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Graston Technique Used In The Treatment Of Patellofemoral Pain In An Ultimate Frisbee Player: A Case Report

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PTH 608/708: Case Report Template

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Graston® Technique Used in The Treatment of Patellofemoral Pain in An Ultimate Frisbee Player: A Case Report

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The patient gave consent to participate in this case study by signing an informed consent form allowing the use of medical information and photography obtained for this report and received information on the institution policies regarding the Health Insurance Portability and Accountability Act.

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ABSTRACT

Background and Purpose:

Graston® Technique (GT) is an instrumented tool used in rehab shown to improve soft tissue injuries. While studies have shown GT to be effective with injuries such as achilles tendinitis, it has not been extensively studied in patients with patellofemoral pain. The purpose of this case report was to investigate a plan of care that included GT in a 38-year-old male ultimate frisbee athlete with patellofemoral pain.

Case Description:

The patient was an active 38-year-old father of four and a recreational ultimate frisbee player. His chief complaints were pain in the lateral compartment of the right knee, knee stiffness, and an inability to play with his children without pain. The patient was seen once a week for sixteen weeks. Physical therapy treatment included IASTM using GT on the surrounding tissue structures of the knee, stretching and strengthening of the lower extremity, and a comprehensive home exercise program (HEP). Outcome measures included lower extremity functional index (LEFI), numeric pain rating scale (NPRS) and the deep squat test.

Outcomes:

LEFI improved from 19% to 6% disability from initial evaluation (IE) to discharge, which indicated a clinically significant difference. At IE, the deep squat test reproduced 5/10 pain on the NPRS with visible lateral patellar tracking to less than 1/10 pain and significantly reduced lateral tracking of the patella at discharge. The patient's pain while playing ultimate frisbee improved from 7/10 to 1/10 on the NPRS.

Discussion:

A rehab program that combined GT with general lower extremity exercise was an effective treatment for a 38-year-old patient with patellofemoral pain. Future research should investigate the use of GT in a larger population of patients with patellofemoral pain.

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BACKGROUND and PURPOSE

Patellofemoral pain (PFP) is characterized by anterior knee pain of an insidious onset that is exacerbated under conditions of increased patellofemoral joint stress. It can persist chronically if the factors contributing to its development are not properly recognized and addressed.[1] Patellofemoral pain accounts for up to 25% of people who presented with knee injuries in sports medicine clinics and is common in runners due to repetitive and/or excessive and specific loading.[2] The prevalence and incidence rate of PFP is 2 to 3 times greater among woman than men.[3] It was thought for many years that PFP was more prevalent in younger patients, but a recent study has shown that injury patterns in masters' runners demonstrate similar rates of PFP between those older and younger than 40 years of age.[4]

Ultimate frisbee is one of the fastest growing sports in the United States.[5] Players run, cut, guard, jump, throw, catch, and dive in a fully outstretched position to catch a disc and advance to score a goal.[5] Physical contact with other players from frequent cutting and jumping are all possible risk factors for injury.[5] Patellofemoral pain is most common in long distance runners due to the repetitive loading on lower extremity joints and is not as common in cutting sports, like ultimate frisbee.[6] 60-80% of knee injuries that occur in ultimate frisbee players are due to high contact stresses to joints.[5]

The Graston® technique (GT) is a form of instrument-assisted soft tissue mobilization (IASTM) that uses unique stainless steel instruments along with appropriate therapeutic exercise to treat areas exhibiting soft tissue fibrosis or chronic inflammation and is most frequently used as an effective protocol to maintain range of motion.[7] Graston® technique has often been known to effectively treat patients with achilles tendinosis and low back pain.[8,9] In a case series looking at the use of the GT in patients with achilles tendinopathy, results showed a mean improvement of 9 points on the Lower Extremity Functional Scale (LEFS), which demonstrated effectiveness

of the GT as a manual therapy approach for the treatment of tendinopathies.[8] Moon et al investigated the use of GT on 24 patients with non-specific low back pain and found that it improved hamstring extensibility and experienced lower pain intensity when applied to the hamstring muscles.[9]

While GT has been studied, and shown to be effective on other impairments, it hasn't been extensively studied in patients with patellofemoral pain. Also, while patellofemoral pain is common in runners, it is an uncommon injury found in ultimate frisbee players. Therefore, the purpose of this case report was to investigate how GT may affect a 38-year-old male ultimate frisbee athlete with patellofemoral pain.

CASE DESCRIPTION

Patient History and Systems Review

The patient gave verbal and written consent to participate in this case report and received a copy of the consent form.

The patient was an active 38-year-old male who was referred to physical therapy by his primary care physician (PCP) because of lateral patellofemoral and lateral gastrocnemius pain that limited his functional activity. The pain and symptoms started gradually in the Fall of 2016 after he attended a company event at a trampoline park. He started feeling pain a couple hours after the event but did not remember a specific incident. Despite the pain, he continued to be active in running and cutting sports especially ultimate frisbee where he played three times a week as part of a recreational league. The pain became intolerable two months later and he was forced to stop participating. His pain at work as a computer programmer was minimal but increased significantly with his sports participation. He went to his orthopedic physician for evaluation and x-rays, which revealed no fractures, arthritis or other knee pathologies. The

patient was advised to decrease activity and was prescribed nonsteroidal anti-inflammatory drugs (NSAIDs). He continued to have pain which was then also exacerbated by prolonged sitting and walking. A couple weeks thereafter he was referred to physical therapy by his PCP for evaluation and management. Physical therapy evaluation revealed patellofemoral dysfunction, medial quadriceps muscle weakness, and iliotibial band (ITB) restriction of the right lower extremity.

