Case Report

Lower extremity thrust and non-thrust joint mobilization for patellofemoral pain syndrome: a case report

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A 40-year old female presented to physical therapy with a one-year history of insidious right anteromedial and anterolateral knee pain. Additionally, the patient had a history of multiple lateral ankle sprains bilaterally, the last sprain occurring on the right ankle 1 year prior to the onset of knee pain. The patient was evaluated and given a physical therapy diagnosis of patellofemoral pain syndrome (PFPS), with associated talocrural and tibiofemoral joint hypomobility limiting ankle dorsiflexion and knee extension, respectively. Treatment included a high-velocity low amplitude thrust manipulation to the talocrural joint, which helped restore normal ankle dorsiflexion range of motion. The patient also received tibiofemoral joint non-thrust manual therapy to regain normal knee extension mobility prior to implementing further functional progression exercises to her home program (HEP). This case report highlights the importance of a detailed evaluation of knee and ankle joint mobility in patients presenting with anterior knee pain. Further, manual physical therapy to the lower extremity was found to be successful in restoring normal movement patterns and pain-free function in a patient with chronic anterior knee pain.

Keywords: Patellofemoral pain syndrome, Knee extension, Talocrural stiffness, High-velocity low-amplitude manipulation, Physical therapy, Regional interdependence

Background

Patellofemoral pain syndrome (PFPS) is commonly described as anterior or retropatellar knee pain in the absence of other specific pathology,¹ and is characterized by pain associated with activities that place increased stress into the patellofemoral joint (PFJ), such as squatting, descending stairs, long-duration sitting, running, and biking. Patellofemoral pain syndrome remains one of the most difficult clinical challenges within orthopedics,² despite being the most common knee condition treated in outpatient rehabilitation practice.^{3,4} Abnormal patellar tracking or patellar malalignment is thought to be one of the precursors of PFPS, with various interventions directed at treating patellar motion (e.g. patellar taping, vastus medialis strengthening, stretching, patellar bracing, patellar mobilizations, foot orthoses).^{5,6} Many patients fail to experience relief with conservative therapy,⁷ calling to question the root cause for patellofemoral pain and the most effective treatment techniques. Recent studies have focused on treatment of PFPS through regional interdependence.^{5,6,8,9} Powers

(2003)¹⁰ emphasized the importance of understanding lower extremity biomechanics, which allows the clinician to identify dysfunctions in the kinetic chain away from the PFJ that may contribute to the patellofemoral pain. Associations with the dynamic Q-angle (angular measurement from anterior superior iliac spine (ASIS) to patellar midpoint and proximal line from tibial tubercle to patellar midpoint) have been extensively studied,^{10–12} and increases in the dynamic Q-angle during various weight-bearing activities have been shown to be good predictors for individuals at risk of developing PFPS.¹⁰

Factors that potentially increase the dynamic Q-angle include increased subtalar pronation, decreased calf flexibility, and poor hip strength.^{8–10} Decreased talocrural dorsiflexion can also increase the dynamic Q-angle, by restricting the knee from traversing sagittally over the ankle and causing increased subtalar pronation to occur during mid-stance. The tibia is then unable to externally rotate to allow the knee to extend in mid-stance, so the femur must internally rotate to allow knee extension to occur, thereby increasing the dynamic Q-angle.¹¹ Talocrural hypomobility into dorsiflexion has been shown to occur chronically after lateral ankle sprains¹² yet to

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our knowledge, limited research exists for describing this joint restriction relationship to PFPS.¹³ Research has shown that manipulation at the talocrural joint improves immediate dorsiflexion at the ankle in patients with sub-acute and chronic lateral ankle sprains.^{12,13} As such, individuals with PFPS and pre-existing ankle/foot conditions (e.g. ankle sprain) may have lingering talocrural joint restrictions and may benefit from manual therapy directed at the ankle/foot to help improve PFPS symptoms.

