Morphologic MRI findings related to new pain development over a period of 4 years – Data from the Osteoarthritis Initiative

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PURPOSE

Pain from osteoarthritis is one of the top causes of disability-adjusted life years, yet the cause of pain in this prevalent disease is unclear[1,2]. The purpose of this longitudinal study was to identify morphological MRI findings that are correlated with development of new pain over a period of 4 years in the knees of subjects at risk for osteoarthritis (OA).

METHODS

This nested case-control study included 136 subjects aged 45-70 years at risk for knee osteoarthritis from the incidence cohort of the Osteoarthritis Initiative (OAI) database[3], that were followed up for a period of 4 years. The Western Ontario and McMaster Universities (WOMAC) Osteoarthritis Index[4] quantified pain in each subject and was obtained at baseline and at yearly intervals. Both in the case (n=60) and control (n=76) cohorts, subjects had no pain at baseline (WOMAC=0); case subjects developed pain over 4 years (WOMAC≥5), whereas controls were asymptomatic at 4 years (WOMAC=0). The WOMAC pain threshold of ≥5 was chosen based on prior research demonstrating that OAI patients with a WOMAC pain score ≥5 had at least 1 activity with moderate amounts of pain[5]. Knee MRIs were obtained at 3T using identical MR scanners (Trio, Siemens, Erlangen) at 4 different sites at baseline and at 4 years. The following 4 sequences were used, as described in the OAI MR protocol[3]: 1) a sagittal 3-dimensional (3-D) double-echo steady-state (DESS) sequence with water excitation and coronal and axial reformations (echo time [TE] 4.7 msec, repetition time [TR] 16.3 msec, field of view [FOV] 14 cm, slice thickness 0.7 mm, in-plane spatial resolution 0.365 x 0.456 mm^2 , flip angle 25°, bandwidth 185 Hz/pixel); 2) a sagittal 2-dimensional (2-D) intermediate-weighted turbo spin-echo (TSE) sequence with fat suppression (TE 30 msec, TR 3200 msec, FOV 16 cm, slice thickness 3 mm, in-plane spatial resolution 0.357 x 0.511 mm^2 , flip angle 180°, bandwidth 248 Hz/pixel); 3) a coronal 2-D intermediate-weighted TSE sequence (TE 29 msec, TR 3850 msec, FOV 14 cm, slice thickness 3 mm, in-plane spatial resolution 0.365 x 0.456 mm^2 , flip angle 180°, bandwidth 352 Hz/pixel); 4) a coronal 3-D T1-weighted fast low-angle shot sequence with water excitation (TE 7.57 msec, TR 20 msec, FOV 16 cm, slice thickness 1.5 mm, in-plane spatial resolution 0.313 x 0.313 mm^2 , flip angle 12°, bandwidth 130 Hz/pixel). Sequences were analyzed blinded to subject data side by side using WORMS[6] and cartilage lesion scores[7]. Findings at baseline and follow-up, as well as changes in findings, were compared between both groups using logistic regression models and likelihood-ratio statistical tests adjusted for age, gender, BMI, and knee side (left or right).

RESULTS

Baseline findings of medial tibial cartilage pathology (p = 0.004) and medial meniscus body pathology (p = 0.014) were associated with pain. A trend suggested that baseline medial tibia bone marrow edema pattern (p = 0.055) also was associated with pain, but was not statistically significant. No findings at 48 months were significantly associated with pain, but a trend suggested that medial femoral condyle bone marrow edema pattern (p = 0.056) and anterior medial meniscus pathology (p = 0.051) were associated with pain. When evaluating findings that changed from baseline to 4 years, an incident effusion (p = 0.001) and progressive patella cartilage pathology (p = 0.043) were associated with pain (Table 1).

DISCUSSION AND CONCLUSION

Previous studies investigating the relationship between pain and MR findings predominantly have been cross-sectional. Our study benefits from the longitudinal, observational, multicenter design of the OAI database, as well as a compartment-based analysis of MR findings. One limitation of our study is a focus on development of new pain without stratification of severity of pain. Acknowledging this limitation, our results are concordant with the current literature. For bone marrow lesions, the association with pain is unclear in the current literature, as multiple studies have demonstrated a strong association[8], whereas others have shown no association[9]. Our findings of statistically insignificant trends between bone marrow edema patterns and pain are concordant with these prior studies. For cartilage lesions, most studies have shown an association with pain[10]. Our findings confirm a clear relationship for baseline medial tibial cartilage pathology and progressive patella cartilage pathology. For meniscal lesions, studies also have shown varying results[11,12]. Our results demonstrate that baseline lesions of the body of the medial meniscus are associated, but other meniscal lesions are not. Finally, multiple studies have correlated an effusion with pain[13]. Our results support a strong association between pain and an incident effusion. Thus, certain baseline findings in asymptomatic patients may predict which patients at risk for osteoarthritis will develop pain in the future. In addition, certain new or progressinve findings may determine whether osteoarthritis is the cause of new knee pain. Clinically, identification of these findings may help the radiologist to better guide clinical treatment and also potentially to develop strategies to prevent painful osteoarthritis.

	Odds Ratio	P-value
Baseline		
Cartilage lesion - medial tibia	2.72504	0.004
Medial meniscus - body	0.5886535	0.014
Changes		
Incident effusion	12.82568	0.001
Progressive cartilage lesion - patella	2.737536	0.043

Table 1. Significant MR findings at baseline and findings that changed from baseline to 48 months.

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