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THE EFFECT OF HIP, ANKLE, AND FOOT CORRECTIVE EXERCISE IN THE TREATMENT OF A PATIENT WITH PATELLOFEMORAL DISORDERS: A CASE REPORT

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Abstract

Introduction: Patellofemoral Disorders is one of the most common conditions encountered in an outpatient physical therapy setting. While there are many different approaches used in the treatment, the purpose of this study is to report the application of hip, ankle, and foot corrective exercise for patient with patellofemoral disorders. **Methods**: This is a case report study participated by a 21-year-old female patient who was medically diagnosed with patellofemoral disorders, using CARE (CAseREport) Guidelines as the writing method. Outcome measures included the International Knee Documentation Committee (IKDC) forms, the Numeric Pain Rating Scale (NPRS), ROM using Goniometer, and self-reported walking tolerance. Corrective exercise included Gluteus Medius isolated-activation, stretching for Adductor Muscle group, ankle stabilization exercise, and medial foot-arc strengthening exercise 3 times a week for a period of 4 weeks. **Results:** With corrective exercise**,** IKDC score improved from 48.28% to 52.87%, NPRS score reduced from 5/10 to 2/10 on the left knee and 5/10 to 3/10 on the right knee. Knee flexion ROM improved from 128^0 to 150^0 and from 125^0 to 145^0 on the left and right knee respectively. Walking tolerance improved to more than 30 minutes. However, patient still unable performing full squatting movement and kneeling position. **Conclusion:** This result demonstrated that hip and ankle corrective exercise can decrease pain and improve function in a 21-year-old female with patellofemoral disorders. Further studies should be conducted to investigate the use of corrective exercise in a larger population with patellofemoral disorders.

Key words: patellofemoral disorders, corrective exercise, IKDC

BACKGROUND AND PURPOSE

Patellofemoral pain syndrome is a problem encountered by physiotherapist characterized by pain in retropatellar (behind the kneecap) or prepatellar (around the kneecap) due to irritation of patellar cartilage (Heijden et al, 2013). Previous studies have shown that patients with patellofemoral disorders who exercise their vastus medial oblique (VMO) can increase their functional knee outcome. However, the mechanism by which this symptomatic improvement still followed by episode of sudden pain and recurrent symptom is still a debate. Several factors, including valgus deformities, gait abnormalities, changes of leg external moment arm may be involved. It is stated that lower extremity kinetic chain involving hip, knee and ankle also play an important role on maintaining the body in proper position (Santos et al, 2014). The effect of long-term VMO activation on patients with patellofemoral disorders provide a good result, however, as does the form of exercise may also affected by some factors.

To date, few studies have rigorously examined whether recurrent patellofemoral joint syndromes result from abnormal kinematic of the hip and ankle joint as this may create any

deformities of the knee joint and a more localized biomechanical changes in the lower extremity (Barton et al, 2010; Barton et al, 2012; Barton et al 2013). A published case-controlled study described the electromechanical delay (EMD) of VMO by 37.3 ± 0.7 miliseconds, longer dan vastus lateralis in individual with patellofemoral disorders. Earlier study conducted by Sullivan and Popelas (2005) describe the importance of VMO activation on PFPS. These both study concluded by stating that VMO activation would be beneficial in the treatment of patellofemoral disorders. However there some tendencies that the patient experienced recurrent symptoms after followed up.

This study was designed to establish whether correcting hip and ankle joint along with VMO training regimen has a beneficial effect on knee functional outcome score in patients with patellofemoral disorders. There was a significant gluteal muscle activity difference between normal individual and individual with patellofemoral pain syndrome (Barton et al, 2013). There was also suggested that greater peak rearfoot eversion was associated with greater peak tibial internal rotation in individual with patellofemoral pain syndrome (Barton et al, 2012). If this were the case, then the hip and ankle corrective exercise program would avoid the biomechanical disadvantages and assist VMO contraction associated patellar tracking by reducing knee valgus tendencies.

Three exercise scheme were planned, a hip corrective exercise, knee VMO isolated activation, and ankle corrective exercise including the foot. Previously, investigators have recommended that a 3-month study, in which participants exercised three times a week, should be used to achieve benefit of this programs. However, effects are also achievable in shorter, lower frequency studies.

Given the above reason, the purpose of this case report is to describe a comprehensive approach for a patient with a patellofemoral disorder that addresses the patient's current impairments in the patellofemoral joint while at the same time correcting the factor that related to the deformities including hip and ankle.

