SMGroup

SM Journal of Orthopedics

Mini Review

A Mini Review of Physiotherapies for Patellofemoral Pain Syndrome

Stuart Hall[1] and Liang Q Liu[2*]

[1]*Chartered Physiotherapist, Precision Physiotherapy, United Kingdom*

[2]*Centre for Critical Research in Nursing and Midwifery, Department of Adult, Child & Midwifery, Middlesex University, United Kingdom*

Article Information

Received date: Oct 15, 2015

Accepted date: Oct 25, 2015

Published date: Nov 04, 2015

***Corresponding author**

Dr. Liang Q Liu, Centre for Critical Research in Nursing and Midwifery, Department of Adult, Child & Midwifery, Middlesex University, United Kingdom, Tel: 0044-(0)2084112893; Email: L.Q.Liu@mdx.ac.uk

Keywords Patella pain; Anterior knee pain; Patellofemoral pain and/or physiotherapy; Gastrocnemius; Patellofemoral biomechanics; Transverse friction massage; Physiotherapy

Abstract

Patellofemoral Pain Syndrome (PFPS) is the most common type of knee pain. It is estimated that PFPS accounts for 25-30% of all knee pathologies. The condition can be very painful and the symptoms can take a long time to settle. There is general consensus that effective treatment strategies should be based on a thorough understanding of pathological changes of PFPS. This mini review briefly outlines biomechanical aspects of pathophysiology of the structures involved and describes current treatment strategies available in the literature, in particular it looks at muscle tightness and provides an insight into stretching techniques as an effective physiotherapy choice for the condition.

Background

Patellofemoral pain syndrome (PFPS) is defined as "diffuse intermittent pain in the anterior region of the knee. This increases with functional activities such as running, squatting, and stair climbing and kneeling due to higher patellofemoral joint reaction forces and associated patellofemoral joint stress [1].

Patients with PFPS account for 10-25% of physiotherapy attendances [2].It is the most common type of knee pain accounting for 25-30% of all knee pathologies [3]. The condition is commonly treated with conservative measures such as physiotherapy and this is thought to be helpful in two third of patients [4]. Other studies suggest that patients continue to suffer pain or are unable to regain full function long-term [5-7].

PFPS experienced for longer than 2 months has been suggested as a predictor for poor outcomes, and early intervention may improve recovery[7]. It may be that a key issue is successfully identifying the structure producing pain [8]. This could be the anterior synovium, infrapatellar fat pad, subchondral bone (medial and lateral patella facets and trochlea groove of the femur) and the medial and lateral retinaculae.

It is widely accepted that there are many potential causes for PFPS and therefore many choices regarding treatment. Effective treatment strategies must be based on a thorough understanding of any pathological changes in any relevant structure. Therefore the aim of this article is to 1) review of the literature about the biomechanical aspects of PFPS, and current treatments particularly whether muscle tightness is considered; 2) explore the contribution of tight gastrocnemius in PFPS and the effect of stretching on this muscle.

Search Method

Searches were carried out using AMED, CINAHL and Medline electronic databases. Key words for electronic database search include patella pain, anterior knee pain, patellofemoral pain and/or physiotherapy, gastrocnemius, patellofemoral biomechanics, transverse friction massage, physiotherapy. In addition, the reference list of included studies and other relevant papers were screened to identify further relevant studies.

Literature Review

Anatomy and function

The role of the patella is to increase the force production of the quadriceps. It acts like a pulley to improve the mechanical advantage of the quadriceps by allowing the knee to extend with a smaller contractile force. This leads to a large compressive force on the patellofemoral joint, which is at a maximum of 90° knee flexion and the foot is planted on the ground. The biomechanics of the patellofemoral joint make it one of the most complex joints in the body. This is due to its numerous capsuloligamentous structures and muscles that act dynamically on the patella.

The anatomy of the patellofemoral joint involves the femur, tibia and patella. The trochlea groove on the femur consists of medial and lateral femoral condyles with an intervening shallow depression of around 5-6mm. The articular surface of the patella is divided by means of a ridge into medial and lateral facets. The medial facet is divided into superior, middle, lateral and inferior portions, or sub facets. The larger lateral facet has superior, middle and inferior portions (facets). With the knee in full extension there is no joint surface contact and the patella lies over an area of thin, smooth synovial tissue.

As the knee moves from extension to flexion the patella begins laterally and moves medially as the patella enters the trochlea groove and it continues to follow this groove until the knee has reached 90°. At this point the patella moves laterally until it covers the condyle at 135°of knee flexion.

