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Patellofemoral osteoarthritis is common in middle-aged people with chronic patellofemoral pain.

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Abstract

Objective: To document the prevalence of radiographic OA in the medial and lateral patellofemoral joint (PFJ) compartments relative to prevalence of tibiofemoral joint (TFJ) OA in middle-aged and older adults with chronic patellofemoral knee pain.

Methods: A convenience sample of 224 people who volunteered for a clinical trial underwent weight-bearing postero-anterior and skyline knee radiographs of their most symptomatic eligible knee. Radiographic severity in the TFJ, and medial and lateral PFJ compartments, was independently graded by two examiners using the Kellgren & Lawrence grading system. Grades 2 and above were considered evidence of OA.

Results: OA was common in this cohort and the most prevalent pattern was combined TFJ and PFJ OA (n=98, 43%), followed by isolated PFJ OA (n=57, 25%). Isolated TFJ OA was rare. Overall, more people demonstrated radiographic OA in the PFJ (n=155, 69%) than the TFJ (n=100, 45%). The majority of people with PFJ OA had OA in both the medial and lateral PFJ compartments (n=98, 63%). Even in people under 50 years, radiographic OA was common (isolated PFJ OA, 26% (n=21); and combined TFJ and PFJ OA, 29% (n=23)). Severity of PFJ OA was similar across males and females.

Conclusion: PFJ OA was highly prevalent, more so than TFJ OA, and even in individuals aged under 50 years. Further research is needed to elucidate the cause and effect relationship between chronic patellofemoral pain and PFJ OA.

Key words: patellofemoral, PFJ, knee, osteoarthritis, OA, anterior knee pain

Significance and innovations (2-4 bullet points)

- Our study fills a gap in knowledge regarding the prevalence of underlying radiographic osteoarthritis in middle-aged and older adults with a clinical diagnosis consistent with chronic patellofemoral pain
- We found that radiographic OA is prevalent, has no specific gender-bias and that the majority of people had signs of OA in one or more PFJ compartments.
- Contrary to popular belief that the lateral PFJ compartment is predominantly at risk of structural damage in patellofemoral pain, we observed that medial PFJ OA was just as common as lateral compartment disease
- Patellofemoral joint OA is likely present in the fourth decade in people who are experiencing patellofemoral joint pain, perhaps as a sequelae of patellofemoral joint problems in earlier years

Introduction

Chronic patellofemoral joint (PFJ) pain is common in adults and occurs more frequently in women. One in six adults who consult a general practitioner for a knee problem will be suspected or diagnosed as having a patellofemoral disorder (1). The annual general practitioner consultation prevalence for PFJ pain is relatively consistent across all adulthood age groups (1), which challenges the widely held notion that it is primarily a disorder of young adults. Chronic PFJ pain is typically characterised by pain that is aggravated by activities that increase joint load, such as squatting, rising from sitting or stair climbing. The condition is traditionally viewed as self-limiting, however increasing research data suggest that complete recovery does not always occur, and that many people continue to report ongoing symptoms (2).

There is speculation that PFJ pain in younger adults could be a precursor to PFJ osteoarthritis (OA) in later years (3). Both conditions share similar biomechanical risk factors (4), including alterations in patella and tibiofemoral alignment, as well as deficiencies in lower limb muscle strength. It is feasible that the elevated PFJ stress accompanying PFJ pain (5), if sustained and combined with reduced patellar cartilage thickness and deformational behaviour (6), could result in characteristic radiographic signs of PFJ OA. It is currently unknown how many middle-aged and older adults with PFJ pain demonstrate concurrent radiographic knee OA. Although a number of studies of people with, or at risk of, knee OA have shown that PFJ OA is common (7, 8), to date no study has evaluated prevalence of PFJ OA in a cohort including people aged under 50 and with a clinical presentation of PFJ pain aggravated by joint loading.

This study analysed the radiographic patterns of OA in middle-aged and older adults with chronic PFJ pain who volunteered to participate in a clinical trial evaluating physiotherapy (9). The primary aim was to document the prevalence of radiographic OA in the medial and lateral PFJ compartment relative to prevalence of tibiofemoral OA.