Locally, a lack of terminal knee extension may contribute to PFPS. Prior work has found an element of knee hyperextension in asymptomatic individuals.¹⁴ Anatomically, terminal knee extension during static standing allows the quadriceps muscles to relax and the patellae to be relieved of pressure.¹⁵ However, with acute knee pain, patients rely on a compensatory standing pattern by unweighting the painful limb and placing the knee in increased flexion.¹⁶ Over time, this adopted pattern may cause a knee flexion contracture, which may serve as a precursor to PFPS.^{1,17,18} Long-term outcomes have been examined after knee surgery and it has been found that an extension loss of just 3°–5°, compared to the opposite limb (including a loss of hyperextension), adversely affected rehabilitation results.¹⁹ Potentially at risk are those undergoing anterior cruciate ligament (ACL) reconstruction, where extension losses greater than 5° have been reported as far out as 2 years.²⁰ Research has shown associations between loss of knee extension, quad weakness, and patellofemoral pain in patients after ACL reconstruction.²¹ PFPS-like symptoms have been reported in as many as 20% of patients undergoing ACL reconstruction,²² so it is important to consider factors like knee ROM that may influence PFPS onset. Currently, research is limited for using tibiofemoral joint mobilization to restore extension mobility in patients with PFPS-like symptoms after knee surgery, or in patients with insidious-onset anterior knee pain.

The purpose of this case study is to describe a case of chronic anterior knee pain in a 40-year old female athlete, with a prior history of ACL reconstruction and chronic lateral ankle sprain ipsilaterally. The case will highlight early manipulation of the talocrural joint and mobilizations of the tibiofemoral joint as means to restore normal arthrokinematic motion of the limb in the treatment of PFPS. We will also describe the progression back to sport through a structured neuromuscular and functional rehabilitative program to treat the deconditioned limb.

Case description

The patient was a 40-year old female with a 1-year complaint of intermittent right-sided anteromedial and anterolateral patellar region pain. Her pain was while running and bike riding. It worsened with

long-duration sitting and while descending stairs. The patient denied swelling, knee locking, or catching sensations, or patellar crepitus. Further, the patient had no numbness or tingling in the lower extremity (LE), and denied pain in any other axial or lower quarter regions. Past medical history included right ACL surgery with ipsilateral bone-patellar tendon-bone autograft 15 years prior, with reported full recovery. The patient also had a history of bilateral lateral ankle sprains, the latest occurring to the right ankle 1 year prior to the onset of knee pain. Her goals were to get back to running and compete in cyclo-cross racing.

Examination

The patient presented to physical therapy with no obvious gait deviations. On visual inspection, the patient was observed to bear more weight through the left leg in stance. In addition, she stood with mild flexion of the right knee, along with ipsilateral internal rotation and adduction of the hip. She had visible right calf and distal quadriceps muscle atrophy.

In weight-bearing, full extension of her right knee produced anterolateral knee pain. The standing squat test created anterior knee pain, along with decreased dorsiflexion at the right ankle, and an observed increase in right ankle pronation and dynamic Q-angle. Verbal cueing to correct the foot pronation and repeat the squat caused anterior ankle pain with no dorsiflexion improvement. Right single-limb balance had visibly increased subtalar pronation and femoral and tibial internal rotation in comparison to the left leg.

Passive range of motion (PROM) testing of the knee and ankle were performed using a standard goniometer. Various special tests provided ROM and LE flexibility data. These data are summarized in Table 1. The standing twist test observes a patient's ability to rotate side-to-side through his/her lower extremities, pelvis, and spine. The practitioner paid close attention to the patient's ability to supinate and pronate her feet, a possible indication of subtalar mobility.

Acceptable reliability has been reported for knee ROM measurements,^{23,24} and for ankle dorsiflexion, inversion, and eversion when performed by a physical therapist specifically trained in goniometric measurements and who uses the tests regularly.²⁵ The various measurements of LE flexibility are detailed in Table 1.

Lower extremity strength testing was scored using a 5-point manual muscle test (MMT) grading scale, with 0/5 representing no strength and 5/5, normal strength (Table 2).²⁸ All other strength measurements were normal bilaterally. Research comparing LE

MMT to other procedures for measuring LE strength found that MMT scores correlate with hand-held dynamometer scores, but concluded MMT may overestimate what 'normal' is for a patient's given strength.²⁸

The sitting talar swing and supine posterior talar glide tests were performed to test talocrural joint posterior glide and conjunct external rotation of the talus.^{29–31} The talar swing test was completed in sitting with the patient's legs hanging freely over the edge of a plinth. Maintaining the patient's foot parallel to the floor, the practitioner used his thumbs on the anterior talus to appreciate the extent of posterior glide and conjunct talar external rotation that occurred during passive ankle dorsiflexion. The right talocrural joint had decreased mobility with a stiff, capsular end-feel, compared with the left. Anterior drawer testing, in full ankle plantar-flexion, revealed mild lateral ankle laxity. Tibiofemoral joint mobility for extension was performed in supine with a pillow under the knees, in a manner similar to that described by previous authors (Fig. 2A).^{32,33} The right knee had a stiff, capsular end-feel, compared with the left. Mobility testing of the PFJs included mediolateral glides and the patellar tilt test,³⁴ both of which were negative with this patient. Medial and lateral tibiofemoral, tibiofibular, and subtalar joint mobility testing were normal bilaterally.

