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RESEARCH ARTICLE

REVIEW: PATELLOFEMORAL PAIN SYNDROME

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Abstract

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Patellofemoral pain syndrome is a common musculoskeletal condition and a major cause for anterior knee pain. It has been associated with excessive compression between the patella and the lateral femoral condyle. It is one of those overuse disorder that can limit activity of daily living along with participation in sports. The prevalence is more on female than those of male with the ratio of 2:1 and it affect athletic female more solely due to greater internal rotation of femur during running which leads to greater hip adduction. The reason for patellofemoral pain syndrome have been multifactorial; increased femoral internal rotation, decreased hip abduction and external rotation strength, decreased VMO function and lateral retinaculum tightness. These factor leads to increase in dynamic Q angle that directly increases patellofemoral contact pressure which map a way to patellofemoral pain syndrome. The literature will have an explanation about altered hip kinetics, kinematics and it's association with patellofemoral pain syndrome along with rehab protocol for patient's with the same condition.

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Introduction:-

Patellofemoral pain syndrome is the common musculoskeletal disorder for which individuals seek medical attention.[11] Anterior knee pain or patellofemoral pain syndrome is one of the common disorders affecting the lower extremities.[8] It is a common overuse disorder that can limit daily activitiy and participation in sports.[9] Women have higher prevalance of patellofemoral pain syndrome than their male counterparts (2:1), with an even higher incidence within the population for athletic women (4:1).[1] Women are more prone to patellofemoral pain syndrome due to anatomic factors including increased pelvic width and resulting excessive lateral thrust on the patella. Patellofemoral pain is a common condition, with one in 10 military recruits and one in 14 adolescents suffering at any one time and one in 5 of the general population experiencing pain within a year[34] (Meta-analysis done at UK). Patellofemoral have high prevalence and incidence level.[34] The postural and sociological factors such as wearing high heels and sitting with legs adducted can influence the incidence and severity of anterior knee pain in women. The athletic women are more prone to patellofemoral pain syndrome because female shows a greater internal rotation of femur during running than men and also have a tendency to larger hip adduction during activities and single leg drop. The larger hip adduction and internal rotation during weight bearing can lead to increased lateral patellar contact pressure as a result of an increase in the dynamic quadriceps angle (Q angle). The Q angle formed by drawing a line from anterior superior iliac spine (ASIS) to the patella's midpoint and another from patella's midpoint to tibial tubercle represents the resultant lateral quadriceps pull.[13] Therefore, an increased Q angle may predispose the patella to excessive lateral tracking and stress.[13] The symptoms most frequently reported is diffuse peripatellar and retropatellar pain associated with activities that load the patellofemoral joint, such as ascending and descending

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stairs and squatting and sitting with flexed knees for prolonged periods.[11,19] The etiology of this condition remains unknown, although many intrinsic and extrinsic factors have been suggested.[32] Recently various authors have suggested an association between hip muscle weakness or motor control impairment and the patellofemoral pain syndrome.[32] Poor hip control may lead to abnormal patellar tracking increasing patellofemoral joint stress and causing wear on articular cartilage.[32] Especially poor eccentric hip abductors and lateral rotators muscle control can result in adduction and medial rotation during weight bearing activities, leading to a predisposition to patellar tracking as the femur medially rotates underneath the patella.[18,32] Excessive medial rotation has been shown to decrease patellofemoral contact area and lead to increased patellofemoral joint stress.[9] Indeed biomechanical studies have reported that persons with patellofemoral pain demonstrate excessive hip internal rotation and hip adduction compared with pain free individuals.[10] Furthermore, persons with patellofemoral pain syndrome have been reported to exhibit impaired muscle performance of hip abductors, hip extensors and external rotators.[10] Individuals with patellofemoral pain syndrome have demonstrated increased hip adduction and medial rotation, as well as increased ipsilateral trunk inclination, excursions during functional tasks.[18] These altered movements have been associated with weakness of hip abductor, lateral rotator and extensor muscle and are thought to lead greater knee valgus angle and consequently, greater pressure on the lateral side of the patellofemoral joint.[18] The hip abductor muscle have been theorized to eccentrically control hip adduction and thus genu valgum angle during stance phase of running. A greater genu valgum angle (or increase in dynamic Q angle) has been purported to increase patellofemoral contact pressure and lead Patellofemoral pain syndrome[18].

Biomechanics

The mechanics in knee joint lies between femur, tibia and patella where patella acts as fulcrum by displacing line of pull and increasing the moment arm of the quadriceps muscle force in relation to the center of rotation of the knee.

During flexion:-

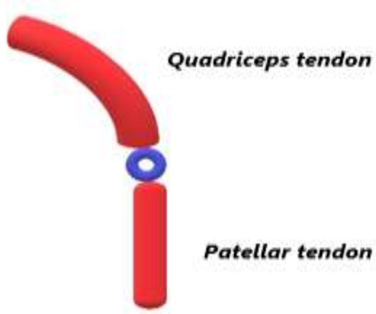
During full flexion, patella moves medially and comes to lie within the intercondylar notch until 130° of flexion, then it starts to move laterally again. As the knee flexion increases larger area of articular surface of patella comes in contact with femur which displaces the increased load that occurs with flexion.

