Patellofemoral osteoarthritis: new insights into a neglected disease

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Knee osteoarthritis (OA) is characterized by joint changes, such as cartilage degradation, subchondral sclerosis and osteophyte formation around the margin of the articular surface. The knee joint has three compartments: the medial tibiofemoral, the lateral tibiofemoral and the patellofemoral. Although most epidemiological studies have predominantly examined risk factors for tibiofemoral rather than patellofemoral disease, pain associated with knee OA commonly emanates from the patellofemoral joint. Evaluating the patellofemoral joint using radiography is problematic, which may have led to the paucity of data on patellofemoral OA. However, the advent of magnetic resonance imaging has enabled direct visualization of the entire knee joint and has given new insights into the pathogenesis of joint pathologies, such as OA. This discussion aims to compare and contrast patellofemoral and tibiofemoral OA and, thus, highlight that they are independent entities and, as such, must be examined as separate pathological processes. Moreover, this discussion demonstrates how new imaging modalities are providing insight into the pathogenesis of patellofemoral OA.

Keywords: magnetic resonance imaging, osteoarthritis, patellofemoral, radiography, tibiofemoral

Osteoarthritis (OA) affects more than half the population over the age of 65 years, while OA of the knee affects approximately one in three people over the age of 65 years [1]. OA of the knee is characterized by joint changes, including cartilage degradation, subchondral sclerosis and osteophyte formation around the margin of the articular surface [2], and is a major cause of disability among the elderly [3]. Despite its impact, it is unclear why some individuals are more prone to developing OA, whereas others are able to maintain healthy joint structure with the passage of time [1].

The knee is a tricompartmental joint consisting of the lateral and medial tibiofemoral and patellofemoral compartments [4]. Pain associated with knee OA commonly emanates from the patellofemoral joint, and patellofemoral pain has been linked to significant disability and reduced knee-related quality of life [4,5]. Despite this, epidemiological studies have predominantly examined risk factors for tibiofemoral rather than patellofemoral disease. This paucity of patellofemoral data may be attributable to the lack of reliable, valid and sensitive imaging modalities to assess the patellofemoral compartment. The advent of magnetic resonance imaging (MRI) has now made it possible to directly examine patellofemoral joint structure noninvasively.

The tibiofemoral and patellofemoral compartments have independent anatomical structure and function [6] and it is therefore important to consider pathology at each compartment as separate entities [5], since risk factors for disease may vary between compartments [6]. Hanna and colleagues demonstrated that there was no relationship between articular cartilage loss at the patella and either the medial or lateral tibiofemoral compartments, despite a significant positive association between cartilage loss in the medial and lateral tibiofemoral compartments [7]. These data demonstrate the potential of risk factors for knee OA to vary between anatomical compartments.

The aim of this discussion is to examine how novel imaging of the patellofemoral joint using MRI is providing new insights into both healthy and diseased patellofemoral joint structure. This provides further evidence to support the notion that the patellofemoral and tibiofemoral joints differ and should be examined separately in order to better understand the pathogenesis of knee OA.

Clinical comparison of patellofemoral & tibiofemoral OA

Incidence & prevalence

In the USA, an estimated 15% of the population (40 million people) suffered from arthritis in 1995 [8]. By the year 2020 this figure is expected to increase to 18.2% (59.4 million people) [8]. The knee is frequently affected by OA and patellofemoral disease is common either in isolation or in combination with tibiofemoral OA (**Table 1**) [9].

Table 1. Investigation, diagnosis and treatment of patellofemoral and tibiofemoral osteoarthritis.

Modality	Patellofemoral osteoarthritis	Tibiofemoral osteoarthritis
Symptoms	Pain with activities that increase retropatellar load, such as squatting and stair climbing	Pain with activities, such as long-distance walking, that increase axial joint loads
Signs	Patellofemoral tenderness Joint effusions Muscle atrophy Crepitus	Tenderness over lateral and medial lines Joint effusions Muscle atrophy Crepitus
Radiography	Skyline or lateral radiographic views	Anteroposterior radiographs
Treatment:		
– Conservative	Physiotherapy	Physiotherapy
– Medical	Analgesia, NSAIDs (analgesic ladder)	Analgesia, NSAIDs (analegesic ladder)
– Surgical	Total knee replacement	Joint replacement rare, efforts to reduce force on the patellofemoral joint

NSAID: Nonsteroidal anti-inflammatory drug.