To help rule in PFPS, palpation was performed along the PFJ, which produced familiar anterior knee pain to the lateral undersurface of the middle patellar facet, and to the medial patellar region along the medial retinaculum. Lateral tilting of the right patellae also reproduced the medial patellar pain.^{35–37}

All special tests of the right knee were negative, which helped rule in PFPS for this patient.¹ These included all ligament integrity tests and meniscal tests (Thessaly's test, McMurray's test, Apley's compression test), and the patellar compression test.

The patient reported 2/10 pain of intermittent duration, using a 10-cm visual analogue scale (VAS)

to indicate her worst pain experienced over the last 24 hours. The scale was defined as 0 for no pain and 10 as the worst pain imaginable. A minimum clinically important difference (MCID) for patellofemoral symptoms has been identified as a change in VAS score between 1.5–2.0 cm.³⁸

The patient provided a self-report of function with the CareConnections Outcomes System (CCFOI) (previously the TAOS).³⁹ This tool measures function by combining five functional activities specific to anatomical location of pain with five functional activities appropriate for all anatomical locations. Each functional activity is rated from 0 to 5, with 0 representing the lowest level of function and 5 representing the highest. It is scored by summing the scores together then reporting it as a percentage ranging from 0–100%.⁴⁰ The patient reported her function at 80%. Limited analysis exists for the responsiveness of this measure,⁴⁰ however the CCFOI has demonstrated face validity in previous cohort studies.^{41,42}

Clinical impression

The patient's clinical diagnosis was PFPS, with lateral patellar compression and medial patellar retinaculum irritation. The negative results to meniscal and knee ligament tests made the hypothesis of PFPS more likely.¹ The therapist felt that the onset most likely occurred secondary to the talocrural joint hypomobility and ankle dorsiflexion restriction. The compensatory standing pattern, which occurs with knee pain, possibly led to the tibiofemoral extension hypomobility, further increasing lateral patellar

Table 2 Baseline lower extremity manual muscle test (MMT) scores

Muscle	Right	Left
G. Maximus	4–/5	5/5
G. Medius	4–/5	5/5
Quadriceps	4–/5	5/5
Hamstrings	4+/5	5/5
Calf raise	24 reps	34 reps

Table 1 Baseline range of motion and flexibility testing for the right lower extremity (LE)

Movement/Test	Range/Result	End-Feel/Pain
Hip (all directions)	Decreased hip extension	Normal
Knee flexion ^{23,24}	Full	Normal
Knee extension (Fig. 1A) ^{23,24}	–6°	Stiff and ↓ tibial external rotation
Ankle plantarflexion ²⁵	Full	Normal
Ankle dorsiflexion ²⁵	–15°	Stiff
Ankle inversion	Full	Normal
Ankle eversion	Full	Normal
Prone heel height test ²⁶	Heel height higher	
Standing twist test for subtalar mobility	Normal supination and pronation observed	
Weight-bearing dorsiflexion test (Fig. 1B) ²⁷	–2 inches	Unfamiliar pain anterior ankle
Prone knee bend	Unable to touch heel to buttock	Tight anterior thigh
90/90 Hamstrings	–10°	Tight posterior knee/thigh
Ober's test	Relaxed thigh above parallel	
Thomas test	Positive for 1-joint, 2-joint muscle tightness

Figure 1 (A) Knee passive range of motion (PROM) testing. The therapist palpated the tibiofemoral joint line to appreciate the conjunct tibial external rotation during extension PROM (B) Weight-bearing dorsiflexion test. The maximum foot-flat distance from the wall to the big toe, is measured with a tape measure.

compression in weight-bearing.¹⁹ Both joint restrictions may contribute to the onset of other objective findings, such as hip weakness, decreased LE flexibility, and altered functional tests. Therefore, it was the therapist's hypothesis that addressing joint hypomobility first would assist in the normalization of the patient's standing and functional movement patterns, and thereby improve symptoms. Physical therapy could then focus on strengthening and progressive functional exercises to help the patient gain normal function.

Figure 2 Techniques used to regain normal tibiofemoral joint extension (A) manual joint mobilization (B) EliteSeat™, (C) Heel propping with belt overpressure.