The influence of femoral internal and external rotation play an important role in defining patellofemoral joint alignment and therefore contact pressure. Furthermore both tibial internal and external rotation influences joint stress.

It is the role of the soft tissues to stabilise the patella. The patella ligament is a strong flat ligament which originates at the apex (distal end) of the patella and it inserts onto the tuberosity of the tibia. The superficial fibres are continuous with those of the quadriceps femoris. The medial and lateral portions of the quadriceps tendon pass down on either side of the patella to be inserted into the upper extremity of the tibia on either side of the tuberosity. These portions merge with the capsule forming the medial and lateral patella retinaculum.

Passive stabilisers of the knee include the medial patellofibula ligament (MPFL), medial patellotibial ligament (MPTL) and the retinaculum. It has been shown that the MPFL and MPTL contribute, respectively, 60% and 22% of the force that opposes lateral displacement of the patella. MPFL injury has been proven to reduce by almost 50% the force needed to dislocate the patella laterally with the knee extended [10].

Biomechanical aspect of PFPS

There is currently no consensus about the pathophysiology of PFPS. Various studies have proposed different structures as the source of pain. Pain-free tracking of the ridge of the patella in the trochlea groove of the femur requires a balance of forces between different anatomical structures. If any imbalance exists then the movement of the patella will be altered which can place additional mechanical stresses on the joint [11] and may result in pain.

Risk factors for developing PFPS can be single or multifactorial as indicated in a recent systematic review by Lankhurst, et al. [5] which identified 523 variables. Commonly cited are the patella position and the factors affecting movement control, such as excessive quadriceps angle, patella compression or tilting, and abnormal reflex timing between vastus medialis oblique (VMO) and vastus lateralis (VL). Other factors include tightness in gastrocnemius, hamstring, quadriceps or iliotibial band. Generalised ligamentous laxity in the medial collateral ligament or patella retinaculum, deficient strength in hamstring, quadriceps, or muscles around the hip are all potential issues.

There is some agreement that increased quadriceps angle (Q-angle) is significant. This angle is relevant in the direction of the quadriceps force and it has been suggested that a Q-angle greater than 16º is a risk factor for developing PFPS [11] and can increase contact pressure by 45% [12].

An increase in hip adduction or internal rotation increases the Q angle by increasing the relative valgus of the lower extremity. This leads to an increase in contact pressure in the patellofemoral joint.

Previous consideration of the causative factors for PFPS have been associated with patella maltracking. However Stephen, et al. [13]. suggest that we should be focusing more-so on contact pressure. They report that before maltracking occurs there is altered pressure capable of creating pain, and these pressures can be 30% elevated in PFPS.

Meira, et al. [14] carried out a systematic review of the influence of the hip on patients with PFPS. There is conflicting opinion on whether hip position influences PFPS and there have been numerous studies to investigate this. One study suggested that females demonstrated greater hip adduction during running, hopping and performing single leg squats, whilst others reported no difference.

The correlation between hip strength and PFPS was reported in 5 systematic reviews with agreement that external rotation and abduction were weaker than controls. The most significant difference was abductor strength which could be up to 27% [15].

It is unknown if this hip weakness is the cause of PFPS or the result. Studies tend to focus on peak strength however hip weakness has been shown to increase through fatigue [16] therefore further studies are required to evaluate abductor endurance.

In a study investigating predictors of pain and function in PFPS, Piva, et al. noted that the only physical impairment that predicted functional outcome was reduced gastrocnemius length [2]. A stretching programme was the only factor that improved fear-avoidance behaviour, even when the increased gastrocnemius length was not statistically significant.

The authors speculate that increased gastrocnemius length may reduce passive resistance at the knee and ankle joints. The clinical implication is that clinicians should consider stretching the gastrocnemius to improve functional outcome.

Collado, et al. propose that a shortened gastrocnemius will restrict talocrural dorsiflexion which then causes a compensatory pronation of the subtalar joint and increased dynamic Q-angle [11]. The talocrural joint requires 10º of dorsiflexion for normal gait and 15º-25º for running; less than this will cause compensatory pronation and potential PFJ dysfunction.

Changes to normal gait biomechanics have an effect on PFPS. Pronation of the foot causes the tibia to internally rotate during mid-stance phase of gait. This prevents the knee from achieving full locking via the screw- home mechanism normally achieved via tibia external rotation. To compensate, the femur internally rotates to allow the knee to fully lock, which creates increased contact pressure between the patella and lateral trochlea groove, which can give rise to painful symptoms.

