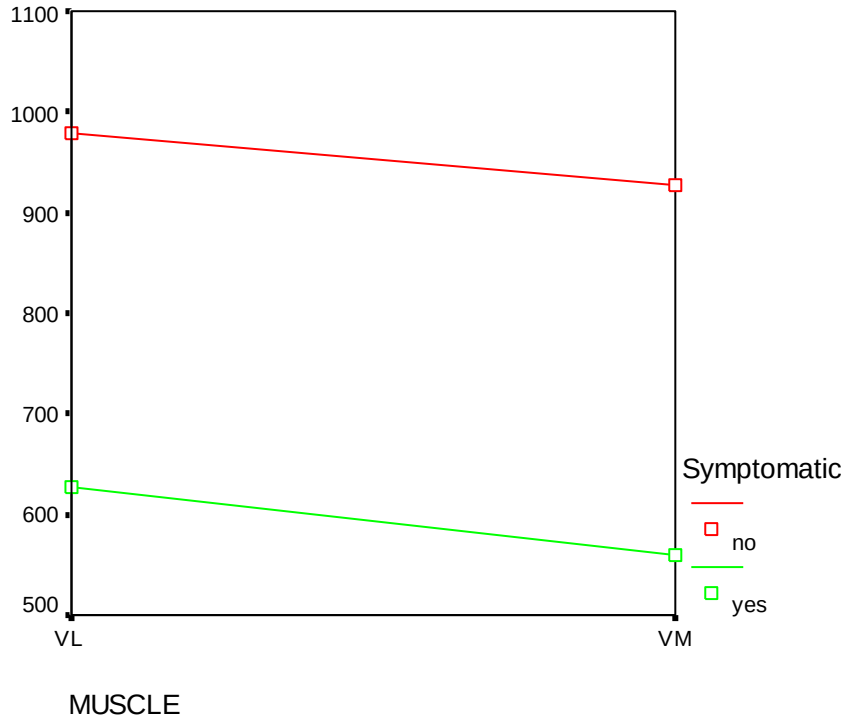


Figure 4.11.3: Mean work (Set) by muscle component and group

Summary: Group A differed significantly from Group B and VM measurements were significantly lower than VL measurements for set total work.

4.12. Discussion of the Results

4.12.1.Total number of myofascial trigger points:

As shown in Figures 4.2.1-4.2.3 and Tables 4.2.1-4.2.3, there is an increase in all active, latent and total number of MFTrp's in the VL muscle, while latent and total number of MFTrp's were increased in the VM muscle in participants suffering with PFPS, shown in Figures 4.3.1-4.3.3 Tables 4.3.1-4.3.3. This is in agreement with the study by Dippenaar (2003), which indicated that 95% of the subjects with PFPS presented with active and / or latent myofascial trigger points of the quadriceps femoris muscle.

Dippenaar (2003) shows a large overlap in the signs and symptoms of the two syndromes; patellofemoral pain syndrome (PFPS) and myofascial pain syndrome (MPS).

Furthermore, the high proportion of MFTrp's, both active and latent, could potentially account for the presence of referred pain, muscular weakness, stiffness of the involved muscle and decreased stretch range of motion within the QF muscle group (Travell, Simons and Simons; 1999:1-5), experienced in both syndromes.

4.12.2. Correlation between the three severity measures for both VL and VM muscles:

Unfortunately the algometer readings shown in Figure 4.2.5, Figure 4.3.4, Table 4.2.5 and Table 4.3.4, may be misleading since the statistical methods used took into account the sum of the 7 possible VL and 2 possible VM trigger points as opposed to the mean values. Thus one cannot adequately comment on the results of these findings.

4.12.2.1. Correlation between the three severity measures for VL

As the NRS increases, so the ratings for the MDS are expected to increase, as is reflected in the results shown in Table 4.2.4, with a high positive correlation between the NRS and mean MDS scores.

With an increase in severity of symptoms, suffered by the sample group, a decrease in the algometer readings in expected, thus the algometer should have an inverse relation to the NRS. Mean algometer readings were negatively correlated with both NRS and MDS scores, as indicated in Table 4.2.4.