Intervention

Treatment one: day of evaluation

Table 3 outlines the main subjective and objective findings at select visits throughout therapy. The patient had no contraindications to manipulation.⁴³ The talocrural joint distraction manipulation was performed in order to, as described by Loudon and Bell (1996),⁴⁴ restore talocrural joint dorsiflexion ROM. The patient lay supine, with her right leg straight and foot over the end of the plinth. The therapist grasped the patient's foot with interlocked fingers and 5th digits overtop the anterior talus. After a 10-second pre-manipulative hold, a long-axis

distraction thrust manipulation was given, producing an audible click in the ankle joint. Reassessment of the weight-bearing dorsiflexion test produced decreased anterior ankle pain along with immediate one-inch (50%) improvement in dorsiflexion ROM, determined by a tape measure. Her home program (HEP) included 10 repetitions of frequent, weight-bearing AROM dorsiflexion and three five-minute end-range low-load dorsiflexion static holds daily.

The tibiofemoral joint was mobilized in the same manner as joint mobility testing was performed, in order to regain knee hyperextension. A Maitland grade IV oscillatory mobilization was delivered for four one-minute intervals,³³ followed by passive end-range knee extension contract/relax proprioceptive neuromuscular reeducation (PNF) in long-sitting. Reassessing her knee extension PROM revealed a 3° (50%) improvement with goniometric measurement.

The right knee HEP included exercises to help further improve knee extension. Whenever standing, she was to focus on maintaining 50/50 weight distribution between legs. She was also told to frequently contract and relax her quads, both in sitting with the knee straight and while standing, to further improve knee extension and quad control. In the experience of the current authors, patients with chronic knee pain are unable to contract and relax the quads in standing terminal knee extension. In our opinion, patients lack full confidence in their knee until they are able to have their patella fully descended in standing knee extension.

Other initial exercises to be performed five times daily included long-sitting heel propping for 10 minutes with 2 lb weights, a towel stretch with an active heel lift,¹⁶ and quad sets each for 10 repetitions. Patient education included instruction to be as active as comfort would allow and to avoid compensatory strategies to avoid pain. Compliance to the HEP was monitored each visit through patient reports. She was scheduled for treatment once weekly for 8 weeks.

Treatment two: 1 week after evaluation

The patient stated that she continued to experience end-range stiffness during standing terminal knee extension, and found it difficult to contract/relax her

right patella in standing. Her ankle mobility improved, but still produced anterior ankle pain at end-range dorsiflexion (Table 3).

The talocrural distraction manipulation was performed, secondary to continued posterior glide stiffness and restriction in weight-bearing dorsiflexion test. Afterward, reassessment of the weight-bearing dorsiflexion test revealed full dorsiflexion with only Achilles tendon tightness noted.

Passive knee mobility testing revealed continued end-range hyperextension stiffness. Manual mobilizations of the tibiofemoral joint were repeated as before. Her knee and ankle HEP remained unchanged.

Treatment three: 2 weeks after evaluation

Reassessment revealed the talar swing test was symmetrical bilaterally. The weight-bearing dorsiflexion stretch was mildly decreased on the right, with only calf tightness noted by the patient (Table 3). Her ankle HEP was altered to frequent, daily gastrocnemius and soleus stretches secondary to normal joint testing.

The patient reported persistent tightness and mild pain to full knee extension with her HEP. Tibiofemoral PROM testing demonstrated 3° lacking of full hyperextension (Table 3). Secondary to continued stiffness, an alternate approach for regaining knee extension was chosen. The EliteSeat™ is a knee extension device designed to produce a progressive stretch (Fig. 2B).¹⁶ It was performed for 10 minutes in supine, with more force applied every 2 minutes, as tolerated by the patient. Afterward, the heel height test and knee extension PROM were equal bilaterally. The weighted heel propping exercise was switched to heel propping with use of a belt and the opposite leg applying progressive overpressure, in order to more closely match the pressure achieved with the EliteSeat™ (Fig. 2C).

Treatment four: 3 weeks after evaluation

The patient demonstrated symmetrical weight-bearing dorsiflexion testing and full, pain-free right knee extension along with full patellar control. On her own accord, she had begun 30 minutes of pain-free, moderate-intensity biking in the previous week.