Patients and Methods

Participants (n=224) were volunteers for a clinical trial evaluating physiotherapy who underwent x-ray evaluation for trial screening (9). Participants were recruited from the community via advertisements and referral from health and medical practitioners. Inclusion criteria were age 40 years and above, anterior or retro-patellar knee pain aggravated by at least two PFJ-loading activities (eg squatting, rising from sitting, stair climbing), average pain >3 (11-point numerical pain scale) during aggravating activities and pain on most days of the past month. Major exclusion criteria included concomitant pain from other knee structures, hip or lumbar spine, current or previous (past 12 months) physiotherapy for knee pain, recent knee injection and body mass index $\geq$ 35 kg/m^2 (9). For bilateral symptoms, the most symptomatic eligible knee was deemed the study knee. Ethics approval was obtained from The University of Melbourne's Human Research Ethics Committee. All participants provided written informed consent.

Symptom evaluation

The Knee injury and Osteoarthritis Outcome Score (KOOS) (10) was used for descriptive purposes. The 5 subscales (pain, symptoms, activities of daily living

function, sport and recreation function and knee-related quality of life) include questions answered using a Likert scale. A normalised score (100 indicating no symptoms to 0 indicating extreme symptoms) was calculated for each subscale.

Radiographic evaluation

All participants underwent radiographic evaluation according to accepted protocols (11). Weight-bearing postero-anterior views of the symptomatic tibiofemoral joint were obtained in a semi-flexed position with feet externally rotated 10°. Weight-bearing skyline views of the PFJ were also obtained with the knees flexed to 30-40°.

Two examiners (RSH and KMC) independently graded digital radiographic images, with discussions held to reach consensus if needed. The Kellgren and Lawrence grading system (12) was used to rate the severity of OA, where grade 0 (none) = no features of OA, grade 1 (doubtful) = doubtful narrowing of joint space and possible osteophytic lipping, grade 2 (mild)= definite osteophytes and possible narrowing of joint space, grade 3 (moderate) = moderate multiple osteophytes, definite narrowing of joint space and possible deformity of bone ends and grade 4 (severe) = large osteophytes, marked narrowing of joint space, severe sclerosis and definite deformity of bone ends. Medial and lateral compartments of the PFJ were graded separately. Inter-rater reliability for grading TFJ and PFJ OA in a subset of 39 participants was substantial, with kappa values ranging from 0.75-0.84.

Data analysis

Data were analysed using IBM SPSS (Version 21.0, Chicago, IL). Descriptive statistics were calculated. Prevalence of radiographic OA was determined for the TFJ

and medial and lateral PFJ compartments by calculating the proportion of the overall cohort with grades ≥ 2 OA within each compartment, as well as 95% confidence intervals (CI) around the proportions. In order to determine whether the presence of OA was less frequent, or if the patterns of radiographic OA differed in younger people with chronic knee pain, participants aged under 50 years were also analysed separately. To determine if severity of PFJ OA differed according to presence or absence of concurrent TFJ OA or according to gender, we determined the relative prevalence of mild (grade 2), moderate (grade 3) and severe (grade 4) PFJ OA within those with combined PFJ and TFJ OA and in those with isolated PFJ OA, as well as within males and females separately. We compared PFJ OA disease severity across subgroups with chi square tests.

Results

Of the 224 participants, 51% were women (n=115). The mean (SD) age, height, weight and body mass index of the sample was 54 (10) years, 1.69 (0.10) m, 79 (15) kg and 27 (4) kg/m^2 respectively. According to KOOS subscales, mean (SD) scores for pain, symptoms (other), activities of daily living function, sports and recreation function and knee-related quality of life were 64 (15), 64 (17), 70 (18), 43 (23) and 43 (18) respectively. Data from the KOOS were unavailable in 10 (4.5%) people.

Sixty seven people (30%, (95% CI 24-36%)) demonstrated no OA (Figure 1). The most prevalent pattern was combined TFJ and PFJ OA (n=98, 44% (95% CI 37-50%)), followed by isolated PFJ OA (n=57, 25% (95% CI 20-31%)). Isolated TFJ OA was evident in only 2 participants (1% (95% CI 0-2%)). Thus, of the two compartments, the PFJ was more frequently affected by OA in this cohort (n=155,

69% (95% CI 63-75%)) compared to the TFJ (n=100, 45% (95% CI 38-51%)). Of the 155 people with PFJ OA, 23 (15% (95% CI 9-20%)) demonstrated OA only in the medial compartment, 34 (22% (95% CI 15-29%)) had OA isolated to the lateral compartment, whilst the vast majority (n=98, 63% (95% CI 56-71%) had OA in both the medial and lateral PFJ compartments. When the subsample of participants aged under 50 years was analysed separately (n=80), the prevalence of isolated radiographic PFJ OA (n=21, 26% (95% CI 17-36%)) and of combined TFJ and PFJ OA (n=23, 29% (95% CI 19-39%)) remained similar to that observed within the entire cohort, although there was a greater proportion with no evidence of OA in any compartment (n=36, 45% (95% CI 34-56%)).

