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Clinical Reasoning and Utilization of a Literature Review during the Management of Patellofemoral Syndrome: A Case Report

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Abstract

Introduction: Evidenced based practice is grounded upon the integration of current literature and clinical practice. Throughout the musculoskeletal management of a patient, clinical questions can be answered based on current research. Patellofemoral pain syndrome (PFPS) is a common condition with a reported incidence of 20-40% of all knee cases in sports medicine clinics. The purpose of this case report is to demonstrate how a literature review can enhance clinical reasoning during the management of the patient/client with PFPS.

Case Description: 17 year old male football player with chief complaint of bilateral anterior knee pain (Right>Left) with activity limitation of squatting, running, and jumping. Methods: A literature search in Medline & CINAHL was conducted reviewing abstracts focusing on movement assessments identify dysfunctional movement patterns and individuals at risk for injuries; and movement assessment assisting in developing prognosis and plan of care. The review of literature revealed 15 articles that were deemed appropriate.

Conclusion: PFPS is a common musculoskeletal condition facing today's clinician. The challenge for clinician's within the current healthcare environment stem from the fact PFPS is a mutifactorial issue with no definitive diagnostic criteria, and limited clinical utility of impairment based clinical tests have provided minimal information that can assist the clinician in managing patients with this condition. Movement assessments are potential alternatives from isolated impairment based tests that can enhance clinical reasoning by capturing regional interdependence implications

Keywords: Anterior knee pain; Patellofemoral pain syndrome; Movement assessment; Physical therapy

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Introduction

Patellofemoral pain syndrome (PFPS) is one of the most common overuse injuries that affects active individuals, and is most prevalent in female and youth athletics [1-3]. It accounts for 25-40% of all knee problems in sports medicine clinics, yet no reference standard has been developed for diagnosing PFPS [4]. Special clinical tests aimed at assessing patellar mobility and palpations have demonstrated poor diagnostic accuracy in identifying the condition [1,5]. Given that impairment based clinical tests are unable to diagnosis PFPS, the purpose of this inquiry is to assess the benefit of incorporating movement assessment procedures into the physical therapy examination for PFPS.

Movement assessment may be a beneficial evaluation approach as PFPS has been found to be a multifactorial issue with numerous identifiable risk factors and regional interdependence implications [6]. Regional interdependence states that unrelated impairments in remote anatomical locations may be associated with the patient's primary complaint [7]. In the case of PFPS, two important areas that should be examined are the hip and the ankle.

Powers demonstrated that during closed kinetic chain functional activities, in which most PFPS symptoms and complaints are felt, excessive femoral internal rotation and adduction results in dynamic knee valgus [2,3]. Below, at the ankle, limitations in dorsiflexion can result in compensatory subtalar joint pronation. Excessive pronation is coupled with tibial internal rotation, which can result in femoral internal rotation and dynamic knee valgus [2-4]. This dynamic knee valgus is a dysfunctional movement pattern that results in decreased Patellofemoral Joint contact area and increased joint pressure [2,3]. Evidence supports that individuals with PFPS demonstrate significant

Table 1: Initial examination findings.

Range of Motion (ROM	**Right Lower Extremity**	**Left Lower Extremity**
Hip ROM (Flexion, ER, IR)	WNL	WNL
Knee ROM	0-125°	0-125°
Ankle Dorsiflexion (Knee straight)	0°	0°
Ankle Dorsiflexion (Knee bent)	0°	1°
Talocrural Joint Posterior Glide	Hypomobile	Hypomobile
Manual Muscle Test (MMT)		
Hip Abduction	3-/5	3-/5
Hip Extension	3-/5	3-/5
Hip Flexion	5-May	5-May
Knee Extension	4-/5	4-/5
Knee Flexion	5-May	5-May
Special Tests		
Thomas Test	Positive	Positive
Conventional SLR	Positive	Positive
Patellar Glide Test	Normal Movement	Normal Movement
Lachman Test	Negative	Negative
McMurray Stress Test	Negative	Negative
Varus Stress Test	Negative	Negative
Movement Assessment		
Deep Squat	- Requires 2-inch heel lift to reach parallel - Bilateral Valgus collapse - Right weight shift & right trunk rotation - Positive for pain	
Y Balance (Anterior Reach)	- Left anterior reach > right anterior reach - Bilateral valgus collapse - Positive for pain bilaterally	

decreased hip external rotation and abduction strength, decreased gastrocnemius flexibility and increased dynamic knee valgus during functional activities [8-14,3,4].