Table 3 Examination findings at select visits

Visit	Initial	3rd	5th	8th, 3-month follow-up
Knee extension A/P ROM	Dec. 6°	Dec. 3°	WNL	WNL
Ankle dorsiflexion A/P ROM	Dec. 15°; lacking 2 in. WB DF test	Mild decrease from normal	WNL	WNL
Tibiofemoral joint mobility	Stiff ant. glide, conjunct ER	No change	WNL	WNL
Talocrural joint mobility	Stiff post. glide, conjunct ER	WNL	WNL	WNL
Visual analogue scale (VAS) pain score (0–10)	2/10 intermittent pain	2/10 intermittent pain	0.5/10 intermittent pain	0/10
Functional score (CCFOI)	80/100	80/100	88/100	100/100

Note: A/P, active/passive; WB DF, weight-bearing dorsiflexion; ER, external rotation; WNL, within normal limits.

Secondary to her progress, the therapist felt the patient was ready for functional progression.

Progression exercises included single-limb balance, simulated step-downs, and squats.⁴⁵ The patient was cued on how to activate hip stabilization musculature in single-limb standing, which included proper knee and foot arch position. Simulated step-downs mimicked a stair descent, where the patient allowed the knee to come forward over the foot without pain or excessive knee valgus. She could initially traverse approximately 50% on the right leg, compared to the left. Squats were initiated with concentration on limiting excessive sagittal anterior translation of her knees. Squat progression included challenging surface and weight distribution over the balls of the feet. Her HEP consisted of three sets of 15 repetitions of squats and simulated step-downs performed daily, and three repetitions of 60 second balance on each leg.

Treatments five through seven: four to 6 weeks after evaluation

At week four, her worst pain was 0.5/10 on the VAS. Her CCFOI score (88%) was a 40% improvement from the initial evaluation. The CCFOI score reflected continued self-report limitations in recreational activities (3/5), squatting (3/5), walking (4/5), and stairs (4/5). She began attending a gym regularly, and could perform 20 minutes of stair stepper and BOSU ball squats with 10 lb dumbbells by week six without pain and/or her familiar symptoms. Her simulated step-down was also pain-free and symmetrical, with equal distance of knee travel over the ankle and without increasing the dynamic Q-angle.

The therapist determined that the patient was ready for a return to running through three functional tests during week six. The single-leg hop for distance and the triple hop test have both been investigated and shown to be valid tests to help identify lower extremity asymmetries, which may be potential risk factors for injury.^{46,47} The third test was a simulated step-down to 60° on the affected limb, with a five-second hold. She performed all tests equally. Treadmill jogging showed no deviations in form at 6.5 mph. She was instructed in a graded running progression, with progression of distance occurring after three consecutive, pain-free runs of a given distance. The plan at this point was to see the patient in 1 month for a further appointment.

Treatment eight: 10 weeks after evaluation

At her final visit, the patient felt she had 100% function, as demonstrated by her CCFOI score. She also reported 0/10 pain on the VAS. She was running up to five miles every other day, and was back to competitive biking. She attended a Zumba™ class twice weekly, which incorporates dance and aerobic elements. The patient had full joint mobility and

passive ROM of her right LE. Flexibility testing and LE strength testing were normal bilaterally. Patellofemoral joint palpation testing was negative. Functional testing was negative.

Three-month post-discharge follow-up

At her three-month post-discharge follow-up in the clinic, the patient's right knee and ankle continued to have normal joint motion, with 100% CCFOI function and 0/10 worst pain on the VAS.

Discussion

Although altered ankle and foot kinematics from decreased ankle dorsiflexion occur in patients with patellofemoral symptoms,^{8,9,11} research supporting the use of talocrural joint manipulation in PFPS is absent. Moreover, research describing a lack of full knee extension in the affected knee of patients with chronic knee pain, as well as subsequent treatment, is limited.¹⁶ This case study describes a treatment strategy that addressed LE hypomobility and compensatory strategies, and progressed to an extensive strengthening and functional retraining program. The patient was discharged with full pain-free function after 10 weeks, which was maintained at her three-month follow-up.