Signs & symptoms

The most common symptom of knee OA is pain that is aggravated by activity [4]. Nevertheless, compartmental pain tends to be task-specific. For instance, patellofemoral pain is more common among activities that increase retropatellar load, such as squatting, rising from the seated position and stair climbing [10]. By contrast, pain in tibiofemoral OA tends to be more common among activities that increase axial joint loads, such as long-distance walking [11].

On clinical examination, the location of tenderness may help diagnose compartmental knee OA. Patellofemoral tenderness, using the grind test, is a reliable sign of patellofemoral OA [12]. Tenderness of the undersurface of the patella, most commonly the lateral facet, is also said to suggest patellofemoral involvement [4,13]. Tenderness over the medial or lateral joint lines has been identified as a reliable sign of tibiofemoral OA when examined by rheumatologists [4,12]. Other clinical signs in knee OA may include bone swelling, joint effusions, crepitus, restricted range of movements and muscle atrophy, but are not distinguished between the patellofemoral and tibiofemoral compartments [14].

Radiographic assessment of patellofemoral & tibiofemoral OA

Radiographic examination of the arthritic joint serves three purposes: to establish the diagnosis and severity of OA; to monitor progression and possible therapeutic responses; and, to look for complications of the disorder or the treatment [15]. The most common features of radiographic OA are joint-space narrowing, the presence of osteophytes and subchondral sclerosis [16]. For both tibiofemoral and patellofemoral OA, radiological joint-space width (JSW), which is considered a surrogate measure of articular cartilage, is the current gold standard for assessing the natural history of radiographic OA [17].

The choice of views to identify radiographic patellofemoral OA has evolved over the last few decades. Previously, radiographic imaging of knee OA was restricted to the tibiofemoral joint, mainly owing to easy accessibility of anteroposterior radiographs [18]. After patellofemoral OA was recognized as a major source of pain and disability, skyline and lateral radiographic views were used to examine the patellofemoral compartment [18]. For the purposes of epidemiological studies, atlases, such as the Osteoarthritis Research Society International Atlas [16], are used to define radiographic disease in each joint by grading the severity of individual radiographic characteristics of disease. In addition to defining disease, these can be used to examine for patella alta (high riding patella) and baja (low riding patella), each of which has been associated with patellar pathologies that cause pain [19,20]. However, little work has been done to standardize patellofemoral views in epidemiological studies and many issues have been raised regarding the reliability and validity of radiographic examination of the patellofemoral compartment [18].

Optimization of radiological assessment of the patellofemoral compartment

Assessment of the severity of OA in the patellofemoral compartment by lateral or skyline views is potentially problematic. The lateral view is often not a true lateral image and is further complicated if patella tilt or subluxation are present [21]. The presence of patella subluxation impedes interpretation of the JSW and, thus, limits the ability to accurately qualify, and subsequently quantify, the presence of joint-space narrowing both cross-sectionally and longitudinally [22]. Similarly, differences in knee flexion may affect radiographic joint-space narrowing in the skyline view, reducing validity of the measure [23]. Indeed, these methodological issues may have contributed to inconsistent findings among studies examining risk factors for the onset and progression of patellofemoral OA [23]. In turn, this may account for the limited data regarding the relationship between risk factors and the natural history of patellofemoral OA.

Management of tibiofemoral & patellofemoral OA

Whilst the use of analgesia and self-management strategies are similar for the involvement of both compartments, there are differences in the physical therapies employed in the management of tibiofemoral and patellofemoral OA.

Physiotherapy tends to be the mainstay of conservative treatment for both patellofemoral and tibiofemoral OA. Although the aims of treatment in both conditions are identical (i.e., maintaining or improving joint range of movement and muscle strength to enable independent function), different strategies to reduce pain and improve function are used to address the extent of involvement of the different compartments. For example, patellofemoral pathology and pain often benefits from reducing laterally directed translation of the patella [24]. This can be achieved via strengthening medial muscles, such as the vastus medialis, while reducing tension in lateral supports, such as the iliotibial band. Taping the patella with a medially directed force may also be beneficial [24–26]. Such techniques are not standard for tibiofemoral pathology, which often responds to exercise in a reduced weight-bearing environment, such as hydrotherapy.