During extension:-

During full extension, patella sits lateral to the trochlea. During extension quadriceps pull patella upwards until the upper border reaches beyond the femoral trochlea groove. The LoG falls behind the center of axis of the knee joint when standing upright (The quadriceps contract to neutralize the rotator effect of gravity on the knee, which would otherwise force knee into flexion). Therefore, when line of gravity falls within or infront of the knee as seen in full extension or hyperextension, the quadriceps become relaxed.

Role of patella in knee joint:-

The largest sesamoid bone in the body that primarily functions as the anatomic pulley for the quadriceps muscle. It lengthen the moment arm of quadriceps muscle by increasing the distance between tendon and axis of the knee joint. It increases the angle of pull and ability to generate extension torque.It is not same as the mechanical pulley. Therefore, anatomical pulley only transmit the forces or motion whereas the mechanical pulley bears the tension. The tension between quadriceps tendon and patellar tendon is equal in mechanical pulley whereas in anatomical pulley the patellar tension is less than the quadriceps tension.



In normal individual, the ratio of length of patellar tendon to the length of patella is 1:1, it is called insall-salvati index. The condition when we have long patellar tendon with high position of patella is known as patella alta and the condition when we are having short patellar tendon with low position of patella is known as patella baja. Patella alta leads to patellar instability. In patella alta the patella positioned proximal to high lateral femoral wall making patella unstable and easy to sublux during the flexion of knee joint. Knee is a complex joint and during it's movement such as flexion, the patella moves prior to tibiofemoral joint via inferior translation to sit at intercondylar groove. The scenario leads larger range of motion within which patella becomes relatively unstable.

Patellofemoral joint reaction force:-

The patellofemoral joint reaction is the measure of the compression of the patella against the femur which is determined by the quadriceps force and amount of knee flexion. In closed kinematic chain, it is a vector summation of the quadriceps muscle and patellar ligament forces. Anatomically , the lateral part of patellofemoral joint i.e, Vastus lateralis is more stronger than the medial part of i.e, Vastus medialis oblique. So, any imbalance in the forces will cause patella to shift laterally.

Patellofemoral joint instability:-

As the quadriceps muscle contract the patellofemoral joint is supposed to get stressed. This stress is minimum during full extension because the forces are uplifted by vastus medialis and lateralis giving small contact surface. During initial knee flexion (0-90°) the joint stress increases due to increase in contact surface. Hence, the reason for increased contact pressure is due to decrease in angle of pull between Quadriceps tendon and patellar tendon. As the knee flexion increases beyond 90°, the contact area decreases and stress increases which leads to increased moment arm for quadriceps making patella work efficiently as a pulley.

Stabilizers of patella:-

Quadriceps tendon, patellar tendon, patellotibio ligament and part of extensor retinaculum are known longitudinal and transverse stabilizers. During knee flexion the compressive force stabilizes the patella. Vastus medialis and lateralis are active stabilizers whereas medial and lateral patellofemoral ligament are passive stabilizers that prevents lateral translation of patella.

Pathomechanics

The patella is unstable solely due to increase in quadriceps angle and the causes are; i) Strong vastus lateralis compared to vastus medialis ii) patella alta iii) Tight iliotibial band iv) Genu valgum V)Femoral anteroversion vi) Lateral tibial torsion vii) Pronation of foot viii) laxity of medial retinaculum and shortening of lateral retinaculum.

In older age group:

This group consists of patients more than 40 years of age. The condition is slowly progressive due to natural wear and tear of the bones ultimately leading to osteoarthritis.

In Teenagers :

In this age group, the condition commonly affects the teenager girls who are involved in active sports. The softening of the articular cartilage is due to excessive and uneven pressure on the cartilage due to following;

a) imbalance around knee:

Vastus lateralis component of the quadriceps femoris muscle is more powerful than vastus medialis thus increasing the tendency of patella to track or dislocate laterally thus including undue pressure on lateral facet leading to cartilage softening and breakdown. The onset of VL activation is prior to VMO during step stepping.

b) Static malalignment:

The static measure(Q-angle)is associated with patellofemoral pain syndrome. Q angle is higher in female due to wider pelvis. The increase in Q angle cause stress on entire kinetic chain of lower extremity leading to patellofemoral pain syndrome.

C) Dynamic malalignment:

It is seen due to increased knee abduction of the symptomatic limb which indicates the presence of dynamic valgus position of the knee joint which might be reinforced by an internal rotation of femur and tibia.

d) Hip muscle weakness:

There is internal rotation of femur due to weakness of hip external rotators and abductors i.e, decreased gluteus medius and gluteus maximus muscle strength is related to increased knee valgus.

e) Hamstring tightness and imbalance:
Due to hamstring tightness patient experience increased joint contact force and joint stress force which provides high stress on patella.