4.12.2.2. Correlation between the three severity measures for VM

As seen with the correlation between the NRS and MDS ratings in the VL, there is a high positive correlation between the two readings of the VM shown in Table 4.3.6. An inverse relation between NRS and Algometer readings as expected in 4.12.2.1., however, this is not shown in this instance as there is an unexpected significant positive correlation between mean algometer reading and NRS, whilst no correlation between mean algometer reading and mean MDS score for VM is shown (Table 4.3.6).

With an increase in severity there is an increase in number of trigger points, as shown in Table 4.3.7, thus number of algometer readings would increase. As the group in this correlation includes both Group A and Group B (symptomatics and asymptomatics), an explanation for the unexpected results could be due to a portion of the participants in Group B (all with NRS score of 0) who had no MFTrp's in the VM muscle and thus a nil (score of 0) Algometer reading.

4.12.3. Correlation between number of VL and VM trigger points and age, distance run per week and gender

4.12.3.1. Correlation between number of VL and VM trigger points and age

Figure 4.1.2 shows the participants in Group A to be slightly older than those in Group B, this does not correlate with the general picture of PFPS which is frequently seen in young adults according to Kannus et al. (1999), this may be due to the age limitations used in the study. There was no correlation between age and number of MFTrp's (active, latent or total) in the VL and VM muscles, shown in Table 4.2.10 and Table 4.3.9 consecutively.

A correlation between latent MFTrp's and increasing age was expected as according to Travell, Simons and Simons (1999:1-13), with advancing age comes reduced activity and stiffness and restricted motion due to latent MFTrp's which become more prominent than the pain of active MFTrp's. This may be explained by the limited sample size, and that both Group A and Group B (differing in numbers of participants) were included in this correlation.

4.12.3.2. Correlation between number of VL and VM trigger points and distance run per week (km/wk)

The participants in Group A ran more kilometers per week than those in Group B (Figure 2), this agrees with Salem and Powers (2001) who found that athletes who participate in sports that involve running activities are at greater risk of developing patellofemoral related injuries.

Travell and Simons (1983:266), found that the QF muscle is likely to develop MFTrp's as a result of strenuous athletic activity such as running. However, distance run per week was not correlated with number of VL or VM MFTrp's (active, latent or in total). This is shown in Table 4.2.10 and Table 4.3.9. The limited sample size may be responsible for these results.

4.12.3.3. Correlation between number of VL and VM trigger points and gender

There was a higher distribution of females (52.5%) in Group A, whilst 90% of participants in Group B were male. As Group A represented the symptomatic group, this correlates with both PFPS and MPS. According to Dehaven and Linter (1986), the incidence of PFPS is reported to be 19.6% in female collegiate athletes and 7.4% amongst their male counterparts. Davidson (1993), attributes the higher incidence amongst women to the wider gynaecoid pelvic structure which inturn increases the Q-angle.

Hou et al. (2002), reports that MPS appears to be more common in females.
As shown previously, in figures 4.2.1,4.2.2 and 4.2.3, the median number of active, latent and total VL trigger points is increased in Group A (those suffering with PFPS) compared to that of Group B (asymptomatic group). Similarly, median number of active and total VM trigger points were increased in Group A compared to Group B, shown in Figures 4.3.1 and 4.3.3, (Although the median number of latent MFTrp's were increased in Group A, this was not statistically significant, Figure 4.3.2). A significant association between number of VL and VM trigger points in the female participants would have been expected. Table 4.4.1 shows this with an increase in latent and total VM MFTrp's in females, however, there is no correlation between VL MFTrp's (active, latent or total) and gender, shown in Table 4.2.11.

4.12.4. Correlation between number of VL and VM trigger points and PSFS scores

4.12.4.1. Correlation between number of VL and PSFS scores

Activities such as running, prolonged sitting, squatting and kneeling have been linked with PFPS, and are all factors that predispose patients to the development and perpetuation of MFTrp's, thus such tests could cause an irritation of the trigger points in PFPS and therefore cause an increase in pain (Travell and Simons, 1983; and Chaitow and Delany, 2002). A high and significant positive correlation between these activities and total VL trigger points is thus expected and shown in Table 4.3.1.

There is no statistically significant correlation between stair climbing and active MFTrp's, however a significant correlation is shown between stair climbing and latent and total number of MFTrp's, indicated in Table 4.3.1. This is an unusual finding that the researcher did not expect.