Investigation of the use of orthotic footwear to correct malalignment as a treatment strategy in knee OA has only been examined in tibiofemoral disease [4]. However, the results of these studies have been inconsistent [4].

With respect to surgical management, joint-replacement surgery is the mainstay of therapy for tibiofemoral disease. However, there may also be a role for osteotomy in the presence of significant malalignment or partial joint-replacement surgery. Although total knee-joint replacement may also be used successfully to treat patellofemoral OA in the absence of tibiofemoral OA, some surgeons believe that this sacrifices too much healthy tissue [14,27]. Other less traumatic approaches include a lateral retinacular release, which aims to reduce the tendency for lateral displacement [28]. Although this should theoretically correct some of the forces contributing to disease progression, there is limited published long-term follow-up of this procedure [28]. In an older procedure, the Maquet procedure, the tibial tuberosity is transferred anteriorly to reduce the loading on the patellofemoral joint [29]. Published results in pure populations of subjects with patellofemoral OA are small case series only, with significant loss to follow-up [14]. Anteromedial transfer of the tibial tuberosity, a modification of the Maquet procedure, is more common in the USA [14]. Since this procedure moves the patellofemoral contact area medially, it would be expected to be most effective where disease is isolated to the lateral facet [30]. Patellofemoral replacement may play a role, providing the disease is truly isolated to the patellofemoral compartment, or may be attributed to malalignment, trauma or trochlear dysplasia [14]. The combined assessment of pre- and post-operative patients with imaging and biomechanical studies will enable these therapies to be further refined and assessed.

Recent developments in the assessment of knee-joint OA

Magnetic resonance imaging

It has been recognized that a major limitation in understanding the pathogenesis of knee OA is the indirect manner in which the articular cartilage is examined when using radiography. Previous studies have defined OA based on radiographic changes, although it has been shown that when the first changes of radiological OA are detected, an average of 13% of the cartilage has already been lost [31]. Therefore, radiographic assessment of the knee joint is insensitive to potential early degenerative change. Indeed, radiographic change at the patellofemoral joint, using either lateral or skyline views, correlates poorly with the change in the amount of cartilage present [32].

Use of MRI has expanded the ability to assess the knee joint directly in its entirety. Its use is established in the clinical management of joint disease (**Figure 1**). By measuring structural change, it has recently begun to be developed as a tool for studying disease pathogenesis. For instance, MRI allows the direct visualization of all structures, including articular cartilage, within the knee joint [33]. Recent studies

Figure 1. Sagittal T_1-weighted fat-saturated 3D MRI images showing a normal patella cartilage (Grade 0).

examining the suitability of MRI for assessing the features of OA have demonstrated accurate assessment of cartilage thickness, demonstrated internal cartilage changes and signal abnormalities in subchondral bone and have also shown the morphological changes occurring at cartilage surfaces [33,34]. Moreover, MRI is more sensitive than radiography for the detection of soft-tissue changes in the joint [35]. With MRI, it is possible to directly visualize the soft tissues in the joint and to detect change over time [36]. Thus, structural change in the joint may be quantified and studied noninvasively, in both healthy and arthritic subjects, to examine risk factors for both the onset and progression of disease more sensitively than has been possible previously.

Use of MRI & cartilage defects

Progressive articular cartilage loss has been one of the major hallmarks of OA [15]. The earliest detectable changes in cartilage are irregularities of the articular cartilage surface, observed on MRI as cartilage defects. Defects are independent predictors of cartilage loss [37]. Ding and colleagues evaluated 325 healthy adult subjects at baseline and 2 years later. They found that the prevalence of patella cartilage defects was 1.9% and that, after an average of 2.3 years, the severity of patella cartilage defects increased significantly [38]. This study also found that an increase in cartilage defect scores was associated with cartilage loss in all compartments in both men and women [38]. The severity of cartilage defects also predicts the need for joint replacement in people with knee OA, regardless of the amount or thickness of cartilage present [39].

