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Abnormalities identified in the knees of asymptomatic volunteers using peripheral magnetic resonance imaging[1]

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Summary

Objective: To estimate the prevalence of bone and soft tissue abnormalities in asymptomatic knees using peripheral magnetic resonance imaging (pMRI) and to examine the relationship between these abnormalities and Kellgren-Lawrence (K-L) graded X-rays.

Method: Volunteers (20–68 years) with no history of knee pain, injury or bone or joint disease were recruited. Individuals underwent a single MRI scan and radiograph of their non-dominant knee. pMR images were acquired in sagittal plane using a 3-D gradient-echo protocol. Two radiologists graded the presence and severity of cartilage degeneration, osteophytosis, meniscal and ligamentous abnormalities, bone marrow edema and subchondral cysts. X-rays were acquired using a fixed-flexion technique and graded using the K-L scale.

Results: Forty-four individuals, mean age (SD) 41.1 (14.2) years, participated. K-L grading of X-rays revealed 29 individuals were grade 0, 12 were grade 1 and 3 were grade 2. Five individuals showed evidence of cartilage lesions, the femoral trochlea, medial femur and patella being those regions most commonly affected. Twelve individuals (27.3%) showed evidence of osteophytosis, nine of whom did not show evidence on X-ray. Forty-three individuals showed evidence of at least one meniscal abnormality while 27 individuals (61.4%) had abnormalities in at least three of the four regions of the knee.

Conclusion: Our results suggest that osteophytes may be more prevalent in this population than radiographic data suggests due to the limitations of two-dimensional imaging. Meniscal degeneration or tears, a risk factor for knee osteoarthritis, are highly prevalent in asymptomatic individuals with the medial anterior and posterior horns being the most commonly affected regions.

Key words: Magnetic resonance imaging, Asymptomatic knee, Cartilage defect, Meniscal abnormality.

Introduction

Magnetic resonance imaging (MRI) is the gold standard in medical imaging of the knee. It is a reliable technique that has been growing in popularity over the past two decades and allows for non-invasive evaluation of meniscal abnormalities, cartilage lesions and other features of knee osteoarthritis (OA). Clinically, however, plain radiography remains the conventional imaging technique used to diagnose knee OA and monitor disease progression[1]. Unfortunately, the use of plain radiographs limits the evaluation of OA to bony features such as joint space narrowing and osteophyte formation. Thus, the primary advantage of MRI is its ability to identify cartilaginous, bony and soft tissues lesions not visualized on plain radiographs. MRI affords researchers the ability to identify abnormalities which exist in various regions and tissues in the joint in asymptomatic individuals. Meniscal abnormalities in this population have perhaps been the most well studied to date where prevalences ranging from 16–67% have been reported[2–7]. However, the prevalence of abnormalities in other soft tissues including ligaments and articular cartilage has not been well documented making estimates of such abnormalities in osteoarthritic individuals difficult to interpret.

The purpose of this study was to estimate the prevalence of bone and soft tissue abnormalities in the knees of

[1] *Institution*: McMaster University is the institution to which this work should be attributed.

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asymptomatic individuals using peripheral MRI (pMRI) and to examine the relations between these results and Kellgren-Lawrence (K-L) graded radiographs from these same individuals.

Methodology

SUBJECTS

Male and female participants between 20 and 69 years of age were recruited to participate provided they were free of knee pain, had never sustained a knee injury nor been previously diagnosed with a bone or joint disease (i.e., rheumatoid arthritis, osteoporosis, etc.). These healthy volunteers were recruited through advertisements posted in a local medical building and through word of mouth. Each volunteer completed a simple questionnaire which collected demographic data as well as data on exercise and use of medications. Volunteers also consented to have a single X-ray and an MRI scan of his/her non-dominant knee.

RADIOGRAPHY

X-rays were acquired using the fixed-flexion technique[8]. Films were evaluated independently by two radiologists according to the K-L scale for OA[9]. Features considered in this scoring system included the presence and/or severity of osteophytes, joint space narrowing, sclerosis of the bone and deformity of bone ends. Where there was disagreement on the score assigned to a particular X-ray film, the radiologists conferred and the consensus grade assigned was the score used in the results.

PERIPHERAL MRI

MR scans were acquired using an FDA approved 1.0 Tesla pMRI system (OrthOne™, ONI Inc., Wilmington, MA, USA), approved for use in Canada by the Therapeutic Products Directorate of the Canadian Government. Subjects were positioned such that their non-dominant knee was centred within the iso-centre of the magnet. A complete description of this particular MR system can be found in a review of office-based MRI scanners by Shellock and Hollister[10]. To ensure correct patient positioning, a sagittal entry locator scan with a 2-D gradient-echo sequence and an axial entry locator performed with fast spin-echo sequence were conducted. A 3-D gradient-echo scan was acquired in the sagittal plane using the following parameters: TR 60 ms; TE 12.4 ms (or minimum); flip angle 40°; bandwidth 30 kHz; matrix 512 × 256 (frequency × phase); 1 excitation; field of view 150 mm; partition thickness 1.5 mm; 56 to 64 partitions depending on patient size; fat saturation (FS) and radiofrequency spoiling; scan time 15−16 min. Images were viewed in the acquired sagittal plane as well as in the reformatted axial and coronal planes by two musculoskeletal radiologists who independently scored the presence and severity of particular features of each knee including cartilage degeneration, osteophyte formation and the presence of bone marrow edema. Features were graded on a categorical scale as indicated in Table I. In the case that the two radiologists did not agree on a score assigned to a particular feature, both radiologists reviewed the study and a consensus grade was assigned. Radiologists were blinded as to patient name and K-L score. This study was approved by the institutional Research Ethics Board.

Table I
Evaluation template for diagnostic pMRI

Grading of bone and soft tissue features observed on pMRI images	Regions graded
A. Cartilage	
0 = Normal	Medial & lateral femur
1 = Area of low signal intensity extending to cartilage surface on adjacent images	Medial & lateral tibia
2 = Mild cartilage surface irregularity, focal defect <1/2 thickness	Femoral trochlea
3 = Severe surface irregularity or defect >1/2 thickness, <full thickness	Patella
4 = Cartilage defect exposing bone	
B. Subchondral cyst	Medial & lateral femur
0 = Absent	Medial & lateral tibia
1 = Present	Patella
C. Bone marrow edema	
1 = None	Medial & lateral femur
2 = Mild (<1 cm)	Medial & lateral tibia
3 = Moderate (1−2 cm)	Patella
4 = Severe (>2 cm)	
D. Osteophyte	Medial & lateral femur
0 = None	Medial & lateral tibia
1 = Present <0.5 cm in length	Femoral trochlea
2 = Present ≥ 0.5 cm in length	Patella
	Tibial spine
E. Meniscus	Medial anterior horn
0 = Normal	Medial posterior horn
1 = Degeneration (intrasubstance high signal intensity)	Lateral anterior horn
2 = Tear (high signal intensity extending to articular surface)	Lateral posterior horn
F. Ligaments	Anterior cruciate ligament
0 = No tear	Posterior cruciate ligament
1 = Tear	Patellar tendon