The patient's chief complaints were pain in the lateral compartment of the right knee with running and cutting activities, general right lower extremity weakness, and right knee stiffness. His main goal for physical therapy was to return to ultimate frisbee and to be able to perform daily functional tasks, such as prolonged standing and walking, without pain. Another goal was to be able to maintain pain-free movement with physical activity to prevent similar dysfunction in the future.

Musculoskeletal impairments were found during systems review and all other systems including neuromuscular, cardiopulmonary, integumentary, and communication were unimpaired. Specific findings of musculoskeletal impairments can be found in Table 1.

Clinical Impression 1

After completing a thorough initial evaluation, a decision was made to continue physical therapy with the patient. His primary problems included difficulties with activities of daily living (ADL), impaired functional mobility, myofascial restrictions, and pain. This problem list was consistent with the patient's diagnosis of patellofemoral pain and ITB syndrome. Differential diagnosis' included: ligament tear, a fracture and osteoarthritis. Diagnosis by exclusion was the outcome as the x-rays and special tests ruled out the differential diagnoses, which led to the conclusion that the pain was due to medial quadriceps weakness, soft tissue restrictions in the ITB, and dysfunctional tracking of the patella. A plan for further examination

based on this data was needed to establish a specific baseline of impairments and included assessments of lower extremity strength, ROM, flexibility, palpation, joint mobility, LE posturing/alignment, pain, sensation and functional mobility.

The patient was a good candidate for this case report because of the multiple mechanical imbalances that contributed to his diagnosis of patellofemoral pain and ITB syndrome. The continuous, repetitive movement with mechanical imbalances of the LE musculature and patella was theorized as the main contributor to the onset of symptoms.

Examination – Tests and Measures

An initial examination was completed which included pain assessment, joint mobility, lower extremity alignment, muscle strength, ROM, flexibility, and functional mobility. Pain was assessed at rest and during movement using the verbal Numeric Pain Rating Scale (NPRS), as described by O'Sullivan,[10] with a score of zero being no pain and ten being the worst pain. There was no pain at rest. Palpation was used as an assessment to seek feedback from the patient to help localize painful structures and to identify skin and soft tissue density and extensibility. The uninvolved side was palpated first to have a normal baseline and was compared to the involved side as described in O'Sullivan.[11]

Joint mobility was assessed using joint play assessment, with a grade zero being no joint movement, a grade six being unstable joint movement, and a grade three being normal joint movement. Joint play was performed by assessing the accessory movement of the joint, passively, in the open pack position, as applied by the Maitland concept.[12] Lower extremity atrophy was assessed using circumferential anthropometric measurements of the bilateral knee joint to indicate the area of muscle atrophy. Measurements were taken using a 60 inch/150cm

retractable measuring tape (Prestige Medical, Northridge, CA) and taken at the knee joint line and 2,4 and 6 inches above the joint line.

Anterior and posterior drawer tests, Lachman's test, and Varus and valgus tests were negative bilaterally, which indicated less likelihood of meniscal or ligament involvement and were all performed as explained by Magee. [13]

Manual Muscle Testing (MMT) was used to assess muscle strength of the lower extremity bilaterally in a sitting position using techniques explained by Kendall.[14] To assess ROM, a 12-inch goniometer (Fabrication Enterprises, White Plains, NY) was used to take passive range of motion measurements in the bilateral lower extremity in the supine position as explained by O'Sullivan.[15] Flexibility of the hamstrings were assessed by measuring hip flexion ROM of a Straight Leg Raise (SLR) bilaterally. ITB tightness was assessed using the Ober Test bilaterally, as explained by Magee.[16] Sensation was assessed on bilateral lower extremity from the upper thigh to the ankle using crude touch directly over the skin and was intact on both sides.

The Lower Extremity Functional Scale (LEFS) was administered at the time of initial evaluation to assess functional mobility. The LEFS has been used in part with LE dysfunction, which has been used extensively in other ailments and known to have great reliability and validity.[17] The LEFS outcome measure has a test-retest reliability of 0.98 and, therefore, was a dependable scale to use to track progress.[17] This 80-point scale that has twenty questions about the difficulty performing certain activities done with the lower extremity, for example, walking, lifting, running, hopping and squatting. Since the patient was an avid athlete, the deep squat test was performed to assess pain/ discomfort and to locate the lateral tracking of the patella with functional mobility. Psychometric properties of tests and measures are outlined in Table 2.

Clinical Impression 2

Based on the examination data taken, the initial clinical impression of the diagnosis of patellofemoral pain and ITB syndrome was confirmed. Related findings from the tests and measures included a positive Ober test indicating a tight ITB, a positive deep squat test indicating pain in the lateral knee compartment, and limited joint mobility of the patella.