Use of MRI & cartilage volume

Knee-cartilage volume measurements derived from MRI have been assessed at both the tibiofemoral and patellofemoral compartments, have been shown to have high reproducibility and are a valid indicator of the radiographic grade of both patellofemoral and tibiofemoral OA [40–42]. Additionally, loss of tibial cartilage, as assessed by MRI, correlates with worsening symptoms [43] and predicts the risk for knee replacement [44]. Using MRI, it is possible to measure the change in cartilage volume over short periods of time, both at the tibiofemoral and patellofemoral compartments in healthy [7,45] and arthritic subjects [36,46]. The assessment of cartilage volume in both tibiofemoral and patellofemoral compartments by MRI has enabled investigators to examine risk factors for cartilage loss and cartilage deterioration in all compartments of the knee [7,36].

Use of MRI & cartilage quality

The potential of MRI to image joint structure has not been fully exploited. New sequences and techniques are being developed to be used as markers of disease severity. Although neither of the following two examples have been assessed in longitudinal studies, they show early promise. For example, the transverse relaxation time constant (T2) of articular cartilage has been proposed as a biomarker for OA [47,48]. These maps may identify localized degeneration of articular cartilage [47,49]. Another technique, the delayed gadolinium enhanced MRI of cartilage, shows promise in identifying areas of abnormal cartilage signal based on different levels of glycosaminoglycan, which are thought to mirror cartilage health [49,50]. These and other new techniques have still to be evaluated over time, before they can be used as research tools.

Use of MRI & anatomical definition

The importance of biomechanical factors in the pathogenesis of OA has become better appreciated [51,52]. Consequently, there is increasing interest in how the geometric characteristics of the joint relate to the symptoms and development of disease [20,53–55]. In the past, many unidimensional measures were made from radiographs to approximate joint shape and these correlated with clinical presentation. With increasing understanding of biomechanical factors and forces acting on each individual joint, there have been many attempts to measure more biomechanically important and relevant components of the joint from the images obtained using computed tomography and, more recently, MRI [20,52,54]. These may be used to assess patellar tracking in various degrees of knee flexion [56]. Although these methods show promise, they have not yet elucidated the causes of patellofemoral pain [14]. Longitudinal use of these techniques may be useful in identifying factors associated with the pathogenesis of OA.

Risk factors: similarities & differences between patellofemoral & tibiofemoral OA

Age & gender

Studies have demonstrated consistently that the prevalence of OA increases with age regardless of what definition of OA (clinical or radiographic) is used [5,57]. Moreover, it has been demonstrated consistently that women are more likely to have knee OA than men, as confirmed by a recent meta-analysis [58]. This may be related to a gender difference in the amount of cartilage present: men have substantially more knee cartilage than women [33]. Nevertheless, when cartilage volume or JSW is adjusted for, there is still a female disparity among the elderly with knee OA [59].

McAlindon and colleagues found that in women with symptomatic knee OA, isolated patellofemoral OA was more common than medial tibiofemoral OA and tended to increase with age [5]. For men in the same study, the opposite was observed; medial-tibiofemoral compartment OA was more common than patellofemoral OA and the frequency tended to increase with age. In the Beijing study, the prevalence of both radiographic patellofemoral and tibiofemoral OA was higher in women than in men (25.9% in men vs 35.7% in women for patellofemoral OA; and 21.9% in men vs 41.8% in women for tibiofemoral OA) [60]. These data indicate that although knee OA may be more common in women, the pattern of compartmental involvement may have a gender disparity.

Obesity & body mass index

Obesity is a major risk factor for both patellofemoral and tibiofemoral OA [5,61]. People with a larger body mass index (BMI) are at an increased risk for tibiofemoral OA, with an estimated 40% increase in risk with each 10-lb weight gain [62]. In a population-based twin study of women aged 48–70 years, obesity increased the risk of developing OA at both the tibiofemoral and patellofemoral compartments, with a 9–13% increased risk for OA per kg weight gain [63].

The obesity–OA relationship may vary among the different compartments of the knee joint: MRI may be helpful in clarifying this relationship. For example, it was demonstrated that, although obesity is a strong risk factor for medial tibiofemoral OA, it did not affect the risk of patellofemoral OA [64]. In addition, MRI studies have found that, whereas change in tibial cartilage volume was affected by BMI [36], the association between patella-cartilage volume and BMI was nonsignificant [7]. However, these data were obtained from a group of healthy men and may not be generalizable to women or in the presence of established OA.