Recent studies regarding conservative treatment for PFPS have focused on regional interdependence. Collins⁵ showed that prefabricated orthoses compared to flat orthoses or physical therapy were superior in relieving short-term symptoms of PFPS. Also, Lowry (2008)⁶ utilized a multimodal approach in a case series of patients with PFPS, with treatment based on clinical examination findings. The majority of patients responded with functional improvements beyond the MCID (≥ 3 point improvement) in the global rate of change scale. This patient presented with similar findings indicative of PFPS. However, she also presented with talocrural stiffness, which occurs in patients with a history of chronic lateral ankle sprains, and has been shown to improve with thrust and non-thrust joint mobilizations.^{12,13} Calf inflexibility has previously been identified as a precursor of PFPS, although the intent and influence of talocrural joint mobility is not explicitly stated.^{6,8,9} Moreover, she had a knee flexion contracture, which we commonly find with patients complaining of chronic patellofemoral symptoms. Average knee extension ROM includes some degree of hyperextension,¹⁴ and regaining this normal hyperextension allows the patellae to descend with quadriceps relaxation and relieves patellar pressure.¹¹ Research has highlighted the long-term importance of regaining normal knee extension, compared to the unaffected limb in post-surgical knee patients.^{19,48} However, no studies (to our knowledge) report a lack of knee extension as a precursor for PFPS, and limited discussion exists on

examining knee extension ROM in patients presenting with chronic knee pain. Shelbourne (2007)¹⁶ showed that 84% of patients with chronic knee pain presenting with knee flexion contractures and limb deconditioning improved with conservative intervention by first regaining full knee extension.

Treating the patient using principles of regional interdependence, by first focusing on regaining normal talocrural and tibiofemoral joint motion, were a priority of early treatment in order to improve patellofemoral pain. As mobility normalized, dynamic muscular retraining was used to help maintain the joint motion and improve the dynamic Q-angle during functional activities. When tibiofemoral extension is unrestricted, normal talocrural dorsiflexion allows for the lower extremity to traverse sagittally over the ankle during mid-stance without increasing the dynamic Q-angle through compensated patterns.¹¹ There is no research, to our knowledge, indicating the applicability of tibiofemoral mobilizations to treat patients with PFPS. The clinician (BS) performed a manual mobilization technique to the tibiofemoral joint to help regain extension ROM,³² and included long-duration end-range extension stretching, with the assistance of EliteSeat™, to help regain symmetrical ROM.⁴⁹

Future research could help determine the efficacy of manual therapy versus passive stretching to regain knee extension ROM. Since emerging evidence suggests that LE kinematics affect the PFJ, it is the current authors' opinion that a thorough subjective evaluation (including history of lateral ankle sprains), LE AROM/PROM and joint mobility assessment should be performed to help determine possible influences on the patient's presenting symptoms. Recognizing subtle side-to-side differences in knee extension ROM in patients with chronic knee pain may help improve long-term results in treating PFPS.^{2,35} In the current case, the patient also demonstrated decreased ipsilateral hip extension and tensor fascia latae (TFL) flexibility, which normalized upon reassessment once her ankle and knee ROM improved.

There are limitations to this case study. The patient's age and high activity level were favorable conditions for a successful outcome. Given the lack of research to support the techniques used to treat this patient, as well as our use of a single case design, we cannot infer causation related to the patient's success. The patient was only followed up at 3 months post-discharge, so long-term outcomes cannot be determined. Care must be taken in assuming strength gains were a reason for her improvement, since manual techniques were performed as opposed to an objective measure (dynamometer) for strength testing. We must also be careful

not to generalize to all patients with chronic anterior knee pain, or a history of lateral ankle sprain, and presume that they have stiffness that will be a predictor of PFPS.

Conclusion

This case report describes a patient with a one-year complaint of PFPS who demonstrated ipsilateral talocrural stiffness into dorsiflexion and tibiofemoral hypomobility with decreased knee extension. She responded favorably to treatment aimed at restoring normal LE mobility and functional patterns prior to further progression of her deconditioned limb. Future research is indicated to determine the likelihood that limited knee extension and restricted talocrural dorsiflexion can predict PFPS in patients with a history of lateral ankle sprain.