The patient continued to be appropriate for this case report due to the susceptibility to develop more serious injures because of prolonged activity with mechanical imbalances. Additionally, he was relatively young, compliant and motivated, which made him an excellent candidate.

A medical diagnosis was established as right knee pain; ICD-10 code M25.561. Multiple physical therapy diagnoses were established as knee pain; ICD-10 code M25.561, other abnormality of gait and mobility; ICD-10 code R26.89, generalized right LE muscle weakness; ICD-10 code M62-81, and right LE stiffness; ICD-10 code M25.60. A medical diagnosis of patellofemoral pain and ITB syndrome was not confirmed but further analysis by a physical therapist was requested. The physical therapy evaluation confirmed the probable diagnosis of patellofemoral pain and ITB syndrome.

There were many factors that led to the prediction of good prognosis for this patient. The patient appeared highly motivated to get back to sporting activities and had a good understanding of the extended time this would take. He was compliant with his home exercise program (HEP) and had a strong support system at home with his wife and four children. Considering his age, active lifestyle, and unremarkable medical history, the chances of a full recovery of myofascial restrictions from scar tissue were high.

No additional referrals or consultations needed to be considered for this case at that time. If improvement was not being made, a referral to the orthopedic physician for MRI testing would have been recommended.

Since the decision was made to proceed, the proposed plan of care for interventions incorporated soft tissue mobilizations using IASTM technique with the use of Graston® tools to improve tissue organization to restore normal alignment of the patella.[18] Strengthening exercises of the medial quadriceps muscles were introduced to balance muscle activation on the medial and lateral compartments of the knee. Stretching of the ITB, hamstrings, gastrocnemius/soleus, and quadriceps muscles were implemented increased flexibility of lower extremities. Medial and lateral joint mobilizations to the patella were introduced to increase mobility of the patellofemoral joint to allow elongation of the tissues. The LEFI and deep squat test were reassessed at the end of 8 weeks and 16 weeks to track progression of improvement. Additionally, pictures were taken to track the improvement of lateral tilting of the patella.

Patient goals are listed in Table 3 and were based on short term goals met in six weeks and long term goals met in twelve weeks.

Intervention

Coordination, communication, documentation, patient related instruction

Communication with the patient included evaluation findings, projected plan of care, and a home exercise program (HEP). The patient was instructed and given written/ picture instructions on exercises that were demonstrated by the therapist to be performed at home at least once per day. The physical therapist communicated the HEP during every visit to ensure proper form and compliance. All documentation taken during the initial evaluation, treatments and at discharge were documented using an electronic medical record system (EMR). EMR allowed all

documentation to be shared with all physicians participating in the patients plan of care which included the patient himself.

The patient was educated on the findings of the examination and how they related to his condition of patellofemoral pain and ITB syndrome. He was educated on the need for physical therapy services to improve biomechanics of the LE and achieve functional goals to return to activity without reoccurrence of pain. A HEP was given on the first visit and included pictures, descriptions, and all parameters. The HEP was updated periodically as exercises were advanced. A table of the comprehensive HEP is listed in Table 4. The patient understood all patient related instruction of examination findings, plan of care and HEP and provided verbalized consent.

Procedural Interventions

The patient's course of therapy consisted of 45-minute sessions, twice per week for the first two weeks then once per week for 16 weeks. The in-clinic interventions primarily consisted IASTM,[15] specifically the Graston® Technique (GT), manual soft tissue mobilizations, stretching and strengthening exercises.

The patient was compliant with most PT sessions and his HEP. The patient missed two sessions in the middle of treatment plan due to family needs, however, continued to be compliant with his HEP during that time.

The GT and soft tissue mobilizations were used to address myofascial restrictions, increase tissue organization/ fiber alignment and improve load capacity of tendons and muscles. Manual soft tissue mobilizations were performed first to locate and treat myofascial restrictions. Soft tissue mobilizations performed on the lateral aspect of the knee, ITB, gastrocnemius, soleus, hamstring and posterior knee. Graston® technique followed manual soft tissue mobilizations. With the patient side-lying, brush/ sweep GT on the ITB, lateral quadriceps and hamstring

muscles were performed using the GT4 instrument (Graston, Indianapolis, IN). With the patient supine, framing and j-stroking GT on the lateral patellofemoral retinacula and infrapatellar tendon were performed using GT3 and GT6 instruments. Also with the patient in side-lying, framing and brush/sweep of the distal ITB and medial soleus muscle were performed using the GT4 and GT6 instruments.

The effectiveness of the use of GT with patellofemoral pain is limited, but it has been shown to be responsive with decreased ITB tightness in athletes in a 2016 randomized control trial.[19] Loghmani, et al looked at the evidence for IASTM including the GT for its emerging efficacy and found that it yielded beneficial effects for several musculoskeletal conditions. They also suggested that more research was needed to determine GT effectiveness.[20] Garrett et al looked at the effects of GT and stretching on patients with chronic Plantar Fasciitis which showed GT to be effective in decreasing pain and improving foot function.[21] Refer to Table 5 for pictures demonstrating GT instruments and stroke patterns.