Despite extensive literature searching, no studies were found about the relevance of trigger points (TrP) in the gastrocnemius muscle in patients with PFPS. One study looked at TrP and stretching in plantar heel pain [17] and found benefits with the addition of TrP massage to a specific stretching programme. This study may be considered relevant when considering effective treatment modalities including stretching and TrP massage specifically for PFPS.

Treatment strategies

There has been a vast amount of research into the optimal treatment strategy for PFPS. The biomechanical complexity of the condition allows for relevant consideration of a wide variety of treatment approaches. A systematic review of physiotherapy interventions for PFPS by Jonbergen, et al. suggests that a multifactorial treatment package may be indicated which could include patella taping, functional exercises, quadriceps strengthening, postural advice, muscle stretching, weight loss, activity modification, and education [18]. Clear guidelines for each of these components were not given here. The wide choice suggested makes it difficult to draw conclusions on the effects of any individual treatment constituents. This multifactorial approach may however reflect the current physiotherapy approach for this complex condition.

Quilty, et al. carried out a randomised controlled trial of physiotherapy techniques involving taping and quadriceps strength training with particular focus on the vastus medialis oblique (VMO) [19]. Results demonstrated a significant increase in quadriceps strength in the treatment group, but only a 16% reduction in reported pain. At 12 months follow-up there was no significant difference between the two groups.

Crossley, et al. carried out a randomised, double-blinded placebo-controlled trial of physiotherapy for PFPS [9]. Treatment was again multifactorial and involved a regimen of gluteal muscle strengthening, patella taping, VMO strengthening, and stretching of soft tissues. Transverse friction massage was included in this trial, which was applied to "lateral soft tissue". After 6 weeks the treatment group demonstrated significant improvement in 3 out of 4 primary outcomes. The authors noted that conclusions could not be drawn on the relative benefits of the various components and that future studies should focus on the effects of individual treatment constituents.

There are numerous studies which utilise strengthening exercises in the treatment of PFPS. Yet, there are few which assess the effects of stretching.

Muscle tightness in PFPS

Witvrouw, et al. [20] carried out a 2-year prospective study using physical education students to analyse which presumed risk-factors might play a significant role in PFPS. At the start of the course none of these students had a history of patellofemoral joint pain. However, at 2-year follow-up, 24 (9%) of students had developed pain. They found a significant reduction in the flexibility of the quadriceps and gastrocnemius muscles in the group with patellofemoral pain compared to control subjects. The authors comment that there is little information in the medical literature about the effect of stretching on PFPS. They suggest that future research should be undertaken to identify the effect of resolving tightness in both the quadriceps and gastrocnemius muscle groups. It could be considered that an effective stretching programme may have a beneficial effect on existing PFPS, and may be also relevant in prevention.

Two studies identified by Waryasz, et al. found that gastrocnemius tightness was significant when comparing PFPS patients with controls [4]. Studies have also shown that hamstring muscles are also considerably shorter in patients with PFPS [21]. However, a gap in the literature exists, which is the assessment of the effects of stretching these tight muscles in patients with PFPS.

Whilst many articles report the use of stretching as standard physiotherapy they often do not mention the frequency, duration or intensity of stretching programmes (leaving the reader to draw their own conclusions.

Stretching as a potential treatment

A randomised controlled trial by Porter, et al. is often cited which compares the length and frequency of Achilles tendon stretching between two groups with heel pain [22]. One group performed a more prolonged stretch held for three minutes, three times a day. A second group performed intermittent stretches for 20 second intervals repeated 5 times a day. The protocol was followed for 4 months with subjects providing a stretching diary. Results demonstrated no significant difference in range of ankle dorsiflexion between the two stretching protocols, and both groups had improved symptoms. This suggests that stretching for 3 minutes is no more effective than stretching for 20 seconds. The study compares frequency and duration, however the intensity of the stretch has not been controlled which makes it difficult to draw conclusions.

There are some relevant studies which demonstrate how to make stretching can be effective for muscle lengthening. Reid, et al. carried out a randomised controlled trial to determine the frequency of hamstring stretches to maintain knee extension ROM [23]. A six-week static stretching programme of 15-60 seconds one to three repetitions per day were sufficient to increase hamstring length. However, these initial improvements were lost four weeks after stopping. The study indicates that there is a need to continue stretching once initial improvements have been made.

A systematic review by Radford, et al. investigated the effect of stretching on ankle dorsiflexion [24]. They reported that calf muscle stretches provide a small but statistically significant increase in ankle dorsiflexion, particularly after 5–30 minutes of stretching.