A possible explanation for this may be found in recognizing the sedentary lifestyle we currently lead. Few individuals may ascend/descend stairs today, as other means of transport such as escalators and elevators are, in most cases, first option. With this in mind, the researcher found that few participants reported pain on stair climbing, and thus a true correlation may not have been reflected.

4.12.4.2. Correlation between number of VM and PSFS scores

It would appear that VL is more related to PFPS than assumed VM to be, due to confounding findings when correlating the number of VM MFTrp's and PSFS scores, as seen in Table 4.4.2. Having said that, the total number of VM MFTrp's has more of an affect on the PSFS score than active and latent VM MFTrp's as seen in running, squatting and other activities in Table 4.4.2.

4.12.5. Findings on the Isokinetic Dynanometer in three positions: neutral, VL and VM

4.12.5.1. The effect of VL trigger points and PFPS on total work

In Group A vs. Group B (Table 4.9.1b), the number of VL trigger points significantly affected the total work variables (Joules, Percentage, Set) with the thigh in the neutral position to represent the entire QF muscle. Likewise, in Group A vs. Group B the number of VL trigger points significantly affected the total work variables (Joules, Percentage, Set) with the thigh in the externally rotated position placing emphasis on the VM muscle, suggesting reciprocal inhibition whereby the VL is responsible for the inhibition of the firing mechanism of the VM. In Group A vs. Group B, the number of VL trigger points had no affect on the total work variables (Joules, Percentage, Set) with the thigh in the internally rotated position placing emphasis on the VL muscle.

4.12.5.2. The effect of VM trigger points and PFPS on total work

In Group A vs. Group B (Table 4.9.2b), the number of VM trigger points significantly affected the total work variables (Joules, Percentage, Set) with the thigh in the neutral position to represent the entire QF muscle.

Likewise, in Group A vs. Group B the number of VM trigger points significantly affected the total work variables (Joules, Percentage, Set) with the thigh in the externally rotated position placing emphasis on the VM muscle. In Group A vs. Group B the number of VM trigger points had no affect on the total work variables (Joules, Percentage, Set) with the thigh in the internally rotated position placing emphasis on the VL muscle, thus showing no inhibition of VL by VM.

4.12.6. Overall Summary of Results

There was a highly significant difference in number and severity of VL and VM MFTrp's between Group A and Group B. Neither age, gender nor distance run per week influenced number of trigger points. The groups (Group A vs. Group B) differed significantly with regards to total work measurements, Group A had much lower readings than Group B. When relationships between number and severity of trigger points and total work were examined, controlling for group, only group (Group A vs. Group B) was significantly associated with total work. Thus it was whether patients were symptomatic or not which influenced their total work measurements, and not the number or severity of their trigger points, although number and severity of trigger points was significantly associated with group. VL measurements were consistently higher than VM measurements for all total work variables, but only significantly so in set total work.

As discussed in Chapter 2, there are 2 hypotheses in the literature:

1. One in which the delayed activation of the VM is directly related to the VM muscle – i.e. myofascial trigger points (Travell, Simons and Simons, 1999:1), or other pathology related to the neuro-muscular functions of the VM (Powers, Landel and Perry, 1996).
2. Or the development of an inhibition mechanism (reciprocal inhibition), whereby the vastus lateralis is responsible for the inhibition of the firing mechanism of the VM (Hopkins and Ingersoll, 2000).

One cannot exclude delayed activation of the VM as directly related to the VM muscle, however, for the purpose of this study, it is highly possible that a large proportion of the participants suffering with PFPS resulting in reduced total work readings (Figures 4.11.1, 4.11.2 and 4.11.3) of the VM muscle is due to reciprocal inhibition by the VL muscle (with reference to the discussion in 4.12.5.1 and 4.12.5.2).

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions:

There was a highly significant difference in number and severity of vastus lateralis and vastus medialis myofascial trigger points between the symptomatic (Group A) and asymptomatic (Group B) groups. The groups differed significantly with regards to total work measurements, as Group A had lower readings when compared to Group B. Futhermore, the total work values of the vastus lateralis were consistently higher than those of the vastus medialis.

It is highly possible that a large proportion of the participants suffering with PFPS resulting in reduced total work readings (Figures 4.11.1, 4.11.2 and 4.11.3) of the VM muscle is due to reciprocal inhibition by the VL muscle.