Severity of PFJ OA was more mild in isolated PFJ OA compared to combined TFJ and PFJ disease, in both medial ($p<0.001$) and lateral ($p=0.001$) PFJ compartments (Figure 2). Only 4% (95% CI 0-8%) (n=2) and 14% (95% CI 1-23%) (n=8) of people with isolated PFJ OA demonstrated ≥Grade 3 OA in the medial and lateral PFJ compartments respectively, compared to 43% (95% CI 33-53%, medial and lateral PFJ OA, n=42) of people with combined TFJ and PFJ patterns of disease. Prevalence of each grade of radiographic OA in both the lateral ($p=0.11$) and medial ($p=0.63$) PFJ compartments was similar across genders (Figure 3).

Discussion

This secondary analysis of clinical trial volunteers demonstrates that most (70%) people over 40 years with PFJ pain have radiographic OA. In our cohort, with moderate levels of pain, physical dysfunction and reductions in knee-related quality of life, OA was more frequently observed in the PFJ (either in isolation or in conjunction

with TFJ disease) compared to the TFJ (69% and 45% of cases respectively). In individuals aged under 50 years, radiographic OA prevalence was considerable, with 55% demonstrating PFJ OA in particular. Severity of PFJ OA did not differ across men and women, but was increased when combined with TFJ disease.

The evidence on radiographic patterns of OA is confined to cohorts of people aged over 50 years with established, and/or at risk of, OA. Our study fills a gap by evaluating a cohort aged 40 and above (mean age 54) with chronic PFJ pain. Our finding that PFJ OA, isolated or combined with TFJ OA, is most common is largely consistent with previous literature. In the Framingham population-based sample of people aged over 50 years with non-specific knee pain on most days of the month, isolated PFJ OA (14%) was observed more frequently than isolated TFJ OA (8%) when using magnetic resonance imaging to detect any cartilage damage (7). Similar to our findings, the dominant pattern was one of mixed TFJ and PFJ disease in these individuals (64%). However when OA was defined as full thickness cartilage damage, isolated PFJ OA was the most common pattern, occurring in 24% of participants. Duncan et al (8), used radiographs to image a population-based sample of general practice patients aged over 50 who reported knee pain in the previous year. They observed that the combined patterned of TFJ and PFJ OA was most common (40%), followed by isolated PFJ OA (24%). Similar to our findings, one third of people (32%) had no radiographic sign of OA and isolated TFJ OA was rarely observed (4%).

Lateral PFJ structural damage (relative to medial) is traditionally reported as more likely, given the laterally-directed application of quadriceps muscle force with respect

to the centre of the patellar tendon (the Q angle) in normally aligned limbs. However amongst those with PFJ OA, most people demonstrated disease in both medial and lateral PFJ compartments. Our findings confirm a recent report (13), which observed that medial patellofemoral cartilage damage was at least as prevalent as lateral damage, on magnetic resonance imaging in three large OA cohorts aged over 50 (average age of each cohort in mid-60's). While it is possible that medial PFJ OA may have been related to increased varus knee alignment, with reduced Q angle and increased medial PFJ force, the high prevalence of medial PFJ OA was noted even in the presence of neutral or valgus alignment (13). Future longitudinal research evaluating modifiable biomechanical risk factors (such as patellar and tibiofemoral alignment, foot pronation or increased toe-out during gait etc) and their relationship to incident PFJ OA in the medial and lateral compartments is required to understand the mechanisms behind the high prevalence of medial PFJ OA.

Contemporary management of PFJ pain, such as medial patellar taping, stretching lateral soft tissues and specific medial quadriceps exercises, revolves about strategies that seek to unload the lateral PFJ compartment. Our data showing the high prevalence of medial PFJ OA in people with mixed tibiofemoral and PFJ disease raises questions regarding the application of these otherwise evidenced-based treatments to people with mixed patterns of OA. Our data also challenge the notion that chronic PFJ pain predominantly affects women. We observed no difference in the radiographic patterns of PFJ OA across genders. Our finding that PFJ OA is generally more mild when occurring in isolation from TFJ disease and tends to increase in severity with co-existing TFJ OA suggest that OA changes in chronic PFJ pain might occur first in the PFJ, preceding structural damage in the TFJ. This hypothesis is

supported by a longitudinal study of adults aged 50 years and over with non-specific knee pain that showed baseline radiographic PFJ OA significantly increased the risk of incident TFJ OA (14).