It is the variation or lack of information regarding duration, frequency and particularly intensity of stretching in the literature that make it make it difficult to draw accurate conclusions. The instructions given to participants is rarely provided. Some studies have referred to a stretch taken to the "pain threshold". Young, et al. looked at the effect of volume and intensity of static stretching in a warm up on explosive force production of the plantar flexors [25]. They noted that stretches performed at 100% intensity reduced muscle function however when performed at 90% intensity muscle function was not affected. They suggest that stretching at 90% intensity may have injury prevention benefits.

A randomised controlled trial by Renan-Ordine and colleagues compared myofascial trigger-point (TrP) massage with self-stretches for plantar heel pain [17]. They suggest that trigger points in the gastrocnemius muscle may be involved in the development of plantar heel pain. They define trigger points as "hyper-irritable areas associated within a taut band of skeletal muscle that is painful on compression, contraction or stretching of the muscle". Their results suggest that the addition of TrP massage to a stretching programme resulted in superior short-term outcome, compared to stretching alone.

Outcome assessment

The eccentric step test has been frequently cited in the literature as a valid and reliable test to assess PFPS. To ascertain the validity and reliability of the test, Selfe, et al. [26] carried out a randomly-controlled repeated measures design study. They found that study participants with PFPS stepped down with reduced knee flexion and with increased velocity on the painful knees, which is thought to increase the joint reaction forces at the patellofemoral joint. The authors also suggest that the use of VAS could be used to record pain severity during performance of the test. This testing procedure has been utilised in more recent studies [27,28].

Summary

The diverse literature about PFPS suggests that the causes of the condition are likely to be multifactorial, and that the structures producing pathology and pain are numerous. Causes include both soft-tissue and joint problems, both tightness and weakness in muscles, and also biomechanical issues of tracking of the patella, knee, ankle and foot. There is some evidence to suggest that tightness in the gastrocnemius is found alongside PFPS, plus localised TrPs in the lateral gastrocnemius muscle. This soft-tissue tightness and tenderness may be a causative factor for pain in the patella area. There do not appear to be any studies which evaluate the effect of stretching or TrP massage for this condition. However, there is some relevant evidence regarding this approach in other areas of the lower limbs, which suggests that massage techniques used alongside a stretching protocol are significantly more beneficial than stretches alone. Whilst many articles report the use of stretching as standard physiotherapy in other realm, they often do not mention the frequency and duration leaving the reader to draw their own conclusions.

In conclusion, there is a gap in the literature regarding the effect of localising treatment to gastrocnemius tightness for PFPS. There is also debate regarding the optimum duration, frequency and perhaps more importantly the intensity for which stretches should carried out. Future research to determine the effect of stretches and transverse friction massage to the gastrocnemius in patients with patellofemoral pain syndrome is warranted.