Physical activity

The issue of whether physical activity, independent of joint injury, is detrimental to joints is unclear. Sporting activities that excessively load joints may increase the risk of OA, whereas light and moderate activities do not appear to increase this risk [65]. Cross-sectional and longitudinal data in children suggest that cartilage growth responds to stimulation [66]. Children who exercised more had higher tibial-cartilage volumes than their sedentary counterparts, although it is unclear whether the same phenomenon occurs in mature adults [67,68]. However, adult cartilage appears to require loading for health. A study of subjects following recent paraplegia showed increased tibial, femoral and patella cartilage loss over 12 months (9–13%) [69]. Healthy adults lose approximately 2% of their knee articular cartilage per year [70].

Studies also suggest that frequently high levels of physical activity increases the prevalence of patellofemoral OA [71]. However, only small studies have assessed the relationship between physical activity and patella-cartilage change in healthy subjects [7]. It is likely that different types of exercise affect the individual knee compartments differently. A study that compared seven weightlifters with seven sprinters and 14 untrained subjects reported that patella cartilage deformation demonstrated a dose-dependent response, where more intense loading led to greater cartilage deformation [72]. A potential explanation may be that when the knee flexes to 15 degrees at initial contact during walking, the patellofemoral joint reaction force is reportedly 50% of the total body weight, while at 60 degrees knee flexion, the retro-patellar force may have increased to 3.3-times the total body weight [73]. Hence, people who take part in weightlifting or other load-bearing exercises that require deep knee flexion may impart excessive loads across their articular patella cartilage, which may predate degenerative change.

Estrogen-replacement therapy

Estrogen deficiency, as a result of the onset of menopause, has been demonstrated to be associated with rapidly progressive OA [74]. Estrogen-replacement therapy (ERT) is gaining increasing support from observational studies, suggesting a protective effect against tibiofemoral OA [75]. Supportive of this, MRI studies have shown long-term ERT to be positively associated with tibial-cartilage volume [76] and decreased prevalence of knee OA-related subchondral bone lesions [77]. However, there are limited data examining the effect of ERT on patella cartilage and patellofemoral OA. A radiographic study by Cicuttini and colleagues found that premenopausal status was protective for patellofemoral OA but was not associated with tibiofemoral OA [78]. When the effect of long-term ERT use on patellar cartilage volume in postmenopausal women was examined, no effect was seen [79].

Joint injury & meniscectomy

It is well established that major joint injury is a common cause of OA, especially at the knee [80]. Isolated patellofemoral OA is common following patella injury [18]. Previous knee injury increased the risk of all forms of knee OA (odds ratio: 2.0–5.5) [9].

Meniscectomy has been recognized as a strong risk factor for tibiofemoral OA [81]. Studies have shown that there is a sixfold increase of developing tibiofemoral OA following total meniscectomy compared with unoperated controls [82]. Nevertheless, the effects of meniscectomy are not confined to the tibiofemoral compartment alone; increased patellofemoral OA was also demonstrated in a meniscectomy population, after adjusting for age, gender and BMI [83].

Quadriceps weakness

Lower extremity muscle weakness may play an important role in knee OA. Cross-sectional studies have shown that individuals with symptomatic knee OA have weaker quadriceps compared with healthy subjects [84,85]. The majority of studies investigating muscle weakness in knee OA have defined the disease as limited to the tibiofemoral compartment. These studies demonstrated a strong correlation between quadricep weakness and women with tibiofemoral OA [84]. The only study to examine the relationship between quadricep weakness and patellofemoral and tibiofemoral OA showed that quadricep weakness was associated with patellofemoral, tibiofemoral and combined patellofemoral and tibiofemoral OA in both men and women [86]. These findings suggest that muscle weakness may affect knee OA in all compartments. Further longitudinal work is required to determine the relationship between muscle weakness and compartmental knee OA.

Varus–valgus alignment

There is mounting evidence to suggest that the mechanical effects of alignment on load distribution are significantly higher in patients with genu varum or valgum deformities. In a longitudinal study of knee OA, baseline varus alignment increased the risk for the progression of radiographic medial-tibiofemoral OA, whereas valgus alignment increased the risk of lateral tibiofemoral OA progression [87].