Impaired proprioception has also been associated with PFPS with patients demonstrating higher trajectory tracking error and impaired active joint position reproduction error compared to healthy controls [15,16]. Most believe this impaired proprioception is a result of PFPS or associated with pain. However, Bennell et al. [17] found that experimentally induced anterior knee pain, which mimicked PFPS, of moderate to high intensity did not affect joint position sense in healthy individuals [17]. This information leads to the possibility that impaired proprioception is not caused by PFPS but impaired proprioception may actually preclude or be a risk factor for developing PFPS.

A review of literature indentified two widely used movement assessments the Functional Movement Screen (FMS) and Star Excursion Balance Test (SEBT)/Y-Balance Test (YBT). Both tools are utilized as pre-participation screens to identify individuals at risk for injury. The FMS utilizes seven tests to assess functional movement patterns incorporating the entire kinetic chain. It is designed to identify individuals who have developed compensatory movement patterns [18,19]. The FMS has been shown to identify individuals at risk for injury in professional American football players, female collegiate athletes, and Marine Corps officers [20-23]. The SEBT and YBT are tools utilized to assess dynamic postural control, balance and functional symmetry of the lower extremities. The YBT has been shown to be able to identify individuals with increase risk for sustaining a lower extremity injury in high school basketball players and collegiate football players [24,25].

Given that dynamic knee valgus is a dysfunctional movement pattern that involves the entire kinematic chain and that impaired proprioception may be a potential risk factor, it could be beneficial to incorporate a movement assessment when screening for or evaluating patients with PFPS. Movement assessments have been shown to be able to identify individuals at risk for injury, and have the potential to capture proprioception, motor control, body awareness and regional interdependence of the lower extremity during functional taks. The purpose of this literature review was to determine the benefit of incorporating a movement assessment during a physical therapy evaluation of a patient with PFPS

Patient Characteristics

A 17-year-old male presented to the outpatient physical therapy clinic via direct access following an athletic screening for bilateral knee pain. Upon initial evaluation, the patient's chief complaint was bilateral anterior knee pain, right greater then left. Patient reported playing defensive end for his high school football team and initially experiencing knee pain a few weeks prior when squatting during off-season workouts. The patient reported he eventually began to experience knee pain during running and jumping activities, but the worst pain was experienced during squatting. He reported squatting over 300# multiple times a week during the off-season, with pre-season workouts and two-a-days starting in three weeks. The patient reported icing his knees after squatting and not stretching or warm up prior to strength training. No imaging was performed. Patient's past

Table 2: Search terms used medline and CINAHL plus databases.

Key Terms	Patellofemoral Pain Syndrome	Functional Movement System	Star Excursion Balance Test	Lower Extremity Injury
Secondary Terms	Patellofemoral Pain PFPS Anterior Knee Pain	Functional Movement Screen FMS Movement Assessment Deep Squat	Star Excursion Balance SEBT Y Balance YBT	LE Injury Non-contact lower extremity injury LE injury risk Injury risk

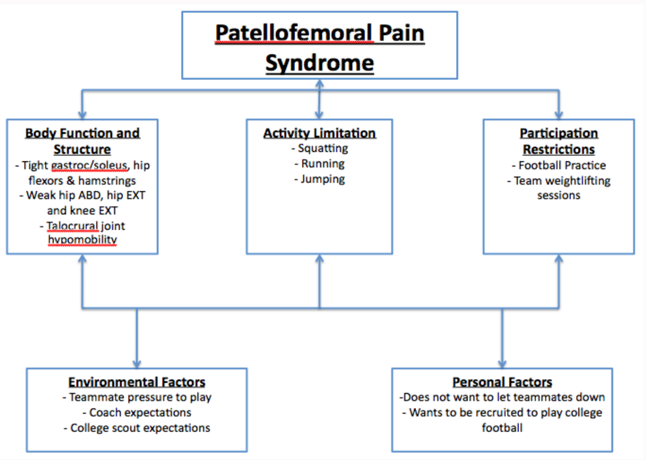

Figure 1: International Classification of Functioning (ICF) model for Patello femoral Pain Syndrome.