PATIENT INFORMATION

The patient signed an informed consent allowing the use of medical information for this report. The patient was a 23-year-old women who went for a physiotherapy session following referral by her Orthopedist with a medical diagnosis of right and left recurrent Patellofemoral Disorders. By the time of initial evaluation was taken, she presented with sharp knee pain over the anterior-medial part of both knees which began approximately six months ago. She reported that the frequency of pain was occurred frequently with a varied intensity of pain on a daily basis. She also reported a consistent daily pattern of symptoms, with stiffness and pain increase by the knee motion, improving as the activity reduced or by total rest, which interfered her from walking or doing any weight-bearing activity. Overall, the patient's primary complaint included a sharp pain that prevented her from walking and interfered with her hobbies, where she is unable to walk or jog more than 30 minutes. The patient's previous medical history included: injury on her right patellar tendon due to overstretch with excessive squatting motion. Previous treatment for this current pain included over the counter pain modality (ultrasound treatment), and pain-free stretching and strengthening exercise for both knees only without any noticeable improvement.

Overall health was self-rated as good, and she rated his quality of life as excellent. She reported being active and independent in the performance of activities of daily living (ADLs) and instrumental activities of daily living (IADLs). There was no significant known family history. The patient reported that she lived in a private home with her family, and being a student at University with her hobby as a dancer. The primary goal of the patient was to

eliminate pain in order to perform her activity without interference and to be able to walk for more than 1 hours. Table 1 details the results obtained from the systems review.

CLINICAL FINDINGS

The patient was a 23-year-old female presenting with the health condition of right and left Patellofemoral Disorders. At the impairment level, the patient presented with pain in the anterior-medial part of both knees. She presented tenderness to touch over the patellar tendon for both knees. Pain in this area resulted in a limited ability to perform activities of daily living, walk for greater than 30 minutes, and participate in her hobbies.

The patient was diagnosed of right and left Patellofemoral Disorders. Possible differential diagnosis included bursitis, *osteochondritis dissecans,* ligamentous injury (ACL, PCL, MCL, LCL), meniscus injury and knee arthritis. Further special tests and measurements are need to be done in order to confirm the diagnosis included: isometric test, and other test to exclude the differential diagnosis. In addition, range of motion and lower extremity strength were assessed to better understand how any motion and strength deficits influenced the patient's functional mobility, or contribute to the pain experienced. The patient was a good candidate for a case report due to the conflicting evidence reporting the effect of physiotherapy treatment particularly for patellofemoral disorders.

DIAGNOSTIC ASSESSMENT

During the initial evaluation, standardized outcomes were measured and objective data were collected from the examination. The patient completed physical examination given by the physiotherapist. Physical examination including test for basic movement, specific test, and differential diagnosis. The International Knee Documentation Committee (IKDC) forms as well as Numeric Pain Rating Scale (NPRS) was given after the examination. Range of Motion (ROM) of both knee was also measured before and after intervention. The IKDC is a self-administered measurement which assesses the impact of knee impairment on the ability to manage everyday activities. This knee documentation form breaks down knee outcome status into three main categories. The categories are comprised of: symptoms, sport activities, and functional status. The IKDC subjective knee form has been found to have good responsiveness in people with variety of knee conditions such as ligamentous injury, meniscus and patellofemoral problems (Siqueira et al, 2012). The NPRS is a quick self-report tool that measures the patient's pain level. It includes an 11-point numeric scale which show the patients general perception of pain. This pain scale instrument has been found to have excellent interrater/ intrarater reliability, excellent internal consistency and large responsiveness in pain condition.

The findings after the examination revealed signs and symptoms consistent with the referred diagnosis of Patellofemoral Disorders. The findings included reported sharp pain in the left and right knee, positive isometric test for knee extension, reduced AROM and PROM finding (decreased knee flexion), and tenderness-to-palpation over the following area: medial side of patella and at the patellar tendon. The last step of the examination was a specific testing in order to rule out or assess any structural pathology that could contribute to the patient's pain. This confirmed with positive result of patellar grind test accompanied by negative finding of differential diagnosis examination such as *Lachman's* test for ACL, posterior drawer test for PCL, valgus and varus stress test for MCL and LCL respectively, McMurray test for torn meniscus, and no presence of crepitation. Radiographic Imaging also showed normal joint space with absence of osteophyte over the femur, tibia, and patellar surface. Based on this findings from the examination and the Orthopedist referral, the plan

was to proceed with physiotherapy intervention. The process of diagnostic assessment procedure can be seen in table 1.