Joint mobilizations of the patellofemoral joint were performed to decrease mal-tracking of the patella and increase tissue extensibility. A non-thrust grade three mobilization of medial and lateral glides were performed in supine with the right knee in full extension, as described by Kaltenborn, to improve the biomechanical movement of the knee.[22]

Due to the patient's decreased tissue extensibility in the ITB, hamstrings and calf muscles, static stretching was introduced prior to strengthening. Stretching of the gastrocnemius and soleus muscles were performed standing using the slant board (Don Courson Enterprises, Birmingham, AL). Addressing ITB and hamstring flexibility was associated with patients with patellofemoral pain.[23] Manual stretching of the ITB and hamstrings were performed with the patient in supine. Gentle stretches were held for 30 seconds to ensure appropriate elongation of

the muscle. The greatest change in ROM with a static stretch has been noted to occur between 15 and 30 seconds.[24]

At the start of each session, a quick screening of the knee/ surrounding structures was performed to ensure clearance for an active warm up. Once cleared, the patient performed a five-minute warm up on an Airdyne® Evolution® Comp bike (Schwinn, Chicago, IL) to increase blood flow to the surrounding tissues in the knee. After manual therapy and stretching, strengthening of hip adductors, quadriceps, hamstrings and gluteal muscles was performed. As most of the therapy session time consisted of manual therapy, strengthening exercises were mainly focused in the HEP. However, some strengthening exercises were performed in the clinic and updated for the HEP. In-clinic exercises consisted of seated leg extensions using the Lido leg press (Loredan Biomedical, West Sacramento, CA). Thera-Band exercise bands (Thera-Band, Akron, OH) were used for resistance exercises for hip adductors and were progressed based on the patient's feedback and tolerance. Dynamic stability exercises were performed with use of a gliding disc (Savvier Fitness, Vista, CA). Agility drills were added later in the rehab plan of care and consisted of lateral side hops, grape vines and forward figure eights using six inch cones. An outline of all in-clinic exercises performed can be found in Table 6.

OUTCOMES

NPRS during squatting, sitting and running/cutting improved from 5/10 with dull achy pain to a 1/10 at discharge with only minor occasional discomfort. There was no pain at rest. Palpation findings included fibrous and painful tissue on the lateral aspect on the right knee, ITB restrictions distally, and mild tenderness in the right proximal lateral calf muscle. Upon discharge, all restrictions and tenderness were eliminated. At IE, the patient had a joint mobility grade 2/6 with right lateral and medial patellar glides which improved to 3/6 upon discharge. At

IE, there was a slight noticeable increase in mid-joint circumference in the right knee compared to the left knee. Also, there was a slight decrease in circumference 6 inches above the joint line on the right knee compared to the left, which indicated atrophy. At discharge, circumferential measurements were not taken due to lack of time, however, a visible improvement was seen and both knees appeared symmetrical. At IE, there was an observable difference in lateral patellar tilt on the right compared to the left, which returned to baseline at discharge. Manual muscle testing (MMT) of the quadriceps taken at IE indicated slight weakness in the right knee compared to the left knee. At discharge, MMT of the quadriceps indicated symmetrical strength on both the right and left knees. During IE, a positive Ober test was indicated on the right and a negative Ober test on the left. Upon discharge, the right LE Ober test was negative. When the patient performed the deep squat test on IE, there was a dull, aching pain in lateral compartment of knee and noticeable lateral patella tracking. At discharge, the patient performed the deep squat test again without pain and minimal lateral patella tracking observed.

After 16 weeks of outpatient visits using GT and therapeutic exercise, the patient demonstrated improvements in patellofemoral pain, and returned to baseline with diminished right lateral patellar tilt. LEFI improved from 19% to 6% disability from IE to discharge, which indicated a clinically significant difference. At IE, the deep squat test reproduced 5/10 pain on the NPRS with visible lateral patellar tracking to less than 1/10 pain and significantly reduced lateral tracking of the patella at discharge. The patient's pain while playing ultimate frisbee improved from 7/10 to 1/10 on the NPRS. Additionally, the patient was able to squat without pain and play with his children by the end of treatment. All short term and long term goals were met by discharge, however, the patient experienced minor less than 1/10 discomfort on the NPRS during intense running and cutting activities although his initial goal was to eliminate the pain completely. Results of tests and measures on IE and discharge can be found in Table 7.

DISCUSSION

This case report investigated the use of GT on a recreational ultimate frisbee player with patellofemoral pain. The primary purpose of this rehab protocol was to improve flexibility and strength to correct muscular/ myofascial imbalances in the lower extremity in order to decrease patellofemoral pain. While patellofemoral pain is common in runners, it is not common in ultimate frisbee players.[6] GT was found to be a helpful intervention for this patient in reducing pain, improving flexibility, and the ability to play ultimate frisbee and play with his children.