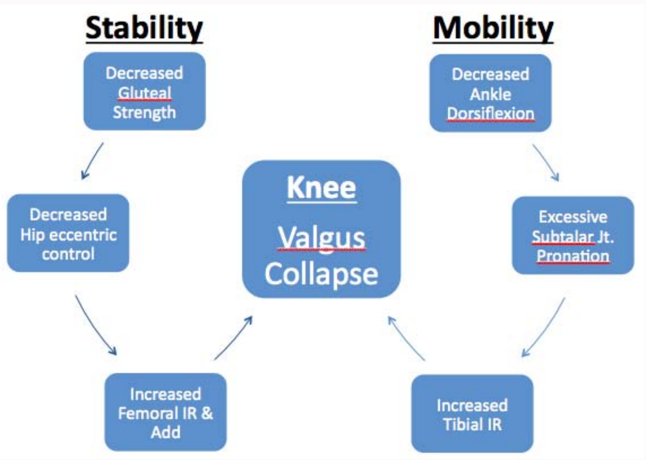

Figure 2: Regional interdependence application of PFPS.

medical and surgical history were unremarkable.

Physical Examination

During the Deep Squat Test the patient was unable to reach parallel, heels rose from the floor, demonstrated bilateral valgus collapse, and increased trunk inclination. Deep Squat with heels placed on 2-inch box the patient reached parallel with decreased bilateral valgus collapse, but demonstrated right weight shift and right trunk rotation. Patient reported increased pain during both Deep Squats. During the Y Balance Test the patient demonstrated decreased anterior reach distance on right lower extremity and bilateral valgus collapse. Y Balance was not quantified.

Significant impairment based findings included anterior pelvic tilt, bilateral positive Thomas tests, bilateral tight gastrocnemius, bilateral talocrural joint hypomobility, decreased hip abduction, hip extension and knee extension strength and anterior core weakness. Patellar movement during Patellar Glide test was normal. Lachman's tests, McMurray test, varus and valgus stress tests were negative for ligament and meniscal damage. Patient's Lower Extremity Functional Scale (LEFS) score was 50/80. From this clinical presentation, it was determined the patient was presenting with bilateral patellofemoral pain syndrome (PFPS). Initial Examination findings are listed in (Table 1).

Interventions

Interventions emphasized manual therapy and corrective exercise to improve lower extremity range of motion, correct movement patterns and build strength in appropriate muscle groups. Manual therapy included posterior glides to the Talocrural joint to increase ankle dorsiflexion and Thomas stretch to increase hip flexor flexibility. Corrective exercises included kneeling closed chain dorsiflexion/ soleus stretch, standing gastroc stretch, kneeling hip flexor stretch and strengthening exercises for hip abduction and extension. Patient also performed Reactive Neuromuscular Training (RNT) corrective squatting with bands to correct the right weight shift and bilateral valgus collapse.

Methods

Search strategy

A literature search in Medline & CINAHL was conducted reviewing abstracts focusing on movement assessments identify dysfunctional movement patterns and individuals at risk for injuries; and movement assessment assisting in developing prognosis and plan of care. Articles deemed appropriate then underwent an analysis of full text and the most appropriate articles were selected for use in this literature review. Search terms used to search the literature are listed in (Table 2).

Findings

The review of literature revealed 15 articles that were deemed appropriate. Four articles provided background information on FMS, developed by Gray Cook [18,19]. The FMS composite score has been found to have moderate to good inter rater (ICC of 0.74 95% CI: 0.60, 0.83) and intra rater (ICC of 0.76 95% CI: 0.63, 0.85) reliability and acceptable measurement error [26,27]. Four articles assessed the FMS's ability to identify individuals at risk for lower extremity injury in professional American football players, female collegiate athletes, and Marine Corps officers [20-23,28].

A systematic review was found that discussed the clinical utility and usefulness of the SEBT/YBT. The review found that the SEBT/ YBT is a reliable and valid measure of dynamic postural control, which is sensitive enough to detect individuals at risk for lower extremity injury [25]. Two articles assessed the ability of the YBT to identify individuals at risk for lower extremity injury, in high school basketball payers and collegiate football players [24,25]. The SEBT has specifically been assessed in patients with chronic ankle instability, ACL reconstruction and PFPS [25]. Aminaka et al. [29] found that patients with PFPS demonstrated decreased YBT reach distances compared to healthy controls, and reach distances and pain improved with Mc Connel taping [29].

One article assessed the use of an injury prediction algorithm, which incorporated movement screening (FMS and YBT), demographic information, and injury history, to identify risk for non-contact lower extremity injuries in male and female colligate athletes. The authors found that athletes categorized as high risk were 3.4 times more likely to obtain an injury over the season [30].

Two articles looked at the prognostic ability of the FMS. One article assessed the ability to improve the FMS composite score through an off-season intervention program. Kiesel found that individuals with a Deep Squat score of 1 were 5x more likely to not improve their FMS composite score following intervention [31]. Another article assessed if FMS scores were associated with longitudinal performance outcomes in elite track and field athletes. Researchers found that FMS scores and presence of asymmetries were related to magnitude in longitudinal performance changes. Specifically athletes with a Deep Squat score of 3 had larger mean improvements in performance then athletes with a score of 2 or 1 [32].