Table 1. Diagnostic Procedure for Patellofemoral Disorders

Physical Examination	Left	Right	Comment
Screening			
Inspection	Valgus	Valgus	Accompanied by adducted hip join & pronated ankle and foot
Palpation	Negative	Negative	No sign of inflammation, edema, muscle wasting, and crepitation
Basic Movement			
Active knee flexion	128^0	125^0	Restriction on both L & R knees flexion with pain on the anterior-medial part of the knee. Extension AROM & PROM are normal with firm end-feel. Isometric knee extension felt slightly pain over anterior part of the patella.
Active knee extension	Full	Full	
Passive knee flexion	130^0	126^0	
Passive knee extension	Full	Full	
Isometric knee flexion	No Pain	No Pain	
Isometric knee extension	Slightly Pain	Slightly Pain	
Specific Test			
Patellar Grind Test	Positive	Positive	Sharp pain experienced on the both knees
Specific Test – Differential diagnosis			
Lachman test	Negative	Negative	No presence of pain, instability, and clicking sound during the maneuver
Posterior Drawer Test	Negative	Negative	
Valgus Stress Test	Negative	Negative	
Varus Stress Test	Negative	Negative	
McMurray Test	Negative	Negative	
Diagnostic Imaging			
Knee X-Ray	Normal	Normal	Normal joint space, no presence of osteophyte and subcondral slecrotic
Measurement			
IKDC Score	48.28%		
NPRS	5/10	5/10	

INTERVENTION

The intervention programs started with Ultrasound Treatment, followed by static quadriceps contraction, slow movement resistance exercise of knee joint and stretching for patellar tendon and VMO isolated activation. After conventional treatment, the patient received corrective exercise included Gluteus Maximus and Medius Isolated Activation, stretching for Adductor Muscle Group, Ankle Stabilization Exercise, and Medial foot-arc strengthening exercise. After examination and evaluation, functional goals were established for the patient Intervention consistent with the ranking of the patient's activity limitations and participation restrictions. She was informed and agreed to the following goals for her physiotherapy program with particular priority. Interventions is a programmed-therapeutic exercise directed at correcting the lower extremity kinetic chain which involved hip, knee, as well as ankle joint. Since patellofemoral joint disorders often experienced by individual along with a presence of knee valgus, it has to be believed that valgus asymmetric correlate significantly with abnormal kinematic of knee joint.

The intervention given in this study includes correcting hip joint into abduction and ankle joint into supination in addition to conventional therapy which address the activation of vastus medialis oblique (VMO) muscle. The combination of this therapy is capable of maintaining the patellar tracking in normal alignment during quadriceps muscle contraction. Principle of intervention can be seen in table 3.

Table 3. Principle of patellofemoral disorders intervention

Patelllofemoral Disorders (PFPS)	
Condition which caused by irritation of patellar bone cartilage due to abnormal movement of patellar bone on the patellar groove of femoral bone	
Impairment	**Intervention**
Inflammation	Ultrasound therapy
Lateral patellar tracking	Vastus medial oblique (VMO) isolated activation
Valgus Deformities: • Hip adduction • Ankle & foot pronated	Corrective exercise: • Gluteus medius isolated activation • Supinator strengthening & stabilization exercise • Medial foot arch strengthening

At first, the therapeutic program addressed at the hip joint by isolated-activation of the gluteus medius in supine, left-side, and right side lying. The exercise was done by moving the hip joint from adduction and internal rotation as starting position, toward abduction and external rotation as the end position. The exercise was finished with 12 times repetition in 3 sets using *thera-band* as the external load. The exercise progressed to train directly at the knee joint to activate the VMO muscle. In long sitting position, patient started the exercise at the last 20^0 of the knee extension, then asked to press down the knee joint into full extension. The therapist also provided a tactile stimulation by palpating and tapping directly on the VMO muscle as a visual biofeedback. This exercise was done with 18 times repetition in 3 sets using therapist hand as resistance. Emphasize of the next exercise was to correct the lower leg kinetic chain at the ankle joint. Ankle stabilization exercise was done to align the ankle joint into supination. Using thera-band, the patient was asked to maintain the ankle and foot in supinated position against the resistance into opposite direction. The session finished at strengthening the medial foot-arc started at even surface then progressed to uneven surface.