5.2 Recommendations:

a) The sample was divided into two uneven groups. In order to provide baseline graphs 10 asymptomatic participants were allocated to a group, while 40 symptomatic participants were allocated to another. Future research of this nature should consider a larger sample group and even allocations when dividing participants to individual groups.

b) In this study the asyptomatic group consisted of a higher percentage of males (90%), while the symptomatic group had much lower percentage of males (47.5%). Further studies should try to focus on one gender or compare the two gender differences.

c) Palpation of the MFTrp's and assessment of the knee were both performed by the researcher. An independent examiner is suggested for future research of this nature as it reduces researcher bias and greatly increases the validity of such studies.

d) Travell and Simons (1983:272-231), state that antagonoists to the quadriceps femoris muscle may develop secondary MFTrp's. Clifton (2003), questioned the role of the hamstring muscle in PFPS after noting the presence of concentric hamstring weakness in subjects with PFPS. Further research should focus on the contribution of the hamstring muscle and its myofascial component to PFPS.

e) Recent developments in Isokinetic Dynanometry have made it possible to isolate extensor muscle groups and determine the presence and extent of dysfunction, however, emphasis was placed on the VM and VL portions of the QF muscle when the thigh was externally and internally rotated consecutively, it did not isolate these muscles. Many studies using EMG analysis fail to use normalised data and so the results have be viewed with scepticism (Callaghan and Oldham, 1996). A more reliable tool that isolates the entire VM muscle (deep and superficial fibres) should be employed.

f) There was a highly significant difference in number and severity of VL and VM MFTrp's between the symptomatic (Group A) and asymptomatic (Group B) groups. Group A vs. Group B differed significantly with regards to total work measurements, however when relationships between number and severity of trigger points and total work were examined, only Group A vs. Group B was significantly associated with total work. Thus it was whether patients were symptomatic or not which influenced their total work measurements, and not the number or severity of their trigger points, although number and severity of trigger points was significantly associated with group. This suggests confounding variables leaving a gap in the knowledge and room for further research in this respect.

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APPENDIX 1

ARE YOU BETWEEN 18 & 20 YEARS OF AGE?
DO YOU
RUN AN AVERAGE OF 20 KMS A WEEK?

ARE YOU INTERESTED IN PARTICIPATING IN RESEARCH?

RESEARCH IS CURRENTLY BEING CARRIED OUT ON

PATELLOFEMORAL PAIN SYNDROME

AT THE DURBAN INSTITUTE OF TECHNOLOGY CHIROPRACTIC DAY CLINIC.

FREE TREATMENT

IS AVAILABLE TO THOSE WHO QUALIFY TO TAKE PART IN THIS STUDY.

FOR MORE INFORMATION CONTACT:
GAIL DALY
031 204 2205 or
083 599 2396

APPENDIX 2

Questions to be asked during the telephonic interview:

Inclusion Criteria:

Do you run a minimum of two hours per week?
Are you between the ages of 18 and 60 years?
Is the pain you are experiencing underneath or around your kneecap?
Do any of the following aggravate your pain?

- Squatting
- Stair climbing
- Kneeling
- Prolonged sitting
- Physical activity

Exclusion Criteria:

Have you had a history of any of the following?

- Traumatic kneecap dislocation
- Any neurological problem affecting the way you walk
- Have you undergone any knee surgery over the past two years
- A cartilage tear
- Injury causing instability
- Does your knee give way underneath you
- Arthritis in your knees

Are you pregnant or breastfeeding at present?

APPENDIX 3

DURBAN INSTITUTE OF TECHNOLOGY
CHIROPRACTIC DAY CLINIC
CASE HISTORY

Patient: _____ Date: _____

File # : _____ Age: _____

Sex : _____ Occupation: _____

Intern : _____ Signature _____

FOR CLINICIANS USE ONLY:

Initial visit

Clinician: Signature :

Case History:

Examination:

Previous:
Current:

X-Ray Studies:

Previous:
Current:

Clinical Path. lab:

Previous:
Current:

CASE STATUS:

PTT:	Signature:	Date:

CONDITIONAL:
Reason for Conditional:

Signature: Date:

Conditions met in Visit No:	Signed into PTT:	Date:
Case Summary signed off:		Date:

Intern's Case History:

1. **Source of History:**

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

3. **Present Illness:**

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

4. **Other Complaints:**

5. **Past Medical History:**

- General Health Status
- Childhood Illnesses
- Adult Illnesses
- Psychiatric Illnesses
- Accidents/Injuries
- Surgery
- Hospitalizations

6. Current health status and life-style:

- Allergies
- Immunizations
- Screening Tests incl. xrays
- Environmental Hazards (Home, School, Work)
- Exercise and Leisure
- Sleep Patterns
- Diet
- Current Medication
  Analgesics/week:
- Tobacco
- Alcohol
- Social Drugs

7. Immediate Family Medical History:

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

8. Psychosocial history:

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

9. Review of Systems:

- General
- Skin
- Head
- Eyes
- Ears
- Nose/Sinuses
- Mouth/Throat
- Neck
- Breasts
- Respiratory
- Cardiac
- Gastro-intestinal
- Urinary
- Genital
- Vascular
- Musculoskeletal
- Neurologic
- Haematologic
- Endocrine
- Psychiatric

Durban Institute of Technology
PHYSICAL EXAMINATION: SENIOR

Patient Name : _____ **File no :**_____ **Date :**_____
Student : **Signature :**

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

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

SYSTEM SPECIFIC EXAMINATION:

CARDIOVASCULAR EXAMINATION

RESPIRATORY EXAMINATION

ABDOMINAL EXAMINATION

NEUROLOGICAL EXAMINATION

COMMENTS

NEUROLOGICAL EXAMINATION: See Regionals

Clinician: **Signature :**

APPENDIX 5

DURBAN INSTITUTE OF TECHNOLOGY
Knee regional examination

Patient:_____ File:_____ Date:_____
Intern:_____ Signature:_____
Clinician:_____ Signature:_____

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

A. Anterior view
Genu Varum:_____
Genu Valgum:_____
Patellar position:_____
Tibial Torsion:_____
Skin:_____
Swelling:_____

B. Lateral view
Genu Recurvatum:_____
Patella Alta:_____
Patella Baja:_____
Skin:_____

C. Posterior view
Swelling:_____
Skin:_____

D. General
Movement symmetry:_____
Structures symmetry:_____

ACTIVE MOVEMENTS
Flexion (0 - 135°)_____
Extension (0 - 15°)_____
Medial Rotation (20 - 30°)_____
Lateral rotation (30 - 40°)_____

- **PASSIVE MOVEMENTS**

Tissue approx_____
Bone-bone_____
Tissue stretch_____
Tissue stretch_____
Patellar movement_____

- **RESISTED ISOMETRIC MOVEMENTS**

Knee: Flexion:_____
Extension:_____
Internal rotation:_____
External rotation:_____
Ankle: Plantarflexion_____
Dorsiflexion_____

- **LIGAMENTOUS ASSESSMENT**

One-Plane Medial Instability
Valgus stress (abduction)
Extended_____
Resting Position_____

One-Plane Lateral Instability
Varus stress (adduction)
Extended_____
Resting Position_____

One-Plane Anterior Instability
Lachman Test (0-30°)_____
Anterior Drawer Sign _____

One-Plane Posterior Instability
Posterior "sag" Sign_____
Posterior Drawer Test_____

Anterolateral Rotatory Instability
Slocum Test_____
Macintosh Test_____

Anteromedial Rotatory Instability
Slocum Test_____

Posterolateral Rotatory Instability

Jacob _____
Hughston's Drawer Sign_____
Reverse pivot shift test_____

Posteromedial Rotatory Instability

Hughston's Drawer Sign_____

- **TESTS FOR MENISCUS INJURY**

McMurray_____ Anderson med-lat grind_____
"Bounce Home"_____ Apley's_____

- **PLICA TESTS**

Mediopatellar Plica _____ Hughston's Plica_____
Plica "Stutter"_____

- **TESTS FOR SWELLING**

Brush/Stroke Test _____ Patellar Tap Test_____

- **TESTS FOR PATELLA FEMORAL PAIN SYNDROME**

Clarke's Sign _____ Passive patella tilt test_____
Waldron test_____

- **OTHER TESTS**

Wilson's_____ Quadriceps Contusion Test_____
Fairbank's_____ Leg Length Discrepancy_____
Noble Compression_____

