



**Distinct Structural Changes Associated with Self-Reported
Knee Injury Among Adults with Incident Knee
Osteoarthritis: Data from the Osteoarthritis Initiative**

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Distinct Structural Changes Associated with Self-Reported Knee Injury Among Adults with Incident Knee Osteoarthritis: Data from the Osteoarthritis Initiative**ABSTRACT**

Purpose: We aimed to characterize the agreement between distinct structural changes on magnetic resonance (MR) imaging and self-reported injury in the 12 months leading to incident common or accelerated knee osteoarthritis (KOA).

Materials and Methods: We conducted a descriptive study using data from baseline and the first 4 annual visits of the Osteoarthritis Initiative. Knees had no radiographic KOA at baseline (Kellgren-Lawrence [KL]<2). We classified 2 groups: 1) accelerated KOA: a knee developed advanced-stage KOA (KL=3 or 4) within 48 months and 2) common KOA: a knee increased in radiographic severity (excluding those with accelerated KOA). Adults were 1:1 matched based on sex. The index visit was when a person met the accelerated or common KOA criteria. We limited our sample to people with MR images and self-reported injury data at index visit and year prior.

Results: Among 226 people, we found fair agreement between self-reported injuries and distinct structural changes ($\kappa = 0.24$ to 0.31). Most distinct structural changes were medial meniscal pathology. No distinct structural changes (e.g., root or radial tears) appeared to differ between adults who reported or did not report an injury; except, all subchondral fractures occurred in adults who developed accelerated KOA and reported an injury.

Conclusions: While there is fair agreement between self-reported knee injuries and distinct structural changes, there is some discordance. Self-reported injury may

Structural Changes in Self-Reported Knee Injury

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3 represent a different construct from distinct structural changes that occur after joint
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5 trauma.
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8 **Keywords:** osteoarthritis; self report; meniscus; knee injuries; magnetic resonance
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For Peer Review

INTRODUCTION

Epidemiological studies of knee osteoarthritis (KOA) often rely on self-reported knee injuries, but it is unclear how these subjective reports relate to observable distinct structural changes caused by trauma (e.g., ligament sprains, meniscal tears) (Driban et al., 2014; Driban et al., 2015). Self-reported injuries are important in assessing how a person interprets an injurious event and are often the most available information (Lovalekar et al., 2017). However, self-reported injury may lead to misclassification of certain types of structural damage and fail to clarify which structural changes from joint trauma are associated with KOA incidence or progression.

It has previously been found that a recent injury is associated with the development of accelerated KOA (Davis et al., 2017b; Driban et al., 2014). Meniscal pathologies, particularly destabilizing tears (e.g., radial or root tears), are associated with an accelerated onset of KOA (Sung et al., 2013), but reliance on self-reported injury data has made it difficult to identify the type of injury sustained. Individuals may be unable to recall an injury in the past year, especially if they did not perceive it as severe (Lovalekar et al., 2017). Additionally, there are individuals who never report an injury and develop accelerated KOA. It is possible that these individuals experienced joint trauma that occurred without a perceived injurious event; however, without imaging this remains unconfirmed. Therefore, we aimed to characterize the agreement between distinct structural changes on magnetic resonance (MR) imaging and self-reported injury in the 12 months leading to incident common or accelerated KOA.

MATERIALS AND METHODS

We conducted a descriptive study using data from baseline and the first 4 annual visits of the Osteoarthritis Initiative (OAI). Knees had no radiographic KOA at baseline (Kellgren-Lawrence [KL] <2). We classified 2 groups: 1) accelerated KOA: a knee developed advanced-stage KOA (KL=3 or 4) within 48 months and 2) common KOA: a knee increased in radiographic severity within 48 months (excluding those with accelerated KOA). Adults were 1:1 matched based on sex (n = 125/group). The index visit was when a person met the accelerated or common KOA criteria. We limited our study sample to people with MR images and self-reported injury data at the index visit and year prior visit.

MR Images

Magnetic resonance (MR) images were acquired annually with one of four identical Siemens Trio 3-Tesla MR systems (Erlangen, Germany) at each clinical site. The two musculoskeletal radiologists (RJW, JWM) performing semi-quantitative scoring were provided all the sequences acquired on each index knee at each visit (e.g., sagittal intermediate-weighted, turbo spin echo, fat-suppressed MR sequence; coronal intermediate-weighted, turbo spine echo, sequence without fat suppression, 3-dimensional dual-echo steady-state sequence). These sequences have been described elsewhere (Peterfy et al., 2008) and the protocol is available online .