Fig. 1. Gluteus medius isolated activation with light-resistance thera-band. Isolated activation was achieved by moving the hip toward abduction and external rotation while keeping the neutral position at sagittal plane, thus inhibiting the tensor fascia latae (TFL) muscle

The emphasis during the third and fourth weeks of treatment continued to be dynamic control of the lower extremities. The emphasis of the exercises was to control the multi-joint movements that occurred during the patient's activities of walking and squatting while maintaining good dynamic control of the patellofemoral joint as well as the rest of the lower extremity. The patient performed more active and functional exercise such as standing, squatting, and lunging activities while keeping the hip, knee, and ankle aligned and maintaining control of the hip and thigh muscles. Dynamic control of the lower extremities was achieved by ascending and descending stairs with the patient keeping the knee aligned with the foot and maintaining control of the hip and thigh muscles. At the end of the 4th week, the patient was educated for home therapeutic program in order to be able for her to do the exercise routinely and continuously. However, she was also advised to visit her physiotherapist to continue her exercise program and monitor her symptoms at least once a week. The patient was also counseled to avoid knee valgus and laterally (externally) rotated positions during activities to decrease the risk of recurrent patellar tracking.

Fig. 2. Dynamic control of lower extremity to prevent knee valgus. The patient was instructed to half-squat while keeping the gluteus medius active by abducting and externally rotating the femur against medium-resistance thera-band.

FOLLOW-UP AND OUTCOMES

The patient reported that she manage to ascend and descend stairs without any difficulty by week 2 of treatment. This was also accompanied by improvement in NPRS score from 5/10 to 2/10 and 5/10 to 3/10 on the left and right knee respectively. By the week 3, knee joint pain-free ROM showed an increase from 128^0 to 150^0 on the left knee and from 125^0 to 145^0 on the right knee. The patient also reported that her walking tolerance has increased to more than 30 minutes by week 4 of the treatment. The patient's significant improvement was also confirmed by an improvement in IKDC score from 48.2% to 52.87% after 4 weeks of physiotherapy session (table 2).

However, there were some movements that still incapable to be done by the patient such as full squatting movement and maintaining her body in kneeling position. She was educated and encouraged to do the home exercise program at least 5 days a week. The follow up was still done following after 4 weeks of physiotherapy session to monitor patients improvement and her compliance to implement the home exercise program. She routinely visit the physiotherapist once a week every Friday for 3 months after the last session and indicated that she was able to tolerate most of her daily activities such as going to campus,

driving her own car, doing the house work and self-care. However, there was no sign of significant improvement during this 3 months of home exercise and she is still having a difficulty performing full squat and kneeling position.

Table 2.Iimprovement of outcome measurement after 4 weeks of physiotherapy session

Measurement	Initial Evaluation Results		At Discharge	
	Left	Right	Left	Right
IKDC	48.2%		52.87	
NPRS	5/10	2/10	5/10	3/10
ROM	128	125	150	145
Walking tolerance	<30 minute with pain		≥30 minute without pain	

DISCUSSION

Over the session of physiotherapy, the patient demonstrated improvements in functional outcomes and other objective measurements. She achieved her goal which is able to perform her daily activity without any complain and pain. The physiotherapy session which was planned for 4 weeks consisting of 3 times visit in each week was successfully finished. She was discharged by the end of week 4 due to the measureable improvements in all outcome measures and subjective reporting.

It was then hypothesized that her pain and functional restriction was due to an irritation of the patellar cartilage causing patellofemoral joint syndrome (Halabchi et al, 2013). Patellofemoral joint syndrome is a condition in which is caused by abnormalities of patellar bone movement on the patellar groove of femoral bone*. This movement abnormalities either can be caused by muscle imbalance or due to abnormal alignment of the knee joint. Meta-analysis presented that the annual prevalence of this condition as 22.7% in general population while 28.9% in adolescents (95% CI 17.4%–28.0%, ranged between 15 to 25 years old who tend to have asymmetrical form of genu valgus accompanied by ligamentous laxity (Smith et al, 2018)

Patellofemoral joint disorders are mostly seen in related to genu valgus deformities. Genu valgus deformities are condition in which Q-angle of the knee joint is above 20^0. This high Q-angle contribute to patellar tracking toward lateral side of patellar groove of femoral bone during tibial on femoral or femoral on tibial movement (Almeida et al, 2016); . The high of Q-angle also increase the tendency of quadriceps muscle to pull the patellar bone toward lateral side and may cause patellar subluxation (Almeida et al, 2016; Kagaya Y et al, 2015; Schmidt E et al, 2017;). In genu valgus, the asymmetric typically seen are the femur tend to adduct and the tibia tend to abduct and externally rotate with ankle and foot in pronate position.