At the patellofemoral compartment, increased varus angulation reduces the Q-angle, which, in turn, increases medial-patellofemoral forces. By contrast, increased valgus angulation increases the Q-angle, thus increasing the lateral patellofemoral forces [88]. Moreover, given that women tend to have slightly larger Q-angles than men, secondary to the relatively wider female pelvis, as well as greater femoral anteversion and genu valgum [89,90], biomechanical factors, such as the Q-angle, may contribute toward the female disparity of knee OA. Findings from a longitudinal study examining the effect of alignment on patellofemoral OA demonstrated progression of medial patellofemoral OA in people with genu varum and progression of lateral patellofemoral OA in those with genu valgum [91]. From these findings, it appears that varus–valgus alignment is associated with the progression of both patellofemoral and tibiofemoral OA in a compartment-specific manner.

Conclusion

Knee OA is a major cause of chronic pain and disability among the elderly [15]. Pain associated with knee OA frequently emanates from the patellofemoral joint, which has been linked to greater disability and a reduced quality of life, compared with tibiofemoral OA [4]. The prevalence of OA increases with age for both patellofemoral and tibiofemoral compartments, particularly in women [5]. Modifiable risk factors, such as obesity and quadricep weakness, have been associated with the progression of both tibiofemoral and patellofemoral OA.

Tibiofemoral and patellofemoral compartments have independent anatomical structure and function. Therefore, it is important to consider patellofemoral OA as a separate entity from tibiofemoral disease and to consider risk factors for disease in the context of compartmental OA rather than global knee OA. Recent developments in MRI of the knee have meant that, for the first time, it is possible to examine the patellofemoral joint noninvasively prior to, and in the presence of, OA. Therefore, the advent of MRI as a valid, reliable and sensitive assessment tool for the patellofemoral joint structure offers new opportunities to help better understand patellofemoral pathologies, including OA.

Future perspective

The advent of MRI has provided a noninvasive, reliable, valid and sensitive tool for the assessment of knee joint structures, such as cartilage volume, in both healthy and arthritic states. Features such as cartilage defects found on MRI have been used as predictors to examine the change in knee cartilage in both normal and osteoarthritic knee joints. MRI allows noninvasive visualization of all structures within the knee joint and has subsequently enabled accurate assessment of cartilage thickness, internal cartilage changes, evaluation of the subchondral bone for evidence of signal abnormalities and also shows the morphological changes occurring at cartilage surfaces. With MRI, it is possible to examine knee structure and change in both people with OA and in the prediseased state over short periods of time, which has the potential to optimize preventative and therapeutic strategies for OA in both the patellofemoral and tibiofemoral compartments.

Executive summary

Why is patellofemoral osteoarthritis significant?

- Osteoarthritis (OA) of the knee affects approximately one in three people over the age of 65 years.
- The knee has three compartments: the lateral and medial tibiofemoral and patellofemoral.
- Pain associated with knee OA often originates from the patellofemoral joint, but little is known about patellofemoral OA.
- Patellofemoral pain has been linked to significant disability and reduced knee-related quality of life.
- Different factors are likely to affect the risk of patellofemoral and tibiofemoral OA.

Radiographic assessment

- Skyline and lateral radiographic views are used for radiographic assessment of the patellofemoral compartment.
- These views are not reliable, which may have led to inconsistent findings regarding factors affecting progression of patellofemoral OA.

Magnetic resonance imaging

- Magnetic resonance imaging (MRI) allows for direct noninvasive visualization of all structures within the knee joint and is sensitive to change (e.g., demonstrates small amounts of cartilage loss).
- Therefore, MRI can assess disease progression at both the patellofemoral and tibiofemoral compartments in a valid, reliable and sensitive manner.
- MRI is being more frequently used in epidemiological studies of the tibiofemoral joint. However, MRI also offers new opportunities to help better understand patellofemoral pathologies, including OA.

Risk factors for patellofemoral & tibiofemoral OA

- Prevalence of both tibiofemoral and patellofemoral OA increase with age and women are at a higher risk for the disease than men.
- Risk factors, such as obesity, varus–valgus alignment, quadricep weakness, joint injury and meniscectomy appear to affect the risk of both patellofemoral and tibiofemoral OA.
- From a limited number of studies, estrogen-replacement therapy appears to be more important in the risk of tibiofemoral than patellofemoral OA.
- It is not well established whether physical activity affects the risk for either tibiofemoral or patellofemoral OA. Nevertheless, different activities, such as squatting, are believed to be more important in mediating patellofemoral pathology than tibiofemoral disease.

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