- **JOINT PLAY**

Movement of the tibia on the femur P → A:_____ A → P:_____
Translation of the tibia on the femur M → L: _____L → M:_____
Long axis distraction of the tibiofemoral joint _____
Inf, sup, lat, + med glide of the patella _____
Movement of the inf. tibiofibular joint A → P_____P → A
Movement of the sup. tibiofibular joint A → P_____P → A
Movement of the sup tibiofibular joint S → I _____I → S_____

- **PALPATION**

Tenderness_____ Swelling_____
Joint line_____ Nodules/exostoses_____
Ligaments_____Muscles: thigh:_____
Patella: _____ Leg : _____
Patella tendon:_____Popliteal artery:_____
Bursae:_____

- **REFLEXES AND CUTANEOUS DISTRIBUTION**

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

- **DERMATOMES**

	R	L		R	L
L2			S1		
L3			S2		
L4			S3		
L5					

APPENDIX 6

LETTER OF INFORMATION

Dear Patient

Welcome to my study. Thank you for your interest.

The title of my study is: **The relationship between myofascial trigger points, total work and other recorded measurements of the vastus lateralis and vastus medialis, in long-distance runners with patellofemoral pain syndrome.**

Name of Supervisors: Dr. N. de Busser (031-2042205)
Dr. C. Korporaal (031-2042205)
Name of Student: Miss Gail Daly (031-2042205)
Name of Institution: Durban Institute of Technology

Purpose of the study:
This study will involve research on 50 patients; testing for the presence of hyperirritable knots within the muscle (myofascial trigger points) of the Quadriceps Femoris (thigh) muscle in long-distance runners that are suffering from Runners Knee and those who are not in order to compare the presence of these knots with the functional ability of the various muscular portions of the thigh.

Procedure:
You will be required to undergo an initial consultation, of approximately 1½ hours, during which a case history, physical examination and knee regional examinations will be performed. You will also be required to fill out a pain questionnaire and answer questions regarding your knee pain.

A second and third consultation at the Kings Park Sports Medicine Centre in Durban, will also be required where you will be asked to perform 6 maximum efforts on the Cybex 700 Isokinetic Dynanometer, in order to record the strength of the outer and inner portion of your thigh muscle and the entire thigh muscle itself. This information will be gathered for the purpose of establishing any strengths or weaknesses of one or more portions of the thigh muscle and correlating this with any hyperirritable knots found in the thigh muscle during the initial consultation.

Risks/Discomfort:
You may experience slight transient discomfort during or after the examination, however the utilisation of an algometer (a tool used to measure your pain levels) may also be beneficial as it mimics a therapeutic intervention. If the pain exceeds a mild discomfort (during isokinetic testing) the testing will be discontinued and you will be excluded from the study to received standard clinical care.

Costs/Renumeration:
The study will not encur any costs to you the participant, however it muast also be noted that no renumeration should be expected as a result in participation in this study.

Benefits:
Two free treatments will be given to all participants, by the researcher for the PFPS.

Withdraw or refusal to participate:
Following on from my study, an extension of this study will be done by a colleague.

You are free to refuse to participate and are able to withdraw at any stage, without any repercussions for your further out-patient treatment at the clinic.

Inclusion criteria:

Participants allocated for Group A must present with at least three of the following:

- Knee pain which is worse on prolonged sitting, climbing and descending stairs, deep knee bends or squats and / or kneeling.

Exclusion criteria:

Participants will be excluded if they have a history of:

- Changes in your walking pattern as a result of anything other than PFPS
- Knee surgery within the past two years and / or traumatic patella dislocation or any other trauma of the involved knee.
- Participants will be excluded if they are diagnosed with one or more of the following: Bursitis, patella tendonitis, fat pad syndrome, any systemic arthritides that affect the knee, any evidence of a meniscal tear or other ligamentous instability (pathological or trauma induced). Abnormalities indicative of osteoarthritis, osteochondritis dessicans or loose bodies will also result in exclusion.
- Due to ligamentous laxity all pregnant or breast-feeding participants will also be excluded.
- Furthermore you may be excluded if you are receiving any form of therapy, manual or medicinal for your PFPS during the course of this research.
- You may not run a marathon during the course of this study, although you may continue to train at the same intensity to avoid aggrevation.

If you experience any pain on completing the isokinetic test, you will be excluded from this study, as the testing may worsen your condition and indicates that standard clinical care is necessary.