Aside of activating the vastus medial oblique (VMO) muscle, correcting the lower extremity kinetic chain may also contribute to reduce the patellar tracking. Our finding suggest that the patient showed that her gluteus medius were not well developed. Thus creating the hypothetical reason that her undeveloped left and right gluteus medius caused her femur to adduct. In this study, the gluteus medius isolated activation help to correct her genu valgus by maintaining her femur into abduction.

These intervention was supported by RCT conducted by Khayambasi et al (2012) that showed the benefit of hip abductor and external rotator muscle strengthening on pain, health status, and hip strength in females with patellofemoral pain. A systematic review from Peters and Tyson, (2013) also supports this idea that it showed the significant result of proximal exercise in correcting functional femoral internal rotation which contribute to anterior knee pain and patellofemoral pain syndrome. Findings from Ramskov D et al, (2018)

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confirm this theory by stating that eccentrically strengthening the hip abductor reduce the risk of developing patellafemoral pain among novice runners

The purpose of the ankle corrective exercise is to maintain the position of ankle and foot as neutral as possible thus correcting her tibial asymmetric which also contribute to genu valgus. Several study also confirm this benefit of ankle correction in case of valgus deformities (Barton, 2012). Research from Aliberti et al (2011) showed that Influence of patellofemoral pain syndrome on plantar pressure in the foot rollover process during gait. This study confirming that ankle and foot correction have significant role to improve functional kinetic of lower extremity chain. In this report, the patient showed that she lacks of medial foot-arc strength as her both feet was flat and in pronated position. It was noticeable while she is standing or walking. Strengthening of the medial arc as well as the invertor muscle of the ankle was addressed in order to correct her tibial external and abduction torsion toward neutral thus helping to reduce the valgus deformities.

The use of corrective exercise as discussed in this case report can be beneficial in addressing chronic pain and improving function for individual with patellofemoral disorders. Corrective exercise in addition to conventional therapy and VMO activation showed a benefit result in management of patellofemoral disorders while VMO activation only has not been successfully in improving her knee functional status. This case study outlines the success with the use of physiotherapy in the treatment of this patient with patellofemoral disorders. The strength of this case report is that this study addressed the intervention completely for hip, knee, and ankle joint. This therapeutic approach was benefit not only as a curative intervention by treating directly the segment with the impairment but also as a preventive intervention by correcting the segments that also contribute for this problem to be persist. The patient made significant improvements over the course of a 4 weeks episode of care which allowed her to resume daily activities and work duties with minimal pain.

On the other hand, the short duration of the total treatment time which is only 4 weeks may become the restriction of this case study. Even though the patient was taught to do the home program, lack of daily monitor during exercise need to be paid in attention as this may become one of the major reason why there was no significant improvement in 3 months following the last physiotherapy session. Any confounding factor such as her motivation and compliance of performing home exercise program, external support such as family of colleague, as well as environmental factor were also need to be considered in further study.

As with any case report, cause and effect between the corrective exercise intervention and the clinical improvement of the patient cannot be inferred. However, the improvement in the chronic symptoms of the patient were likely due to the benefits of the intervention applied. Further research with a larger sample size and extended duration is warranted to investigate and report on the outcome of using a corrective exercise approach for hip and ankle in the management of patellofemoral disorders.

CONCLUSION

This case report highlights the effect of hip and ankle corrective exercise in combination with conventional therapy for a patient with a patellofemoral disorders. Conventional therapy such as isolated activation of VMO help to reduce the patellar tracking toward lateral side. The hip corrective exercise focusing on activating the gluteus medius muscle helps to position the femur toward abduction while ankle corrective exercise helps to correct the position of ankle and foot toward supination which combination between these two approach help to correct the valgus deformities. This framework allowed for an intervention at the level of the whole lower extremity kinetic chain which interconnected within each other. Consideration by physiotherapist of the hip and ankle corrective exercise

as a protocol system in treating any knee disorders may be beneficial in the care of patients and the management of various conditions.

In conclusion, there are several factors to consider when managing patients with patellofemoral disorders including connection between posture of the hip and ankle. With correction of the hip and ankle, physiotherapist will provide a better approach to the impact of lower extremity kinetic chain in management of patellofemoral disorder especially, and any lower extremity impairment generally.

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