Distinct structural changes

Structural Changes in Self-Reported Knee Injury

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Two musculoskeletal radiologists reviewed MR images (RW: 255 cases, JM: 120 cases) to assess the integrity of the cruciate and collateral ligaments, extensor mechanism, and gastrocnemius proximal tendons. The readers scored infrapatellar synovitis, meniscal extrusion (medial and lateral), and bone attrition as normal, mild, moderate, or severe. Meniscal pathology was assessed in 3 regions (anterior, body, posterior) of each meniscus based on the International Society of Arthroscopy, Knee Surgery, and Orthopaedic Sports Medicine meniscal tear classification: normal, degeneration, horizontal, flap horizontal, vertical longitudinal, radial, long radial, morphologic deformity, maceration, complex, or vertical flap tear (Anderson et al., 2011; Antony et al., 2017). Readers had good inter-observer agreement on the presence of each pathology among 25 cases: prevalence-adjusted and bias-adjusted kappa were 0.41 to 0.75, except for the posterior medial meniscus where the PABAK was fair at 0.25 (50% agreement). We defined a distinct structural change as any incident finding that was absent one year prior to the index visit but present at the index visit.

Self-reported injury

At each follow-up visit, participants were asked “Since your last annual visit to the OAI clinic about 12 months ago, have you injured your right knee badly enough to limit your ability to walk for at least two days?” A similar question was asked for the left knee .

Other clinical measures

Structural Changes in Self-Reported Knee Injury

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3 Age, body mass index (BMI), self-reported injury, frequent knee pain, days with limited
4 activity in prior month, overall global rating, and The Western Ontario and McMaster
5 Universities Osteoarthritis Index (WOMAC) pain were acquired at each visit based on a
6 standard protocol.
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Statistical analyses

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19 Descriptive statistics were calculated for the participant demographics and each of the
20 distinct structural changes. Kappa statistics were used to assess the agreement
21 between self-reported injury and distinct structural changes. We evaluated the sample
22 overall and then stratified by those who had accelerated or common KOA. Analyses
23 were performed in SAS Enterprise Guide version 7.15 (Cary, NC).
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Ethical standards

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37 The OAI has been approved and meets all criteria for ethical standards regarding
38 human and animal studies defined in the 1964 Declaration of Helsinki and all
39 amendments made after. Institutional review boards at each OAI clinical site and the
40 OAI coordinating center (University of California, San Francisco) approved the OAI
41 study (IRB #10-00532). All participants provided informed consent prior to participation.
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RESULTS

Structural Changes in Self-Reported Knee Injury

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3 Among 250 people, 226 had complete data with 103 adults with accelerated KOA group
4 (65% female, age=63±8 years, BMI=29.7±4.5 kg/m²) and 123 adults with common KOA
5 (67% female, age=59±9 years, BMI=28.0±4.5 kg/m²).
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10 Table 1 summarizes the distinct structural changes for each group. Among reported
11 injuries in the accelerated KOA group, they were most likely to experience medial
12 meniscal pathology, more than half of which were root or radial tears. Those with
13 accelerated KOA that did not report an injury also experienced mainly medial meniscal
14 pathology, however it was more evenly distributed among specific structural changes.
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16 Individuals with common KOA who either reported or did not report an injury also had a
17 majority medial meniscal pathology.
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27 The most common distinct structural change was medial meniscal pathology. No distinct
28 structural changes (e.g., root or radial tears) appeared to differ between adults who
29 reported or did not report an injury; with an exception that all subchondral fractures
30 occurred in adults who developed accelerated KOA and reported an injury (n=2). Both
31 groups had a high occurrence of meniscal pathology among those who did not report an
32 injury.
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42 There was fair agreement between self-reported injuries and distinct structural changes
43 (kappa = 0.24 to 0.31; Table 2). Among those with accelerated KOA, more than a third
44 of adults without a reported injury had a distinct structural change. In contrast,
45 approximately 70% of adults with common KOA who reported an injury had no distinct
46 structural changes (Table 2).
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DISCUSSION

Knee injuries are known to be a potent risk factor for KOA, particularly for accelerated KOA, and yet the reliance on self-reported injuries hinders clinicians' ability to determine which type of trauma may put an individual at risk for accelerated KOA. Self-reported injuries are often the best method we have for detecting trauma among large populations. While there was fair agreement between self-reported knee injuries and distinct structural changes, there was some discordance. Among adults with accelerated KOA, self-reported injury often underrepresented structural changes. In contrast, adults with common KOA who reported an injury often lacked evidence of new structural changes. The discordance may serve as an important reminder that self-reported injury may represent a unique construct from joint trauma that causes distinct structural changes.