Confidentiality:

All patient information is confidential and the results will be used for research purposes only, although supervisors and senior clinic staff may be required to inspect records. You have the right to be informed of any new findings that are made. You may ask questions of an independent source if you wish to (my supervisors are available on the above numbers). If you are not satisfied with any area of the study please feel free to forward any concerns to my supervisor(s).

New Findings:

Any new findings and / or results of this study are available to you the participant. Should you wish to receive these results, please indicate this to the researcher and such will be posted to you after completion of the study.

Thank you for your interest and participation.

Yours Faithfully

Miss Gail Daly (Chiropractic Intern)	**Dr. N. de Busser (Supervisor)**	**Dr. C. Korporaal (Supervisor)**

APPENDIX 7

INFORMED CONSENT FORM

The title of my study is: **The relationship between myofascial trigger points, total work and other recorded measurements of the vastus lateralis and vastus medialis, in long-distance runners with patellofemoral pain syndrome.**

Name of Supervisors: Dr. N. de Busser (031-2042205)
Dr. C. Korporaal (031-2042205)
Name of Student: Miss Gail Daly (031-2042205)
Name of Institution: Durban Institute of Technology

This study will involve research on 40 patients; testing for the presence of hyperirritable knots within the muscle (myofascial trigger points) of the Quadriceps Femoris (thigh) muscle in long-distance runners that are suffering from a condition commonly known as Runners Knee.

Please circle the appropriate answer:

1. Have you read the patient informed sheet?
   YES/NO
2. Have you had the opportunity to ask questions regarding this study?
   YES/NO
3. Have you received satisfactory answers to your questions?
   YES/NO
4. Have you had an opportunity to discuss this study?
   YES/NO
5. Have you received enough information about this study?
   YES/NO
6. Who have you spoken to?_____
7. Do you understand the implications of your involvement in this study?
   YES/NO
8. Do you understand that you are free to withdraw from this study?
   YES/NO
   - At any time?
   - Without having to give a reason for withdrawing, and
   - Without affecting your future health care.
9. Do you agree to voluntarily participate in this study?

YES/NO

PATIENT/SUBJECT
Name_____ Signature

WITNESS
Name_____Signature

RESEARCH STUDENT
Name _____ Signature

APPENDIX 8

MYOFACIAL DIAGNOSTIC SCALE

Patients Name: _____

Muscle: _____

Treatment No: _____

Signs:

Soft tissue tenderness

1. Grade

No tenderness

0

I Tenderness to palpation WITHOUT grimace or flinch

ii Tender WITH grimace and/or flinch to palpation

iii Tenderness with WITHDRAWAL (+ "Jump sign")

iv Withdrawal (+ "Jump sign")
To non-noxious stimuli (ie. Superficial palpation, pin prick, gentle percussion

2. Snapping palpation of the trigger point evokes a local twitch response

3. The trigger point is found in a palpable taut band.

4. Moderate, sustained pressure on the trigger point causes or intensifies pain in the reference zone

NUMERICAL RATING SCALE:

0 1 2 3 4 5 6 7 8 9 10

APPENDIX 9

CLINICIAN TO READ AND FILL IN BELOW: Complete at the end of the history and prior to physical examination.

Initial assessment:

I am going to ask you to identify up to three important activities that you are unable to do or are having difficulty with as a result of your problem. Today, are there any activities that you are unable to do or are having difficulty with because of your_____problem/ (Clinician: Show scale to patient and have the patient rate each activity.)

Follow-up assessments:

When I assessed you on (state previous assessment date), you told me that you had difficulty with (read all activities from list at the time). Today do you still have difficulty with: (read and have patient score each item on the list)?

PATIENT – SPECIFIC ACTIVITY SCORING SCHEME (Point to one number):

0	1	2	3	4	5	6	7	8	9	10

Unable to Perform activity problem

Able to perform activity at same level as before injury or

(Date and score)

Activity	Initial	8th	9th			
1						
2						
3						
4						
5						
Additional						
Additional						

APPENDIX 10

Algometer Readings:

	Tendinous Portion	Distal muscle	Mid-belly	Proximal muscle	Other	Total
Vastus Medialis						
Vastus Lateralis						
Vastus Intermedialis						
Rectus Femoris						

Total number of MTrp's _____

Mean Weight (kg) _____