The findings in this case report were supported by research. GT for the treatment of patients with achilles tendinitis were revealed to be effective in releasing myofascial restrictions, which yielded similar results with increased patellar mobility and hamstring flexibility.[8] In this study, Smith et al found that twenty patients who had GT in the treatment of achilles tendinitis showed similar results with greater than a 9-point difference on the LEFI.[8] Additionally, Papa et al found that GT combined with therapeutic exercise has been shown to be effective in the treatment of lateral epicondylitis and showed similar results with significant decrease in pain on the NPRS and the ability to return to functional activities without pain.[40]

Although the patient did not fulfil his goal of eliminating patellofemoral pain completely, he did reduce his pain significantly from IE to discharge. Benefits of GT intervention integrated into the physical therapy plan of care were observed. Therefore, GT combined with general lower extremity flexibility and strengthening exercises was an effective treatment for an active 38-year-old recreational ultimate frisbee player with patellofemoral pain. Future research should investigate the use of GT in a larger population of patients with patellofemoral pain.

REFERENCES

1. Dutton RA. Patellofemoral Pain. *Physical Medicine and Rehabilitation Clinics of North America.* 2016;27:1:31-52.
2. M.D. Devereaux, S.M. Lachmann Patello-femoral arthralgia in athletes attending a sports injury clinic. *Br J Sports Med*. 1984;18:1:18-21.
3. Boling M, Padua D, Marshall S, et al.Gender differences in the incidence and prevalence of patellofemoral pain syndrome. *Scand J Med Sci Sports*. 2010;20:5:725-730.
4. McKean K.A, Manson N.A, Stanish W.D. Musculoskeletal injury in the masters runners. *Clin J Sport Med*. 2006;16:2:149-154.
5. Akinbola M, Logerstedt D, Hunter-Giordano A, Snyder-Mackler L. Ultimate Frisbee Injuries in a Collegiate Setting. *International Journal of Sports Physical Therapy*. 2015;10:1:75-84.
6. Tschopp M, Brunner F. Disease and overuse injuries of the lower extremities in long distance runners. *Z Rheumatol.* 2017;76:5:443-450. doi: 10.1007/s00393-017-0276-6.
7. About. Graston Technique | About. http://www.grastontechnique.com/about. Accessed July 14, 2017.
8. Phipps RL, Carney SL, Loghmani MT, Bayliss AJ. An innovative manual therapy approach for the treatment of patients with Achilles tendinopathy: a case series. *J Orthop Sports Phys Ther*. 2011;41:1.
9. Moon JH, Jung JH, Won YS, Cho HY. Immediate effects of Graston Technique on hamstring muscle extensibility and pain intensity in patients with nonspecific low back pain. *J Orthop Sports Phys Ther*. 2017;29:2:224-227.
10. White D. Musculoskeletal Examination. In: O'Sullivan SB, Schmitz TJ, Fulk GD. *Physical Rehabilitation*. 6th ed. Philadelphia: F.A. Davis Company; 2013;128-130.

11. White D. Musculoskeletal Examination. In: O'Sullivan SB, Schmitz TJ, Fulk GD. *Physical Rehabilitation*. 6th ed. Philadelphia: F.A. Davis Company. 2013;133-134.
12. Hengeveld E, Banks K, Maitland GD. Chapter 9. In: *Maitland's Peripheral Manipulation*. 4th ed. Edinburgh: Elsevier/Butterworth Heinemann; 2005;237-247.
13. Magee, DJ. Chapter 12; Knee. In: *Orthopedic Physical Assessment*. 6th ed. St. Louis, MO: Elsevier, Saunders. 2014;808-834.
14. Kendall FPP, McCreary EK, Provance PGG, Rodgers M, Romani W. *Muscles: Testing and Function with Posture and Pain.* 5th ed. Baltimore. MD: Lippincott Williams and Wilkins; 2005.
15. White D. Musculoskeletal Examination. In: O'Sullivan SB, Schmitz TJ, Fulk GD. *Physical Rehabilitation*. 6th ed. Philadelphia: F.A. Davis Company. 2013;134-136.
16. Magee, DJ. Chapter 11; Hip. In: *Orthopedic Physical Assessment*. 6th ed. St. Louis, MO: Elsevier, Saunders. 2014;725-727.
17. Watson CJ, Propps M, Ratner J, et al: Reliability and responsiveness of the lower extremity functional scale and the anterior knee pain scale in patients with anterior knee pain. *J Orthop Sports Phys Ther.* 2005;35:136–146.
18. Baker R, Nasypany A, Seegmiller J, Baker J. Instrument-Assisted Soft Tissue Mobilization Treatment for Tissue Extensibility Dysfunction. *International Journal Of Athletic Therapy & Training.* 2013;18:5:16-21.
19. Heyer K, Docherty C, Donahue M, Schrader JW. Effect of implement assisted soft tissue mobilization techniques on iliotibial band tightness. *Journal of Athletic Training - abstract*. 2012;47:3:S128.
20. Loghmani T, Bane S. Instrument-assisted soft tissue manipulation: evidence for its emerging efficacy. *Journal of Novel Physiotherapies*. 2016;S3:012.