One article specifically researching Deep Squat mechanics found that individuals with different scores on the FMS Deep Squat had mechanical differences when performing the test [33]. This information can assist in developing specific interventions to improve the Deep Squat score.

Discussion

Majority of the research found in the literature review focused on movement assessments identifying healthy/injury free individuals who were at risk for sustaining an injury during the competitive season [20-25,30]. This ability to utilize movement assessments, specifically the FMS and YBT, to identify individuals at risk for injury supports that altered movement patterns, motor control and proprioception are risk factors for injury. Research shows that individuals with PFPS have impaired proprioception compared to healthy controls and Bennell et al. [17] demonstrated that this impaired proprioception might not be caused by PFPS but actually be a risk factor for the development of PFPS [15-17]. The FMS and YBT have the potential to identify this impaired proprioception and dysfunctional movement patterns that could lead to PFPS. This particular patient demonstrated a dysfunctional squat pattern and pain with a participation restriction of inability to play football.

Applying this research to the specific sport of football, the FMS and YBT have been supported in the literature to identify professional and collegiate football players at risk for sustaining a lower extremity injury. Kiesel et al. [31] found that professional football players with an FMS score of 14 or less had an eleven-fold increased chance of suffering a time loss injury during the season [21]. Also any asymmetry identified during testing regardless of FMS total score resulted in a 2.3 increase in injury risk [28]. Butler et al. [24] found that collegiate football players with an YBT composite scoreless then 89.6% were 3.5 times more likely to sustain a non-contact lower extremity injury [24]. Lastly, utilizing an injury risk algorithm, which included the FMS & YBT, Lehr et al. [30] was able to classify collegiate athletes (including football players) into low and high risk categories, and found high risk athletes were 3.4 times more likely to sustain an injury [30]. This specific patient was a high school senior defensive end with aspirations to play collegiate football. The patient was only assessed with the FMS Deep Squat and YBT anterior reach, so a FMS total score and YBT composite score were not obtained. However, the patient demonstrated asymmetries during the Deep Squat, indicating 2.3 times greater risk for injury, and asymmetrical reach difference on the YBT. Research in high school basketball players found that anterior reach difference of >4cm indicated 2.5 times increase in injury risk [25]. The FMS and YBT have been accurate in identify injury risk in football players. The question to be considered is if dysfunctional movement patterns were a contributing factor to the patient's current condition. Our working hypothesis is movement dysfunction could be a factor contributing to his pathology.

A thorough examination that includes movement assessment specifically in this case can have prognostic benefits as well. Utilizing the FMS scoring criteria the current patient scored a 2 on the Deep Squat. This information has prognostic benefits as Kiesel et al. [31] found that a player's inability to improve their FMS score above the injury threshold of 14 was correlated to Deep Squat scores. Players with a Deep Squat score of 1 were found to be five times more likely to fail to improve their FMS score with interventions [31]. The researchers hypothesized that the deep squat had predictive power because it incorporated the entire kinematic chain and that failure to score greater then a 1 may indicate significant movement dysfunction. Relating back to the current patient, his Deep Squat score of 2 would indicate a good prognosis to improve and correct his dysfunctional movement patterns and decrease his risk for further injury. The prognostic information can be take a step further as the FMS has been correlated to longitudinal performance changes in elite track and field athletes [32]. It was found that individual athletes with FMS scores<14, presence of bilateral asymmetry or Deep Squat scoreless then 3 had smaller improvements in longitudinal performance [32]. This information directly applies to the current patient as he demonstrated a bilateral asymmetry and a FMS Deep Squat score of 2. The presence of these movement deficits will potentially affect the patient's ability to improve his on field performance, which will be critical when transitioning from high school to college football.

In addition to the prognostic benefit that it can yield to the clinician the information gained from movement assessment can drive interventions aimed at movement correction. Kiesel et al. [31] demonstrated in a group of professional American football players that an intervention program aimed at correcting the identified movement deficit resulted in an average increase of 11% on the FMS totalscore.[21]This shows that identifying and prescribing interventions to address the movement deficits can improve the movement pattern and decrease the patient's risk for injury.