References

1. Mostamand J, Bader D, Hudson Z. Reliability testing of the patellofemoral joint reaction force (PF JRC) measurement during double legged squatting in healthy subjects: a pilot study. Journey of Bodywork and Movement Therapies. 2011; 16: 217-223.
2. Piva S, Fitzgerald G, Wisniewski S, Delitto. Predictors of pain and function outcome after rehabilitation in patients with patellofemoral pain syndrome. Journal of Medical Rehabilitation. 2009; 41: 604-612.
3. Escamilla RF, Zheng N, Macleod T, Edwards W, Imamura R, Hreljac A. Patellofemoral joint force and stress during the wall squat and one leg squat. Medicine and Science in Sport Exercise. 2009; 41: 879-888.
4. Waryasz GR, McDermott AY. Patellofemoral pain syndrome (PFPS): a systematic review of anatomy and potential risk factors. Dyn Med. 2008; 7: 9.
5. Lankhorst NE, Bierma-Zeinstra SM, van Middelkoop M. Factors associated with patellofemoral pain syndrome: a systematic review. Br J Sports Med. 2013; 47: 193-206.
6. Pappas E, Wong-Tom WM. Prospective Predictors of Patellofemoral Pain Syndrome: A Systematic Review With Meta-analysis. Sports Health. 2012; 4: 115-120.
7. Collins N, Bierma-Zeinstra S, Crossley K, Van Linscoten R, Vincenzino B, Van Middelkoop M. Prognostic factors for patellofemoral pain: a multicentre observational analysis British Journal of sports Medicine. 2013; 47: 227-233.
8. Mc Connell J. Management of patellofemoral problems. Man Ther. 1996; 1: 60-66.
9. Crossley K, Bennell K, Green S, Cowan S, Mc Connell J. Physical therapy for patellofemoral pain: a randomized, double-blinded, placebo-controlled trial. Am J Sports Med. 2002; 30: 857-865.
10. Senavongse W, Amis AA. The effects of articular, retinacular, or muscular deficiencies on patellofemoral joint stability: a biomechanical study in vitro. J Bone Joint Surg Br. 2005; 87: 577-582.
11. Collado H, Fredericson M. Patellofemoral pain syndrome. Clin Sports Med. 2010; 29: 379-398.
12. Huberti HH, Hayes WC. Patellofemoral contact pressures. The influence of q-angle and tendofemoral contact. J Bone Joint Surg Am. 1984; 66: 715-724.
13. Stephen JM, Lumpaopong P, Dodds AL, Stephen JM, Lumpaopong P, Dodds AL, et al. The Effect of Tibial Tuberosity Medialization and Lateralization on Patellofemoral Joint Kinematics, Contact Mechanics, and Stability, American Journal of Sports Medicine. 2015; 43: 186-194.
14. Meira EP, Brumitt J. Influence of the hip on patients with patellofemoral pain syndrome: a systematic review. Sports Health. 2011; 3: 455-465.
15. Robinson R, Nee R. 2007 Analysis of hip strength in females seeking physical therapy treatment for unilateral patellofemoral pain syndrome. Journal of Orthopaedic Sports Physical Therapy. 232-238.
16. Dierks TA, Manal KT, Hamill J, Davis IS. Proximal and distal influences on hip and knee kinematics in runners with patellofemoral pain during a prolonged run. J Orthop Sports Phys Ther. 2008; 38: 448-456.
17. Renan-Ordine R, Alburqueque-Sendin F, De Souza D, Cleland J, Fernandez-De-Las-Penas C. Effectiveness of Myofascial trigger point manual therapy combined with a self-stretching protocol for the management of plantar heel pain: a randomised controlled trial. Journal of Orthopaedic and Sports Physical Therapy. 2011; 41: 43-50.
18. Van Jonbergen HP, Poolman RW, van Kampen A. Isolated patellofemoral osteoarthritis. Acta Orthop. 2010; 81: 199-205.
19. Quilty B, Tucker M, Campbell R, Dieppe P. Physiotherapy, including quadriceps exercises and patellar taping, for knee osteoarthritis with predominant patello-femoral joint involvement: randomized controlled trial. Journal of Rheumatology. 2003; 30:1311-1317.
20. Witvrouw E, Lysens R, Bellemans J, Cambier D, Vanderstraeten G. Intrinsic risk factors for the development of anterior knee pain in an athletic population. A two-year prospective study. Am J Sports Med. 2000; 28: 480-489.
21. White LC, Dolphin P, Dixon J. Hamstring length in patellofemoral pain syndrome. Physiotherapy. 2009; 95: 24-28.
22. Porter D, Barrill E, Oneacre K, May BD. The effects of duration and frequency of Achilles tendon stretching on dorsiflexion and outcome in painful heel syndrome: a randomized, blinded, control study. Foot Ankle Int. 2002; 23: 619-624.
23. Reid D, Kim J. The frequency of hamstring stretches required to maintain knee extension range of motion following an initial six-week stretching programme. New Zealand Journal of Physiotherapy. 2014; 42: 22-27.
24. Radford JA, Burns J, Buchbinder R, Landorf KB, Cook C. Does stretching increase ankle dorsiflexion range of motion? A systematic review. Br J Sports Med. 2006; 40: 870-875.
25. W Young; G Elias; J Power. Effects of static stretching volume and intensity on plantar flexor explosive force production and range of motion. Journal of Sports Medicine and Physical Fitness. 2006; 46: 403-411.

26. Selfe j, Harper L, Pederson I, Breen-Turner J, Waring J. Four outcome measures for patellofemoral joint problems part 1. Development and validity. Physiotherapy. 2001; 87; 507-515.

27. Loudon JK, Wiesner D, Goist-Foley HL, Asjes C, Loudon KL. Intrarater Reliability of Functional Performance Tests for Subjects With Patellofemoral Pain Syndrome. J Athl Train. 2002; 37: 256-261.

28. Nijs J, Van Geel C, Van der auwera C, Van de Velde B. Diagnostic value of five clinical tests in patellofemoral pain syndrome. Man Ther. 2006; 11: 69-77.