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PATELLOFEMORAL PAIN SYNDROME: CAUSES AND CONSEQUENCES — A NARRATIVE REVIEW

Physiotherapy

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ABSTRACT

Patellofemoral pain syndrome (PFPS) is one of the most prevalent musculoskeletal disorders affecting the knee joint and represents a common cause of anterior knee pain in adolescents, young adults, and physically active individuals. The condition is characterized by retropatellar or peripatellar pain that is aggravated by activities such as running, squatting, stair climbing, jumping, kneeling, and prolonged sitting. Despite its high prevalence, the etiology of PFPS remains complex and multifactorial, involving the interaction of biomechanical, muscular, neuromuscular, proprioceptive, psychological, and behavioral factors. Contributing factors include quadriceps and hip muscle weakness, altered lower-extremity kinematics, dynamic knee valgus, impaired neuromuscular control, proprioceptive deficits, foot and ankle abnormalities, and training errors. Persistent symptoms may lead to significant consequences, including functional limitations, reduced physical activity levels, impaired dynamic balance, decreased quality of life, and psychological distress. Emerging evidence also suggests a potential association between chronic PFPS and the development of patellofemoral osteoarthritis. This narrative review summarizes the current evidence regarding the causes and consequences of PFPS and emphasizes the importance of a comprehensive, multidimensional approach to assessment and rehabilitation. Understanding the underlying mechanisms and long-term implications of PFPS may facilitate the development of effective treatment strategies and improve clinical outcomes.

KEYWORDS

Patellofemoral Pain Syndrome, Neuromuscular Control, Proprioception, Dynamic Balance, Functional Limitation.

INTRODUCTION

Patellofemoral pain syndrome (PFPS) is one of the most common causes of anterior knee pain among adolescents and young adults, accounting for approximately 25% of knee disorders presenting in sports medicine settings (Crossley et al., 2016). The condition is characterized by pain around or behind the patella that is aggravated by activities such as stair climbing, squatting, running, jumping, and prolonged sitting (Willy et al., 2019).

The prevalence of PFPS is particularly high among physically active individuals and females, who may exhibit greater susceptibility because of differences in lower-extremity biomechanics and neuromuscular control (Boling et al., 2010). Although previously considered a benign and self-limiting condition, recent evidence suggests that PFPS often persists for several years and may result in long-term disability (Collins et al., 2013).

PFPS is now recognized as a multifactorial disorder in which several intrinsic and extrinsic factors interact to produce pain and dysfunction (Powers et al., 2017). Understanding these contributing factors is essential for developing effective rehabilitation strategies.

Pathophysiology of PFPS

The articular cartilage of the patella is aneural and therefore cannot directly generate pain. Instead, pain is believed to originate from nociceptive structures surrounding the patellofemoral joint, including the synovium, retinaculum, subchondral bone, infrapatellar fat pad, and periarticular soft tissues (Dye, 2005).

The current load-management model proposes that PFPS develops when patellofemoral joint loading exceeds the capacity of surrounding tissues to tolerate stress (Powers et al., 2017). Repetitive loading during activities such as running and squatting may increase patellofemoral joint stress and contribute to symptom development.

Causes of Patellofemoral Pain Syndrome

Patellofemoral Joint Overload

Increased patellofemoral joint reaction forces occur during activities requiring substantial knee flexion, including squatting, stair climbing, running, and jumping. Excessive or repetitive loading may result in tissue irritation and pain (Powers et al., 2017).

Quadriceps Weakness

Quadriceps weakness is among the most commonly reported impairments in individuals with PFPS. Reduced quadriceps strength may impair shock absorption and increase patellofemoral joint stress (Lankhorst et al., 2012).

Delayed activation of the vastus medialis obliquus relative to the vastus lateralis has also been proposed as a contributing factor, although evidence remains inconsistent (Petersen et al., 2014).

Hip Muscle Dysfunction

Weakness of the hip abductors, extensors, and external rotators has been strongly associated with PFPS. Deficits in these muscles may contribute to excessive hip adduction and femoral internal rotation during weight-bearing activities (Nakagawa et al., 2012).