Hip abductor weakness

Weight bearing on affected extremity

Contralateral pelvic drop

Ipsilateral trunk lean
(results in**)**

GRF vector passing lateral to the knee joint
(leads to**)**

increased knee valgus

Dyanmic Q angle increases

Increases lateral vector force in patella

Stress on lateral compartment of the patellofemoral joint

Fig:- Pathomechanics Flow Chart

Rehab protocol:-

Protocol	Illustration
1)HAMSTRING STRETCH:- <u>Position and movement:</u> Supine lying. Patient is asked to raise a leg by pulling the towel/ theraband toward themselves while keeping a knee straight. <u>Intervention</u>: Hold the stretch for the count of 10, perform 2 sets of 10 repetitions once a day for 4 week.	

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2)STATIC QUAD/ LEG PRESS:-

Position and movement:- Supine lying. Patients are instructed to push the towel down with the active contraction of it's quadriceps muscle with ankle in dorsiflexion position.

Intervention: Hold the contraction for the count of 10, perform 2 sets of 10 repetitions, once a day for 4 weeks.

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3) CLAM SHELL:

Position and movement: Side lying with knees bent. The patient is asked to position their feet in line with the back and tilt the hip of the top leg forward slightly. The patient is asked to raise the knee and hold it for 5 seconds.

Intervention: Hold for count of 5, 10 repetition, 2 set/day

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4) DONKEY KICK:

Position and movement: Quadruped. The patients are asked to get on quadruped position, keep the affected knee 90° bent, flex the affected side foot and lift knee to hip level, hold the contraction for 5 second and lower the knee without touching the floor and lift again for 10 repetition.

Intervention: 5 second hold, 10 repetition, 2 set a day.

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5)FIRE HYDRANT

Position and movement : Quadruped. On all fours, hands directly under shoulders and knees over hips. Abdominals are engaged. Ask to lift leg up and out maintain 90° of hip flexion and knee flexion. Avoid rotating hips or arching back as you lift the leg. Goal is to lift thigh to level of torso. Foot is flexed the entire time.

Intervention: 5 second hold, 10 repetition, 2 set a day.

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Special test for PFPS:-
Patellar Compresion Test:
Position of patient: Supine lying with the knee flexed 20 degree approximately.

Method:-

The examiner places the web space of his hand just superior to the patella and compressed downward in femoral groove and moved forward and backward. Positive sign: Pain and crepitus.

Patellar Grind Test:
Position of patient: Supine lying with knee flexed. Method: The patella is forced forward and the patient then actively contracts the quadriceps. Positive sign: clark's sign is present when patient experience pain and grinding.

Discussion:-

Hip weakness is a well-documented impairment in females with patellofemoral pain and has been postulated to contribute to abnormal patellofemoral joint kinematics and kinetics.[11] The main finding of this study is to revise the biomechanics, pathomechanics and physical therapy protocols based on Gluteal activation with advanced lateral hip strengthening exercises results in greater pain relief among patellofemoral pain syndrome. Historically, the etiology of patellofemoral pain has been attributed to impairments in quadriceps muscle performance.[10] As such strengthening the quadriceps muscle has been widely advocated as the treatment of choice for patellofemoral pain.[10] However, a study of **Fukuda et al[10]** reported decreased pain and improve pain function in persons receiving hip and knee strengthening compared with quadriceps strengthening alone[10]. Similarly, **Kimberly et al[1]** suggested that compared to initial quadriceps strengthening, initial hip strengthening result in less pain, more strength and better preparation for functional exercises[1].

Therefore, many authors have recently added exercises for the external rotators and abductor muscle to patellofemoral pain syndrome treatment protocols[9,1] due to biomechanical influences of these muscle on femur alignment: a lack of motor control from hip external rotators and abductor muscle would increase femur rotation under patella while standing. The abduction and external rotation is also done by iliotibial band along with tensor fascia lata and some fibers of gluteus maximus which originates from iliac crest and attaches to the lateral patellar retinaculum. Thus, the increase in tension of ITB will therefore have an effect on the lateral retinaculum which causes lateral drift to the position of the patella leading to a maltracking type of syndrome.[39] This also supports that it is needed to work on hip abductor and external rotator muscle because when Gmed is weak the TFL puts more strain on ITB to overwork. Similar way, when Gmax is inhibited it puts strain on ITB because both Gmax and TFL inserts into ITB, that either leads to maltracking syndrome or friction syndrome. This pathological factor is an additional point indicating how working on gluteus is important in case of patellofemoral pain syndrome. The study done by **Rodrigo et al[19]** also reported that hip abductor deficit is greater than the hip adductor torque deficit in the patellofemoral pain syndrome[15]. Another study done by **Thiago et al[9]** demonstrated that hip deficit is associated with excessive dynamic valgus of knee[9].

John D et al.[2] in their study of clinical biomechanics have reported that females with patellofemoral pain syndrome demonstrated delayed onset and shorter duration GMED activation during running compared during sunning compared with females without patellofemoral pain syndrome. This delayed onset was associated with increased hip abduction excursions and later onset time of GMAX was associated with increased hip internal rotation. Along with several studies, this study have also summarized that, Gluteal activation with lateral hip strengthening exercises helps to reduce pain and improve function in patients with patellofemoral pain syndrome.

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