References

- 1 Crossley K, Bennell K, Green S, McConnell J. A systematic review of physical interventions for patellofemoral pain syndrome. *Clin J Sports Med.* 2001;11:103–10.
- 2 Wilk KE, Davies GJ, Mangine RE, Malone TR. Patellofemoral disorders: a classification system and clinical guidelines for nonoperative rehabilitation. *J Orthop Sports Phys Ther.* 1998;28:307–22.
- 3 Taunton JE, Ryan MB, Clement DB, McKenzie DC, Lloyd-Smith DR, Zumbo BD. A retrospective case-control analysis of 2002 running injuries. *Br J Sports Med.* 2002;36:95–101.
- 4 Fulkerson JP, Arendt EA. Anterior knee pain in females. *Clin Orthop Rel Res.* 2000;372:69–73.
- 5 Collins N, Crossley K, Beller E, Darnell R, McPoil T, Vicenzino B. Foot orthoses and physiotherapy in the treatment of patellofemoral pain syndrome: randomized clinical trial. *Br J Sports Med.* 2009;43:169–71.
- 6 Lowry CD, Cleland JA, Dyke K. Management of patients with patellofemoral pain syndrome using a multimodal approach: a case series. *J Orthop Sports Phys Ther.* 2008;38:691–702.
- 7 Blond L, Hansen L. Patellofemoral pain syndrome in athletes: a 5.7 year retrospective follow-up study of 250 athletes. *Acta Orthop Belg.* 1998;64:393–400.
- 8 Piva SR, Goodnite EA, Childs JD. Strength around the hip and flexibility of soft tissues in individuals with and without patellofemoral pain syndrome. *J Orthop Sports Phys Ther.* 2005;35:793–801.
- 9 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;28:480–9.
- 10 Powers CM. The influence of altered lower-extremity kinematics on patellofemoral joint dysfunction: a theoretical perspective. *J Orthop Sports Phys Ther.* 2003;33:639–46.
- 11 Neumann DA. *Kinesiology of the musculoskeletal system: foundations for physical rehabilitation.* Philadelphia, PA: Mosby, Inc.; 2002.
- 12 Prins MR, Wurff PV. Females with patellofemoral pain syndrome have weak hip muscles: a systematic review. *Aust J Physiother.* 2009;55:9–15.
- 13 Tiberio D. The effect of excessive subtalar joint pronation on patellofemoral biomechanics: a theoretical model. *J Orthop Sports Phys Ther.* 1987;9:160–5.
- 14 Dananberg HJ, Shearstone J, Guiliano M. Manipulation for the treatment of ankle equinus. *J Am Podiatr Med Assoc.* 2000;90:385–9.
- 15 Pellow JE, Brantingham JW. The efficacy of adjusting the ankle in the treatment of subacute and chronic grade I and grade II inversion ankle sprains. *J Man Physiother.* 2001;24:17–24.
- 16 DeCarlo MS, Sell K. Normative data for range of motion and single leg hop in high school athletes. *J Sports Rehabil.* 1997;6:246–55.
- 17 Shelbourne KD, Biggs A, Gray T. Deconditioned knee: the effectiveness of a rehabilitation program that restores normal