Limitations to our study include its cross-sectional design. Longitudinal studies are needed to explore relationships between incidence and progression of PFJ pain relative to incidence and progression of OA within the PFJ (and the TFJ). Another limitation is our convenience sample of clinical trial volunteers, which resulted in a relatively small sample size that renders our findings hypothesis-generating rather than conclusive. This is particularly relevant for the sub-group analyses where the relatively wide confidence intervals around the proportions indicate some uncertainty about the findings. We also assessed structural OA damage using radiographs, which are relatively insensitive compared to magnetic resonance imaging. Thus some of our cohort with no evidence of radiographic OA may have showed signs of early disease had we used more sensitive imaging measures.

In conclusion, a mixed pattern of PFJ and TFJ OA was most common in this cohort of middle-aged and older adults with chronic PFJ pain. However, the PFJ more frequently displayed radiographic evidence of OA compared to the TFJ. Most people with PFJ OA demonstrated radiographic disease in both the medial and lateral compartments.

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Figure 1: Patterns of radiographic osteoarthritis within the tibiofemoral (TFJ) and patellofemoral (PFJ) joints, reported as a proportion of the total cohort (n=224).

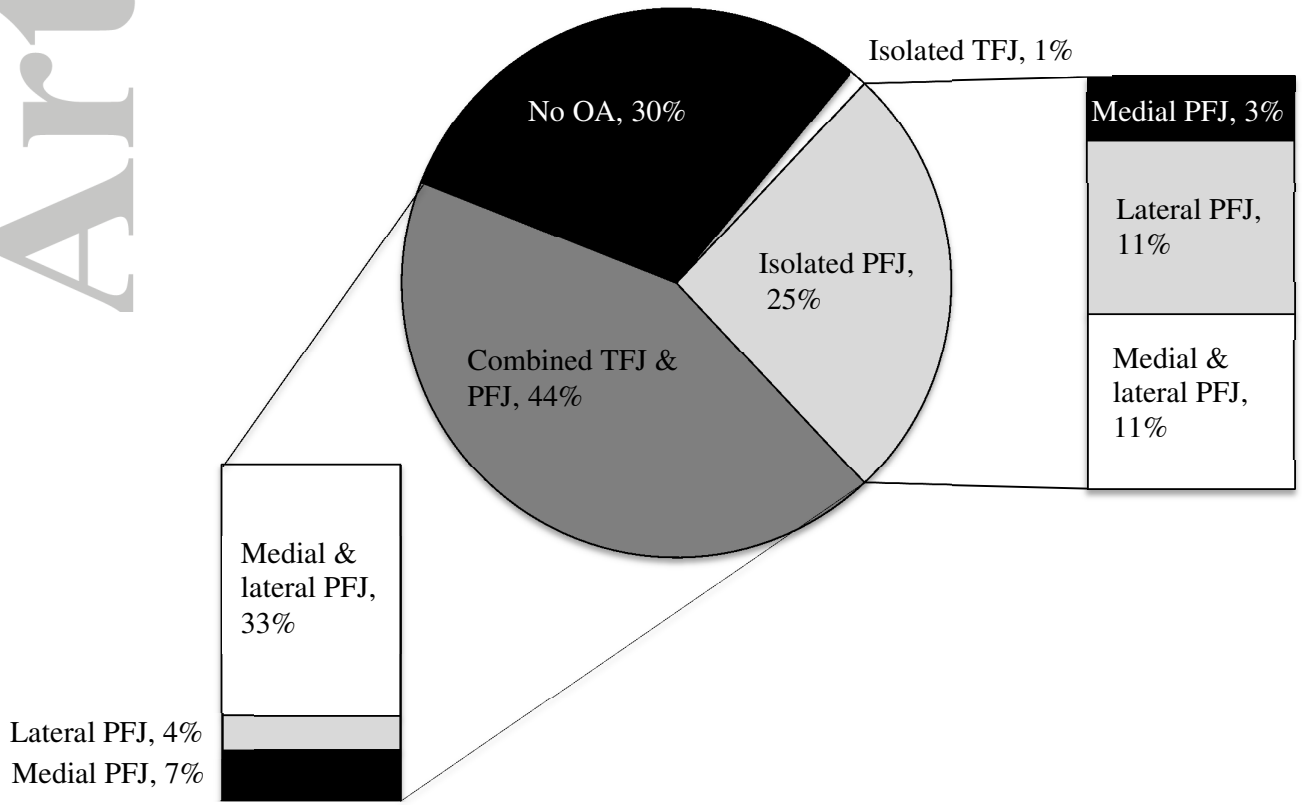

Figure 2: Severity of patellofemoral joint (PFJ) osteoarthritis (OA) in those with isolated PFJ OA (n=57) and in those with combined tibiofemoral joint and PFJ disease (n=98).

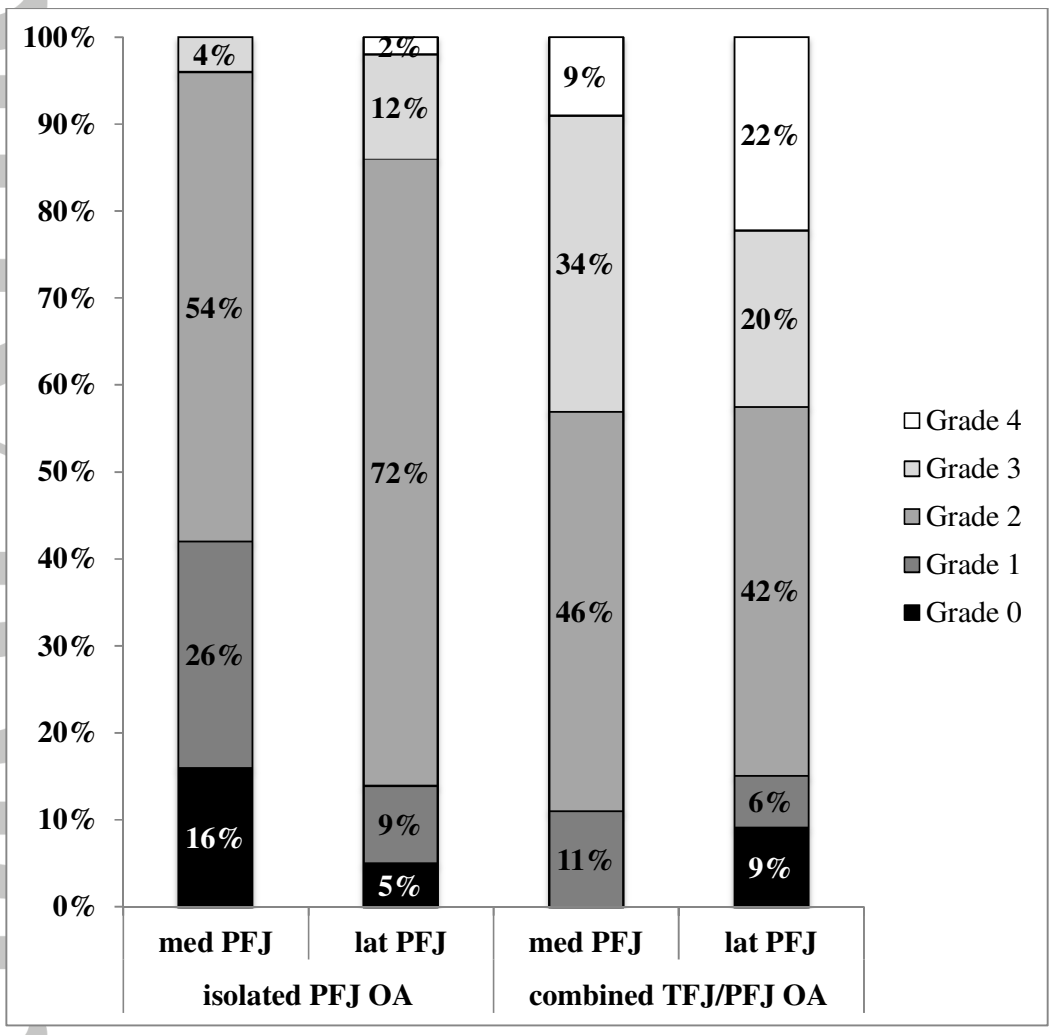

Figure 3. Severity of patellofemoral joint (PFJ) osteoarthritis (OA) across men (n=109) and women (n=115).