21. Garrett TR, Neibert PJ. Effect of Graston Technique as a treatment for patients with chronic plantar fasciosis: a randomized controlled trial. *Journal of Athletic Training*. 2014;49:3:S57-58.
22. Kaltenborn FM. *Manual Mobilization of the Joints, Volume I: The Extremities*. Minnesota: OPTP. 2011;293-294.
23. Tyler TF Nicholas SJ Mullaney MJ McHugh MP. The role of hip muscle function in the treatment of patellofemoral pain syndrome. *Am J Sports Med*. 2006;34:4:630-636.
24. Page P. Current Concepts in Muscle Stretching for Exercise and Rehabilitation. *International Journal of Sports Physical Therapy*. 2012;7:1:109-119.
25. Cook JL, Khan KM, Kiss ZS, et al: Reproducibility and clinical utility of tendon palpation to detect patellar tendinopathy in young basketball players. *Br J Sports Med.* 2001;35:1:65.
26. Tragord BS, Gill NW, Silvernail JL, Teyhen DS, Allison SC. Joint mobilization forces and therapist reliability in subjects with knee osteoarthritis. *The Journal of Manual & Manipulative Therapy*. 2013;21:4:196-206. doi:10.1179/2042618613Y.0000000033.
27. Cuthbert SC, Goodheart GJ. On the reliability and validity of manual muscle testing: a literature review. *Chiropractic & Osteopathy*. 2007;15:4. doi:10.1186/1746-1340-15-4.
28. Kolber MJ, Hanney WJ. The Reliabiliyt and concurrent validity of shoulder mobility measurements using a digital inclinometer and goniometer: A Technical Report. *International Journal of Sports Physical Therapy*. 2012;7:3:306-313.
29. Ferraz MB, Quaresma MR, Aquino LR, Atra E, Tugwell P, Goldsmith CH. Reliability of pain scales in the assessment of literate and illiterate patients with rheumatoid arthritis. *J Rheumatol.*1990;17:1022–4.

30. Teyhen DS, Shaffer SW, Lorenson CL. The Functional Movement Screen: A Reliability Study. *J Orthop Sports Phys Ther*. 2012;42:6:530-540. doi:10.2519/jospt.2012.3838.
31. Soderberg GL, Ballantyne BT, Kestel LL. Reliability of lower extremity girth measurements after anterior cruciate ligament reconstruction. *Physiother Res Int.* 1993;1:7-16.
32. William E, Melchione M, Sullivan S. Reliability of Measurements Obtained by Use of an Instrument Designed to Indirectly Measure Iliotibial Band Length. *J Orthop Sports Phys Ther.* 1993;18:3:511-515.
33. Boeree NR, Ackroyd CE: Assessment of the menisci and cruciate ligaments: an audit of clinical practice. *Injury.* 1991;22:291–294.
34. Rubinstein RA Jr, Shelbourne KD, McCarroll JR, VanMeter CD, Rettig AC. The accuracy of the clinical examination in the setting of posterior cruciate ligament injuries. *Am J Sports Med.* 1994;22:550-7.
35. Cooperman JM, Riddle DL, Rothstein JM. Reliability and validity of judgments of the integrity of the anterior cruciate ligament of the knee using the Lachman's test. *Phys Ther.* 1990;70:225–233.
36. McClure PW, Rothstein JM, Riddle DL: Intertester reliability of clinical judgements of medial knee ligament integrity. *Phys Ther.* 1989;69:4:268–275.
37. Snyder-Mackler L. Valgus stress test study. *Phys Ther.* 1990;70:204.
38. Garvin GJ, Munk PL, Vellet AD. Tears of the medial collateral ligament: magnetic resonance imaging findings and associated injuries. *Can Assoc Radiol J.* 1993;44:199-204.

39. Sell KE, Verity TM, Worrell TW, Pease BJ, Wigglesworth J. Two measurement techniques for assessing subtalar joint position: a reliability study. *J Orthop Sports Phys Ther*. 1994;19:162–167.

40. Papa JA. Two cases of work-related lateral epicondylopathy treated with Graston Technique® and conservative rehabilitation. *The Journal of the Canadian Chiropractic Association.* 2012;56(3):192-200.

TABLES and FIGURES

Table 1: Systems Review

Systems Review	
Cardiovascular/Pulmonary	**Unimpaired**
Musculoskeletal	**Impaired** Limited R knee extension ROM. Decreased R knee extension strength with increased pain. All other R LE ROM and strength were within functional limits. Noticed R lateral patellar tilt and patellar tracking
Neuromuscular	**Unimpaired**
Integumentary	**Unimpaired**
Communication	**Unimpaired**
Affect, Cognition, Language, Learning Style	**Unimpaired**

Right (R), lower extremity (LE), range of motion (ROM)

