

Osteoarthritis and Cartilage



Association of baseline knee sagittal dynamic joint stiffness during gait and 2-year patellofemoral cartilage damage worsening in knee osteoarthritis



A.H. Chang [†]*, J.S. Chmiel [‡], O. Almagor [§], A. Guermazi ^{||}, P.V. Prasad [¶], K.C. Moio [†], L. Belisle [§], Y. Zhang [†], K. Hayes [†], L. Sharma [§]

[†] Department of Physical Therapy and Human Movement Sciences, Feinberg School of Medicine, Northwestern University, Chicago, IL, USA

[‡] Department of Preventive Medicine, Feinberg School of Medicine, Northwestern University, Chicago, IL, USA

[§] Department of Medicine, Feinberg School of Medicine, Northwestern University, Chicago, IL, USA

^{||} Quantitative Imaging Center, Department of Radiology, Boston University School of Medicine, Boston, MA, USA

[¶] Department of Radiology, NorthShore University HealthSystem, Evanston, IL, USA

ARTICLE INFO

Article history:

Received 11 April 2016

Accepted 5 October 2016

Keywords:

Knee osteoarthritis
Patellofemoral joint
Magnetic resonance
Imaging
Cartilage
Gait

SUMMARY

Objective: Knee sagittal dynamic joint stiffness (DJS) describes the biomechanical interaction between change in external knee flexion moment and flexion angular excursion during gait. In theory, greater DJS may particularly stress the patellofemoral (PF) compartment and thereby contribute to PF osteoarthritis (OA) worsening. We hypothesized that greater baseline knee sagittal DJS is associated with PF cartilage damage worsening 2 years later.

Methods: Participants all had OA in at least one knee. Knee kinematics and kinetics during gait were recorded using motion capture systems and force plates. Knee sagittal DJS was computed as the slope of the linear regression line for knee flexion moments vs angles during the loading response phase. Knee magnetic resonance imaging (MRI) scans were obtained at baseline and 2 years later. We assessed the association between baseline DJS and baseline-to-2-year PF cartilage damage worsening using logistic regression with generalized estimating equations (GEE).

Results: Our sample had 391 knees (204 persons): mean age 64.2 years (SD 10.0); body mass index (BMI) 28.4 kg/m² (5.7); 76.5% women. Baseline knee sagittal DJS was associated with baseline-to-2-year cartilage damage worsening in the lateral (OR = 5.35, 95% CI: 2.37–12.05) and any PF (OR = 2.99, 95% CI: 1.27–7.04) compartment. Individual components of baseline DJS (i.e., change in knee moment or angle) were not associated with subsequent PF disease worsening.

Conclusion: Capturing the concomitant effect of knee kinetics and kinematics during gait, knee sagittal DJS is a potentially modifiable risk factor for PF disease worsening.

© 2016 Osteoarthritis Research Society International. Published by Elsevier Ltd. All rights reserved.

* Address correspondence and reprint requests to: A.H. Chang, Department of Physical Therapy and Human Movement Sciences, Feinberg School of Medicine, Northwestern University, 645 N. Michigan Ave. #1100, Chicago, IL 60611, USA. Tel: 1-312-908-8273; Fax: 1-312-908-0741.

E-mail addresses: hsini@northwestern.edu (A.H. Chang), jchmiel@northwestern.edu (J.S. Chmiel), o-almagor@northwestern.edu (O. Almagor), guermazi@bu.edu (A. Guermazi), p-prasad2@northwestern.edu (P.V. Prasad), k-moisio@northwestern.edu (K.C. Moio), laura.belisle@northwestern.edu (L. Belisle), y-zhang3@northwestern.edu (Y. Zhang), k-hayes@northwestern.edu (K. Hayes), l-sharma@northwestern.edu (L. Sharma).

Introduction

In knee osteoarthritis (OA), patellofemoral (PF) compartment involvement occurs frequently^{1–3} and is an important source of symptoms^{4–7} associated with knee OA. Despite knowledge concerning the prevalence of PF OA and its substantial impact on pain and physical function, movement parameters influencing PF OA disease course remain largely unknown. PF-predominant OA differs from tibiofemoral (TF)-predominant OA in several aspects, including joint patho-mechanics, factors contributing to disease process, patterns of symptoms and function limitation, and

management strategies⁷. Understanding mechanical factors associated with PF OA disease worsening will help identify targets for compartment-specific interventions to prevent disease worsening.

Alterations in ambulatory mechanics have been linked to the pathogenesis of knee OA⁸, albeit previously studied chiefly in the TF compartment. The loading response phase is the initial part of the gait cycle that immediately follows initial contact, transitioning from double-limb stance to single-limb support, and a critical time period during which the knee absorbs the rapid rise of ground reaction force (GRF). Impaired lower limb mechanics less able to attenuate the abrupt and large loading during this phase have been hypothesized to provoke and accelerate joint damage in knee OA^{9,10}.

