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Technical and measurement report

Association of radiographic osteoarthritis, pain on passive movement and knee range of motion: A cross-sectional study

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ABSTRACT

Background: Knee pain is associated with radiographic knee osteoarthritis, but the relationships between physical examination, pain and radiographic features are unclear.
Objective: To examine whether deficits in knee extension or flexion were associated with radiographic severity and pain during clinical examination in persons with knee pain or radiographic features of osteoarthritis.
Design: Cross-sectional data of the Somerset and Avon Survey of Health (SASH) cohort study.
Methods: Participants with knee pain or radiographic features of osteoarthritis were included. We assessed the range of passive knee flexion and extension, pain on movement and Kellgren and Lawrence (K/L) grades. Odds ratios were calculated for the association between range of motion and pain as well as radiographic severity.
Results/findings: Of 1117 participants with a clinical assessment, 805 participants and 1530 knees had complete data and were used for this analysis. Pain and radiographic changes were associated with limited range of motion. In knees with pain on passive movement, extension and flexion were reduced per one grade of K/L by −1.4° (95% CI −2.2 to −0.5) and −1.6° (95% CI −2.8 to −0.4), while in knees without pain the reduction was −0.3° (95% CI -0.6 to −0.1) (extension) and −1.1° (−1.8 to −0.3) (flexion). The interaction of pain with K/L was significant ($p = 0.021$) for extension but not for flexion ($p = 0.333$).
Conclusions: Pain during passive movement, which may be an indicator of reversible soft-tissue changes, e.g., reversible through physical therapy, is independently associated with reduced flexion and extension of the knee.

1. Introduction

Knee pain and functional impairments, such as restricted range of motion (ROM), may limit activities and restrict participation (Theis and Furner, 2011). More than half of the persons with osteoarthritis of the knee who experienced pain have some restrictions in activities of daily living. Sufficient ROM is important for activities of daily living, such as standing up from a chair or walking. Reduced knee ROM is also a predictor of both the incidence of OA and the progression of preexisting cartilage deficits (Shelbourne et al., 2012) and earlier joint replacement (Zeni et al., 2010). Joint ROM can be limited mechanically by changes in bone and cartilage, for instance osteophytes or joint space narrowing that are visible on radiographs (Ersoz and Ergun, 2003; Ozdemir et al., 2006; Holla et al., 2011). In addition to mechanical limitations, joint ROM can be impaired by soft-tissue changes such as shortening of the quadriceps or hamstring muscles, thickening of the joint capsule or increased muscle tone that arises from the viscoelastic properties of soft tissues or the degree of activation of the contractile elements (Simons and Mense, 1998).

Simple clinical tests such as measuring passive ROM are widely used, but it is unclear whether pain during passive movement provides information in addition to the observed radiographic

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changes in people with knee OA. If movement is associated with pain, then pain reduction might improve ROM, assuming that pain is an indicator of reversible soft-tissue changes related to ROM and not merely an indicator of radiographic changes (i.e., cartilage and bone changes). Using cross-sectional data from a prospective cohort study, we determined whether deficits in knee extension or knee flexion were associated with radiographic severity and pain during clinical examination.

2. Methods

2.1. Participants

We used cross-sectional data collected during the follow-up of participants in the Somerset and Avon Survey of Health (SASH) who reported knee pain at any time point, or those with knee Kellgren and Lawrence (K/L) grades >0. SASH was a community-based prospective cohort study with examinations at baseline in 1994/95 and follow-up in 2002/03. Details of the cohort are described elsewhere (Ayis et al., 2007).

This study was conducted with the approval of the local research ethics committees of Somerset and Avon and all participants provided written informed consent.

2.2. Measurements

Experienced health professionals measured maximum passive knee flexion and extension with a goniometer in increments of one degree. Flexion could range from 0° (straight knee), through 90° (right angle), to a maximum of approximately 160°. For extension, 0° indicated a straight knee, negative values an extension deficit, and positive values hyperextension. We also classified knees according to the presence or absence of a flexion deficit (flexion < 110°) (Rowe et al., 2000) or extension deficit (extension < 0°), and we recorded the presence or absence of pain during full passive flexion and extension. Anterior-posterior knee radiographs were read for K/L grades (Kellgren and Lawrence, 1957; Reichenbach et al., 2011). Potential confounders included age, body mass index (BMI), gender, social class (blue versus white collar, i.e., social classes IIIM and V versus social classes I to IIINM), (OPCS, 1991) presence of chondrocalcinosis, and self-reported comorbidities (diabetes, inflammatory arthritis, depression, or stroke) (Eachus et al., 1996; Nuesch et al., 2011).