- knee motion to improve symptoms and function. *N Amer J Sports Phys Ther.* 2007;2:81–9.
- 18 Ireland ML, Willson JD, Ballantyne BT, Davis IM. Hip strength in females with and without patellofemoral pain. *J Orthop Sports Phys Ther.* 2003;33:671–6.
 - 19 Shelbourne KD, Gray T. Minimum 10-year results after anterior cruciate ligament reconstruction. *Amer J Sports Med.* 2009;37:471–80.
 - 20 Kocher MS, Steadman JR, Briggs K, Zurakowski D, Sterett WI, Hawkins RJ. Determinants of patient satisfaction with outcome after anterior cruciate ligament reconstruction. *J Bone Joint Surg Am.* 2002;84:1560–72.
 - 21 Sachs RA, Daniel DM, Stone ML, Garfein RF. Patellofemoral problems after anterior cruciate ligament reconstruction. *Am J Sports Med.* 1989;17(6):760–5.
 - 22 Aglietti P, Buzzi R, D'Andria S, Zaccherotti G. Patellofemoral problems after intraarticular anterior cruciate ligament reconstruction. *Clin Orthop Relat Res.* 1993;288(3):195–204.
 - 23 Fritz JM, Delitto A, Erhard ER, Roman M. An examination of the selective tissue tension scheme, with evidence for the concept of a capsular pattern of the knee. *Phys. Ther.* 1998;78:1046–61.
 - 24 Watkins MA, Riddle DL, Lamb RL, Personius WJ. Reliability of goniometric measurements and visual estimates of knee range of motion obtained in a clinical setting. *Phys Ther.* 1991;71:90–7.
 - 25 Martin RL, McPoil TG. Reliability of ankle goniometric measurements: a literature review. *J Am Podiatr Med Assoc.* 2005;95:564–72.
 - 26 Schlegel TF, Boublik M, Hawkins RJ, Steadman JR. Reliability of heel-height measurements for documenting knee extension deficits. *Amer J Sports Med.* 2002;30:479–82.
 - 27 Konor MM, Morton S, Eckerson JM, Grindstaff TM. Reliability of three measures of ankle dorsiflexion range of motion. *Int J Sports Phys Ther.* 2012;7:279–87.
 - 28 Bohannon RW. Manual muscle test scores and dynamometer test scores of knee extension strength. *Arch Phys Med Rehabil.* 1986;67(6):390–2.
 - 29 Deneger CR, Hertel J, Fonseca J. The effect of lateral ankle sprain on dorsiflexion range of motion, posterior talar glide, and joint laxity. *J Orthop Sports Phys Ther.* 2002;32:166–73.
 - 30 Greenman PE. Principles of manual medicine. Philadelphia, Pennsylvania: Williams & Wilkins; 1989.
 - 31 Keyser K. Lower quadrant course. Eugene, OR: North American Institute of Orthopaedic Manual Therapy Inc.; 2006.
 - 32 Edmond SL. Manipulation & mobilization: extremity and spinal techniques. St Louis, Missouri: Mosby; 1993.
 - 33 Maitland GD, Banks K, English K, Hengevel E. Vertebral Manipulation. 7th edition.. Oxford, Elsevier: Butterworth-Heinemann; 2005, 8–11.
 - 34 Kolowich PA, Paulos LE, Rosenberg TD, Farnsworth S. Lateral release of the patella: indications and contraindications. *Am J Sports Med.* 1990;18:359–65.
 - 35 Fulkerson JP. Evaluation of the peripatellar soft tissues and retinaculum in patients with patellofemoral pain. *Clin Sports Med.* 1989;8:197–202.
 - 36 Dye SF, Vaupel GL, Dye CC. Conscious neurosensory mapping of the internal structures of the human knee without intraarticular anesthesia. *Amer J Sports Med.* 1998;26:773–7.
 - 37 Sanchis-Alfonso C, Rosello-Sastre E. Immunohistochemical analysis for neural markers of the lateral retinaculum in patients with isolated symptomatic patellofemoral malalignment: a neuroanatomic basis for anterior knee pain in the active young patient. *Am J Sports Med.* 2000;28:725–31.
 - 38 Crossley KM, Bennell KL, Cowan SM, Green S. Analysis of outcome measures for persons with patellofemoral pain: which are reliable and valid? *Arch Phys Med Rehabil.* 2004;85:815–22.
 - 39 Schunk C, Rutt R. TAOS Functional index: ortho paedie rehabilitation outcomes tool. *J Rehabil Outcomes Meas.* 1998;2:55–61.
 - 40 Polissar N, Neradilek B. Evaluation of The CareConnections Health Questionnaire For Physical Therapy Patients. Seattle, WA: The mountain-whisper-light statistical consulting; 2008. Available at: <http://www.careconnections.com/assets/docs/NonTechSummary121508.pdf>.
 - 41 George SZ, Stryker SE. Fear-avoidance beliefs and clinical outcomes for patients seeking outpatient physical therapy for musculoskeletal pain conditions. *J Orthop Sports Phys Ther.* 2011;41:249–59.
 - 42 Simon CB, Stryker SE, George SZ. Comparison of work-related fear-avoidance beliefs across different anatomical locations with musculoskeletal pain. *J Pain Res.* 2011;4:253–62.
 - 43 Pettman, E. Manipulative thrust techniques: an evidence-based approach. Aardvark Publishing; 2006.
 - 44 Loudon J, Bell S. The foot and ankle: an overview of arthrokinematics and selected joint techniques. *J Athl Train.* 1996;31:173–8.
 - 45 Willson JD, Davis IS. Lower extremity mechanics in females with and without patellofemoral pain across activities with progressively greater task demands. *Clin Biomech* 2008;23(2); 203–11.
 - 46 Bolgla LA, Keskula DR. Reliability of lower extremity functional performance tests. *J Orthop Sports Phys Ther.* 1997;26:138–42.
 - 47 DeCarlo MS, Sell K. Normative data for range of motion and single leg hop in high school athletes. *J Sports Rehab.* 1997;6:246–55.
 - 48 Muneta T, Sekiya I, Ogiuchi T, Yagishita K, Yamamoto H, Shinomiya K. Objective factors affecting overall subjective evaluation of recovery after anterior cruciate ligament reconstruction. *Scand J Med Sci Sports.* 1998;8:283–9.
 - 49 Light KE, Nuzik S, Personius W, Barstrom A. Low-load prolonged stretch vs. high-load brief stretch in treating knee contractures. *Phys Ther.* 1984;64:330–3.