Previous work has focused on either joint kinematics or kinetics during gait, rather than examining the concomitant effects. Knee sagittal dynamic joint stiffness (DJS) is the biomechanical interaction between change in the external knee flexion moment and knee flexion joint excursion during gait^{11–13}. DJS is quantified as the slope of the linear regression line of external flexion moments with respect to flexion angles, during the loading response phase of gait¹³ (Fig. 1). Conceptually, DJS is determined by the collective physical properties of all active and passive structures spanning the joint^{12,14}; DJS captures the contributions from both active muscle contraction and passive muscular and capsuloligamentous tension to dynamic angular joint stiffness. During the loading response phase, the knee flexes to dissipate the initial impact of ground force through surrounding active muscles and passive soft tissue structures¹⁵. When the same amount of load is applied to a knee joint that flexes less (i.e., a stiffer and less compliant knee), joint cartilage and bone are likely to sustain more impact^{12,16,17}. Elevated DJS has been associated with greater joint impact, possibly due to lesser limb compliance and reduced shock absorption through a combination of decreased joint excursion and increased joint load^{17,18}.

Gait biomechanical parameters in the sagittal plane, such as knee flexion moment and angle, have been linked to PF mechanical

loading^{19–21} and disease progression²². Capturing the interplay of sagittal knee joint kinetics and kinematics, DJS may serve as a comprehensive indicator of how well the lower limb moderates PF loading. In theory, a greater knee DJS may indicate impaired lower limb control in attenuating loading in the sagittal plane and lead to PF disease worsening. We tested the hypothesis that greater baseline knee sagittal DJS during the loading response phase is associated with baseline-to-2-year PF compartment cartilage damage worsening in persons with knee OA.

Methods

Study sample

In our prospective, longitudinal, observational cohort study of knee OA, the MAK-3 Study (Mechanical Factors in Arthritis of the Knee-Study 3), participants were recruited from the community using advertising in periodicals targeting older persons, neighborhood organizations, letters to members of the registry of the Buehler Center on Aging, Health, and Society at Northwestern University, and via medical center referrals. Inclusion criteria were: definite TF osteophyte presence [Kellgren/Lawrence (K/L) radiographic grade ≥ 2] in one or both knees; and Likert category of at least “a little difficulty” for two or more items in the WOMAC (Western Ontario and McMaster Universities Arthritis Index) physical function scale. Exclusion criteria were: corticosteroid injection within the previous 3 months; history of avascular necrosis, rheumatoid or other inflammatory arthritis, periarticular fracture, Paget’s disease, villonodular synovitis, joint infection, ochronosis, neuropathic arthropathy, acromegaly, hemochromatosis, gout, pseudogout, osteopetrosis, or meniscectomy; or exclusion criteria for magnetic resonance imaging (MRI). Approval was obtained from the Institutional Review Boards of Northwestern University and NorthShore University HealthSystem Evanston Hospital. All participants provided written consents.

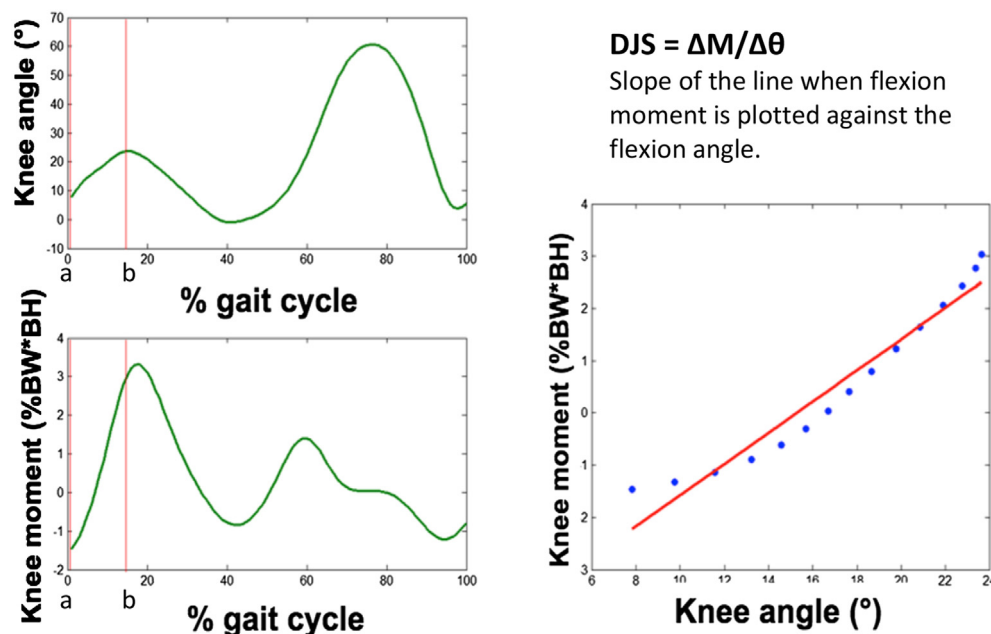


Fig. 1. The graph in the upper left corner illustrates the knee flexion angle during the gait cycle, where the x-axis is the % of gait cycle and the y-axis is the knee flexion angle. The graph in the lower left corner is the external knee flexion moment during the gait cycle, where the x-axis is the % of gait cycle and the y-axis is the knee flexion moment (external flexion moment is in the positive direction). As shown in the plot on the right, each knee angle data point is plotted against that of the corresponding knee moment from the time at peak external knee extension moment (Line a) to the time at maximal knee flexion angle (Line b) during the loading response phase. Knee sagittal DJS is the slope of the linear regression line.

Download English Version:

<https://daneshyari.com/en/article/5669470>

Download Persian Version:

<https://daneshyari.com/article/5669470>

[Daneshyari.com](https://daneshyari.com)