484 **Table 2: Psychometric Properties of Tests and Measures**
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Tests & Measures	Psychometric Properties
Palpation	Palpation is a reliable test and is moderately sensitive but not specific.[25]
Joint Mobility	Intra-clinician reliability was excellent (>0.90) when using the Maitland technique in patients with knee OA.[26]
Manual Muscle Testing (MMT)	Twelve randomized control trials (RCTs) that were reviewed showed that MMT findings were not dependent upon examiner bias.[27]
Goniometry	Excellent intra-rater reliability was present with Intra-class Correlation Coefficients (ICC- 3,k) for goniometry ≥ 0.94 and digital inclinometer ≥ 0.95.[28]
Numeric Pain Rating Scale	High test–retest reliability has been observed in both literate and illiterate patients with rheumatoid arthritis (r = 0.96 and 0.95, respectively) before and after medical consultation.[29]
Deep squat test	Excellent inter-rater and intra-rater reliability. [30]
Circumferential Knee Measurement	The measurements established sufficiently high reliability to justify their use both within and between examiners for subjects recovering from surgery of the ACL.[31]
Ober Test	Ober's test repeated measurement was shown to have good inter-rater reliability 0.73 and excellent intra-rater reliability 0.94 in participants with anterior knee pain.[32]
Lower Extremity Functional Scale (LEFS)	Good test-retest reliability of 0.98.[17]
Anterior Drawer Test	Specificity: 92%; Sensitivity: 56%; Positive likelihood ratio: 6.7; Negative likelihood ratio: 0.5.[33]
Posterior Drawer Test	The posterior drawer test has a high sensitivity and specificity, and its accuracy is increased when results are combined with other tests for posterior instability, such as the posterior sag sign.[34]
Lachman's Test	Lachman's test judgments have limited reliability and may be more useful for predicting that a patient does not have an ACL injury than for predicting that the ACL is injured.[35]
Valgus Stress Test	Interrater reliability is poor.[36] Sensitivity and specificity is high.[37]
Varus Stress Test	There is a lack of well-designed studies that evaluate the sensitivity and specificity of the Varus and valgus stress tests, or their inter-examiner reliability, in the diagnosis and grading of collateral ligament injuries.[38]
Navicular Drop	Inter-tester and intra-tester reliability for navicular height ranges from .73 to .96.[39]

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Table 3: Patient Goals

Time Frame	Goal
Short Term: 6 weeks	Patient will increase right hamstring flexibility to a 60º SLR to decrease stress on the patellofemoral joint and improve LE biomechanics.
	Patient will minimize right lateral patellofemoral tissue tightness contributing to lateral patella tracking with 3/6 patellofemoral joint mobility for prolonged walking without pain.
	Patient will have decreased right ITB restrictions with a negative Ober Test to improve LE biomechanics.
Long Term: 12 weeks	Patient will have no knee pain and decreased visibility of lateral patella tracking during the deep squat test to return to running and cutting activities.
	Patient will achieve good balance of right medial and lateral quadriceps strength to a 5/5 to allow appropriate dynamic patella tracking to prevent future reoccurrence of injury.
	Patient will report a zero out of ten on the NPRS pain scale with running and cutting activities to return to play ultimate frisbee.

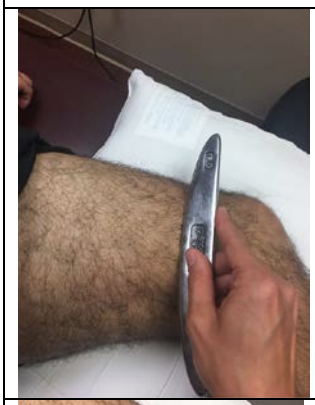
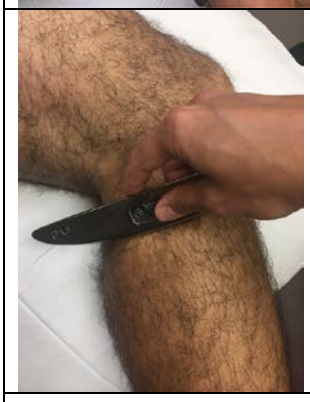
Straight leg raise (SLR), lower extremity (LE), iliotibial band (ITB), numeric pain rating scale (NPRS)

Table 4: Description and Acceleration of Home Exercise Program in Chronological Order

Exercise	Parameters	When added to HEP	Diagram
Quad Sets with isometrics plus holds (long sitting)	R LE: 3 sec hold followed by 3 sec hold plus Repetitions: 10 Sets: 2 Frequency: Twice per day	Initial Evaluation	 www.hep2go.com
Active hamstring stretch (supine)	R LE Hold: 30 seconds Sets: 2 Frequency: Twice per day	Initial Evaluation	 www.hep2go.com
Standing hip abduction with green Thera-Band	R LE Repetitions: 10 Sets: 2 Frequency: Twice per day	Added at 3 weeks	 www.hep2go.com
Gastrocnemius stretch (standing)	R LE Hold: 30 seconds Sets: 2 Frequency: Twice per day	Added at 3 weeks	 www.hep2go.com
Soleus stretch (standing)	R LE Hold: 30 seconds Sets: 2 Frequency: Twice per day	Added at 6 weeks	 www.hep2go.com

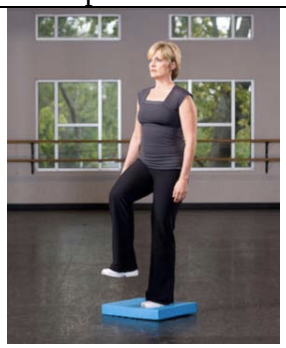
Right lower extremity (R LE)

Table 5: Graston Technique Instruments and Stroke Patterns

Picture	Graston Technique Method
	Brush/ sweeping technique on the ITB, lateral quadriceps and hamstring muscles using the GT4 instrument with the patient in side-lying.
	Brush/ sweeping technique on the medial gastrocnemius/ soleus muscles using the GT4 instrument with the patient in side-lying.
No picture available.	Framing and j-stroking technique on the lateral patellofemoral retinacula and infrapatellar tendon using the GT3 and GT6 instruments with the patient in supine.
No picture available.	Framing technique on the distal ITB using GT6 instrument with the patient in side-lying.