2.3. Statistical analyses

Using univariable logistic regression, we calculated odds ratios (OR) at the participant level for the association between extension or flexion deficits and age, BMI, and comorbidities, and at the knee level for pain on passive movement, K/L grade, and the presence of chondrocalcinosis. Using univariable linear regression, we calculated the mean difference in continuous end ROM for the association of ROM with categorical variables, including gender, socioeconomic status, chondrocalcinosis, comorbidities, and continuous variables, including age (per 10-year increase) and BMI (per 1-kg/m^2 increase). Robust standard errors were calculated to account for the clustering of knees within participants. We plotted the probabilities of extension or flexion deficits against K/L grades and end-range flexion and extension against K/L grades, separately for knees with and without pain during passive movement. Probabilities and ROM were predicted from uni- and multivariable logistic or linear regression that accounted for the interaction of pain during passive movement with the association between deficits in end ROM and K/L grades. The multivariable analyses were adjusted for age, body mass index, social class, sex and comorbidities. Analyses were restricted to knees with complete data. A sensitivity analysis with multiple imputation showed similar results; we present only the results for knees with complete data available. Stata 12.1 (Stata Corporation, College Station, Texas) was used for all analyses.

3. Results

Of 1117 participants who had a clinical assessment, 891 had radiographic information for at least one knee. Of the 891 participants, 29 had no knee pain or radiographic knee OA and 57 had missing values on at least one covariate, resulting in 805 participants and 1530 knees with complete data. For extension, 521 participants had no pain during passive extension in either knee, 142 had pain in only one knee, 87 had pain in both knees, and 80 had missing information on pain for one knee. For flexion, 427 had no knee pain during passive flexion, 197 had pain on only one side, 139 had pain on both sides, and 80 had missing information on pain during flexion on one side. The characteristics of the 805 participants (1530 knees) with complete data and their univariable associations with ROM in degrees and with extension and flexion deficits are shown in Table 1. An extension deficit was present in 183 knees (12%) and a flexion deficit in 166 knees (11%). Fifty knees were restricted in both flexion and extension. Pain was experienced in 21% of knees during extension and 31% during flexion.

Participants with extension deficits were on average 5.2 years older (95% CI 3.3–7.1) than those without; for flexion the difference in age was 3.7 years (95% CI 1.7–5.7). Pain on passive extension was associated with more than a 3-fold increase in the odds of an extension deficit, whereas pain on passive flexion was associated with more than a 2-fold increase in the odds of a flexion deficit in crude and adjusted analyses. The same pattern was observed in analyses of ROM as a continuous variable. K/L grades were also associated with extension and flexion deficits and corresponding changes in ROM (Table 1, bottom). In the analyses with K/L as a continuous variable, the crude OR for an extension deficit per one grade increase in K/L was 1.63 (95% CI 1.39–1.90), and the adjusted OR was 1.4 (95% CI 1.18–1.66). For flexion deficits, the crude OR was 1.53 (95-CI 1.31–1.78) and the adjusted OR was 1.15 (95% CI 0.96–1.37). Extension decreased by −0.8° (95% CI −1.1 to −0.5) and −0.6° (0.9 to −0.3) per K/L grade in crude and adjusted analyses, while the corresponding decreases in flexion were −3.0° (95% CI −3.7 to −2.3) and −1.3° (−1.9 to −0.6).

Fig. 1 presents the association of extension deficits (left) and flexion deficits (right) with radiographic severity in crude (top) and adjusted (bottom) analyses by presence or absence of pain on passive movement. The probability of having an extension deficit increased somewhat more with higher K/L scores in participants with pain as compared to participants without pain, but corresponding tests of interaction were negative. Differences in slopes between participants with and without pain were even less pronounced for flexion deficits (right). Fig. 2 shows the association of ROM with K/L grades for extension (left) and flexion (right). The difference in the maximum degrees of extension in those with pain on passive extension and those without pain over all K/L grades was 2.3°, with differences ranging from 1.0° (K/L 0) to 4.8° (K/L 4). The differences in the maximum degrees of flexion in those with pain on passive flexion and those without pain over all K/L grades was 4.1°, with differences ranging from 3.4° (K/L 0) to 5.8° (K/L 4). See Fig. 2. The extension decreased more with higher K/L grades in participants with pain during passive extension as compared to participants without, with positive tests of interaction in both crude (top) and adjusted (bottom) analyses. For flexion, we found no evidence of any interaction.