Utilizing movement assessment allows the clinician to identify the dysfunctional movement pattern and then break down the movement pattern to identify the most meaningful impairments in terms of mobility and stability deficits. This specific patient demonstrated a dysfunctional squat pattern; with bilateral valgus collapse, heels coming off the floor and pain. YBT also revealed decreased anterior reach distance on the right side compared to left, valgus collapse, and pain. Two regions that significantly contribute to the squat pattern and YBT anterior reach are the hip and ankle. Specifically at the ankle, Butler et al. [33] demonstrated that the major mechanical difference between a Deep Squat score of 3 and 2 is peak dorsiflexion excursion, with a score of 3 requiring greater peak dorsiflexion [33]. Also the YBT anterior reach has been correlated to closed chain ankle dorsiflexion mobility [34]. During the Deep Squat and YBT, in order to gain additional motion our patient compensated for his limited ankle dorsifelxion mobility with excessive Subtalar joint pronation that is coupled with tibial internal rotation resulting in valgus collapse of the knee, which is consistent with the findings of Macrum and colleagues [35]. Moving up to the hip, Powers has demonstrated valgus collapse of the knee is caused by increased femoral adduction and internal rotation [2,3]. For our patient, hip manual muscle testing revealed decreased Gluteus Medius and Maximus stability, which during squatting resulted in decreased eccentric hip control and increased femoral adduction and internal rotation causing valgus collapse of the knee, which has been shown in research by Souza and Powers [13]. Proper efficient performance of the FMS Deep Squat and YBT anterior reach requires sufficient ankle dorsiflexion mobility and Gluteal stability.

Based on the findings of the movement assessment, isolated impairment based testing followed to rule in or out key impairments in terms of mobility and stability. Specifically for this patient, impairment based mobility testing revealed ankle dorsiflexion ROM restriction, Talocrural joint hypomobility, and Triceps Surae tightness. Impairment based stability testing revealed Gluteus Medius and Maximus manual muscle testing grade of 3-/5. The Gluteal weakness led to the assessment of hip flexor flexibility revealing bilateral positive Thomas tests. Janda's Lower Crossed Syndrome shows that muscle imbalances around the hip can alter static and dynamic function. The syndrome promotes an anterior pelvic tilt, another characteristic of the current patient, and hip flexor tightness causing reciprocal inhibition of the Gluteals resulting in weakness. (Janda) Based on the movement assessment findings a plan of care was developed to address the most meaningful impairments that drive the patient's valgus collapse and movement dysfunction.

The patient's first treatment session consisted of Thomas stretch to lengthen the hip flexors followed immediately by single leg bridging to increase Gluteus Medius and Maximus activation and strength. Treatment also included Talocrural joint posterior glides and self-stretching to the gastrocnemius and soleus bilaterally to increase dorsiflexion mobility. Reactive Neuromuscular Training (RNT) corrective squatting was then performed with heels elevated in an attempt to correct the patient's bilateral valgus collapse and right weight shift. With heels elevated the patient was able to reach parallel but continued to demonstrate a right weight shift and experienced pain. When applying the RNT bands the patient squatted symmetrically with decreased valgus collapse and no reports of pain. The movement assessment allowed the clinician to appreciate the regional interdependence applications of the lower extremity, breakdown the dysfunctional pattern to reveal the underlying meaningful impairments and assisted in identifying the best interventions to improve the patient's movement pattern.

There are limitations in applying the literature directly to the current patient case. The FMS and YB Tare primarily utilized to identify healthy individuals who are at risk for sustaining an injury. The YBT has been assessed in populations with chronic ankle instability, ACL-deficiency and PFPS; and has been shown to be able to differentiate between the injured patients and healthy controls but has not been shown to diagnosis specific conditions [25,29]. Unlike the YBT, the FMS has not been assessed in a population of individuals with pain or current injuries, so caution must be taken when applying the FMS research to the current patient case due to the presence of pain and injury. Further research is needed in a movement assessment that discriminates painful versus non-painful fundamental movement patterns.

Conclusion

PFPS is a common musculoskeletal condition facing today's clinician. The challenge for clinician's within the current healthcare environment stem from the fact PFPS is a mutifactorial issue with no definitive diagnostic criteria, and limited clinical utility of impairment based clinical tests have provided minimal information that can assist the clinician in managing patients with this condition. Movement assessments are potential alternatives from isolated impairment based tests that can enhance clinical reasoning by capturing regional interdependence implications. Movement assessments have been shown to be reliable in identifying individuals at risk for injury, but can also identify movement deficits that can be used to guide interventions in order to improve movement patterns and decrease risk for injury. Two established movement assessments tools, the FMS and YTB, can provide clinicians with valuable information regarding injury risk, prognosis and intervention selection for patients with PFPS.

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