Accelerated KOA individuals were more likely to experience distinct structural changes and not report an injury compared to common KOA, who frequently reported an injury despite having no observable structural changes. This supports our previous findings that accelerated KOA individuals are more likely to progress after a recent injury as well as potentially underreporting an injury when compared to common KOA (Davis et al., 2017b; Driban et al., 2015). Those at risk for accelerated KOA and experiencing greater pain should be monitored closely even if they are not reporting a recent injury (Davis et al., 2017a; Driban et al., 2016). It is possible that these adults experienced a subtle traumatic event that failed to limit their ability to walk but resulted in distinct structural changes. They may also have experienced an injury but felt that they could not limit their walking for two or more days (e.g., a need to keep working) and therefore did not

Structural Changes in Self-Reported Knee Injury

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3 report the event as an injury. It may be beneficial to educate these high-risk patients
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5 about the risk of injury and KOA to help increase awareness about the importance of
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7 injuries and to ensure appropriate reporting.
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11 While we often observed no structural changes among adults with common KOA who
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13 reported an injury it is important to consider the reasons for the discordance. First, the
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15 person may have experienced a significant joint trauma that limited their ability to walk
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17 but the joint recovered prior to the subsequent OAI visit. Alternatively, they may have
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19 perceived a significant injury that limited their walking, but the structural damage was
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21 minor or not at the knee joint. Hence, it is important to consider the value of self-
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23 reported injury data since it may capture injuries that have healed or injuries that the
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25 patient perceived as significant despite minimal structural damage. Researchers may
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27 need to consider their interest in potentially healed injuries and the development of
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29 accelerated KOA.
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35 While this study is an important step in characterizing the structural changes associated
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37 with self-reported knee injuries, we acknowledge that there are limitations beyond those
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39 described above. Although we were able to determine the time frame of an injury in the
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41 year before disease onset, we are unable to discern if the damage is accurately
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43 revealing the injury or if it is due to osteoarthritis progression. However, the availability
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45 of MR images every year has given us the opportunity to identify the changes occurring
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47 in the critical year before progression. With a larger sample size, there may be more
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49 opportunity to further explore the relationship between the distinct structural changes
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51 and the rate of self-reporting.
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Structural Changes in Self-Reported Knee Injury

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3 While there was fair agreement between self-reported injury and distinct structural
4 changes, our results suggest that self-reported injury may represent a different
5 phenomenon from distinct structural changes that occur after joint trauma. Furthermore,
6 a self-reported injury may fail to identify people with incident meniscal injuries; for
7 example, destabilizing meniscal tears (e.g., root or radial tears). Clinicians should be
8 aware that among those at risk for KOA, the lack of a reported injury may not be
9 sufficient in determining if structural changes are affecting the risk of disease onset.
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Structural Changes in Self-Reported Knee Injury

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Structural Changes in Self-Reported Knee Injury

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Table 1. Distinct Structural Changes Stratified by Self-Reported Injuries among Adults with Accelerated and Common Knee Osteoarthritis (KOA)

	Accelerated KOA		Common KOA	
	Reported Injury	No Reported Injury	Reported Injury	No Reported Injury
	n=19	n=30	n=5	n=9
Bone Pathology (Subchondral Fracture or Attrition; n = 10)	6	3	0	1
Lateral Meniscal Pathology (n = 10)	3	6	1	0
Medial Meniscal Pathology (n = 49)	15	22	4	8
Complex*	4	4	2	2
Root/Radial*	8	5	0	1**
Vertical Long, Vertical Flap, Horizontal Flap (or a combination)	1	6	2	4
New Morphologic Deformity or Maceration	2	3	0	1
Progression to Morphologic Deformity or Maceration	0	4	0	0

* With or without other meniscal pathology in another region

** This case was a complex tear that involved the root

Note: lateral meniscal pathology typically involved severe degeneration (morphologic deformity or maceration, 8/10)

Table 2. Fair Agreement Between Distinct Structural Changes and Self-Reported Injury Status in Accelerated Knee Osteoarthritis (AKOA) and Common Knee Osteoarthritis (KOA)

	No Distinct Structural Change		Distinct Structural Change	
	n	%	n	%
Overall (kappa = 0.31)				
No Reported Injury	146	(79%)	39	(21%)
Reported Injury	17	(41%)	24	(59%)
AKOA (kappa=0.28)				
No Reported Injury	48	(62%)	30	(38%)
Reported Injury	6	(24%)	19	(76%)
KOA (kappa = 0.24)				
No Reported Injury	98	(92%)	9	(8%)
Reported Injury	11	(69%)	5	(31%)

Note: Accelerated and common KOA had an overall sample size of 125/group. The data presented here is for those who had complete data (MRI and self-reported injury status).