These biomechanical changes increase lateral patellar loading and may contribute to symptom development (Lack et al., 2015).

Altered Lower Extremity Biomechanics

Abnormal movement patterns frequently observed in PFPS include:

- Dynamic knee valgus
- Excessive femoral internal rotation
- Increased hip adduction
- Contralateral pelvic drop

These biomechanical alterations may increase patellofemoral joint stress during functional activities (Powers, 2010).

Foot and Ankle Factors

Excessive foot pronation, increased rearfoot eversion, and limited ankle dorsiflexion have been associated with PFPS. Distal biomechanical alterations may influence tibial rotation and patellar tracking (Barton et al., 2010).

Neuromuscular Control Deficits

Neuromuscular control refers to the coordinated activation of muscles to maintain joint stability. Individuals with PFPS often demonstrate delayed muscle activation, altered movement patterns, and impaired motor control (Willy et al., 2019).

Deficits in neuromuscular control may lead to abnormal lower-extremity alignment and increased patellofemoral stress.

Proprioceptive Deficits

Proprioception plays a critical role in maintaining joint stability and movement coordination. Studies have demonstrated impaired joint position sense and sensorimotor control in individuals with PFPS, potentially contributing to recurrent faulty movement patterns and functional impairment.

Overuse and Training Errors

Extrinsic factors contributing to PFPS include:

- Sudden increases in training volume
- Excessive running mileage
- Inadequate recovery

- Changes in training surfaces
- Improper footwear

These factors may exceed the adaptive capacity of the patellofemoral joint tissues (Witvrouw et al., 2000).

Psychological Factors

Psychological variables such as fear of movement, pain catastrophizing, anxiety, and reduced self-efficacy have been associated with increased pain and disability in PFPS (Maclachlan et al., 2017).

Psychological factors may influence both symptom severity and treatment outcomes.

Consequences of Patellofemoral Pain Syndrome

Persistent Pain

PFPS frequently becomes chronic. Approximately 40–90% of patients continue to experience symptoms several years after diagnosis (Collins et al., 2013).

Functional Limitations

Pain may impair:

- Stair climbing
- Running
- Squatting
- Jumping
- Kneeling

Functional deficits are commonly assessed using the Kujala Anterior Knee Pain Scale.

Reduced Physical Activity

Persistent pain often leads to decreased participation in physical activity, resulting in deconditioning and reduced muscular strength.

Impaired Dynamic Balance

Several studies have reported deficits in postural control and dynamic balance among individuals with PFPS. Reduced reach distances during balance tasks may contribute to functional limitations.

Muscle Weakness

Chronic pain may lead to quadriceps inhibition and weakness of the hip musculature, further perpetuating abnormal movement patterns.

Altered Movement Patterns

Individuals with PFPS often adopt compensatory movement strategies, including reduced knee flexion and altered gait mechanics.

Psychological Consequences

Chronic symptoms may result in:

- Fear avoidance
- Anxiety
- Reduced confidence
- Lower quality of life

These factors can contribute to long-term disability.

Risk of Patellofemoral Osteoarthritis

Persistent PFPS may increase the risk of future patellofemoral osteoarthritis. Long-term studies suggest that chronic anterior knee pain may precede degenerative changes within the patellofemoral joint (Holden et al., 2018; Utting et al., 2005).

Clinical Implications

Current evidence supports a multimodal rehabilitation approach that includes:

- Hip and quadriceps strengthening
- Neuromuscular control training
- Proprioceptive exercises
- Dynamic balance training
- Movement retraining
- Load management
- Patient education

Exercise therapy remains the cornerstone of treatment (Crossley et al., 2016; Collins et al., 2018).

CONCLUSION

Patellofemoral pain syndrome is a multifactorial condition involving biomechanical, muscular, neuromuscular, proprioceptive, and psychological factors. The consequences extend beyond pain and include functional limitations, impaired balance, reduced physical activity, and diminished quality of life. Understanding these causes and consequences is essential for developing effective rehabilitation strategies and preventing long-term disability.

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