Iliotibial band (ITB), graston technique (GT)

Table 6: In-clinic Exercises

Exercise	Parameters	When added	Diagram
SLS with disc slide out to clock positions (standing)	R LE Repetitions: 5 cycles at 12, 9, 6 o'clock Sets: 2	2nd visit	 www.womanista.com
Lido Leg Press (sitting)	R LE Repetitions: 10 at 75 lbs Sets: 2	2nd visit	 www.platinumfitnessusvi.com
SLS on Airex block (standing with knee unlocked)	R LE Hold: 30 seconds Sets: 3	3rd visit	 www.acefitness.org
Slant board calf stretching (standing)	R LE Hold: 30 seconds Sets: 2	4th visit	 www.highperformancept.com
Agility drills (light jog)	Lateral side hops 20ft for 1 minute Lateral Grapevines 20ft for 1 minute Forward Figure 8 20ft for 1 minute	12th visit	 Above: Lateral Grapevines www.ptacademy.edu.au

Single leg stance (SLS), Right lower extremity (R LE)

502 **Table 7: Results of Tests and Measures**

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<table>
<tr><th>Tests & Measures</th><th>Initial Evaluation Results</th><th>Discharge Results</th></tr>
<tr><td>Palpation</td><td>R lateral retinacula and ITB restricted distally
R lateral calf tenderness – mild</td><td>No restrictions palpated

No tenderness to palpate</td></tr>
<tr><td>Joint Play/ Mobility</td><td>R limited lateral patella glide – 2/6
R limited medial patella glide – 2/6</td><td>Normal patellar mobility - 3/6</td></tr>
<tr><td>Lower Extremity Alignment</td><td>R lateral patellar tilt</td><td>Returned to baseline with diminished patellar tilt</td></tr>
<tr><td>Atrophy/ Edema</td><td>No noticed edema in R or L LE

Noticed indication of muscle atrophy

Anthropometric Circumferential Measurements: Knee joint
<table>
<tr><th></th><th>Right</th><th>Left</th></tr>
<tr><td>Mid-joint line</td><td>15 ¼ “</td><td>14 ¾ “</td></tr>
<tr><td>2” above</td><td>16 “</td><td>15 ½ “</td></tr>
<tr><td>4” above</td><td>16 ¾ “</td><td>16 ¼ “</td></tr>
<tr><td>6” above</td><td>18 ¼ “</td><td>18 ½ “</td></tr>
</table></td><td>Not taken</td></tr>
<tr><td>Manual Muscle Testing:

Right LE Strength:

Left LE Strength:</td><td>R knee extension: 4+/5
R knee flexion: 5/5
R hip flexion, extension, abduction, adduction: 5/5

L knee extension: 5/5
L knee flexion: 5/5
L hip flexion, extension, abduction, adduction: 5/5</td><td>All L and R LE strength: 5/5</td></tr>
<tr><td>Range of Motion (degrees):</td><td>R knee flexion: 140º
R knee extension: -2º

L knee flexion: 140º
L knee extension: 0º</td><td>R knee flexion: 140º
R knee extension: 0º

L knee flexion: 140º
L knee extension: 0º</td></tr>
</table>

Numeric Pain Rating Scale:		
At Rest:	0/10	0/10
With Movement:	5/10 (R lateral patellofemoral and lateral calf) dull and achy pain with deep squat, prolonged sitting, cutting when running and sprinting	<1/10 (R lateral patellofemoral and lateral calf) dull discomfort with deep squat and prolonged standing. No pain with cutting, running and sprinting
Flexibility:		
Hamstring (degrees):	R SLR: 55º L SLR: 60º	R SLR: 60º L SLR: 60º
ITB:	R Ober Test: positive L Ober Test: negative	R Ober Test: negative L Ober Test: negative
Sensation: Crude Touch	R LE: none, WNL L LE: none, WNL	Not taken
Functional Outcome Measures		
Lower Extremity Functional Index	Total Score: 66/80, 18% deficit	Total score: 75/80, 6% deficit
Deep Squat Test	5/10 dull, aching pain in lateral compartment of knee with noticed lateral patella tracking	<1/10 discomfort in lateral compartment of knee with diminished lateral patella tracking
Special tests for other knee/ankle pathologies	**Right and Left:** - Anterior Drawer = negative - Posterior Drawer = negative - Lachman's = negative - Trendelenburg = none - Valgus & Varus tests = negative - Navicular Drop = negative (4mm bilateral)	Not taken

Iliotibial Band (ITB), lower extremity (LE), right (R), left (L), single leg raise (SLR), within normal limits (WNL)

Figure 1: Noticeable lateral tilting of the right patella in supine.

APPENDICES