TITLE: ALTERED KNEE LOADING IN PATIENTS WITH LATERAL KNEE OA WHILE ASCENDING AND DESCENDINS STAIRS - CASE STUDIES

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Purpose

Subjects with knee osteoarthritis (OA) often complain first of pain during weight-bearing activities involving bending of the knee, as climbing or descending stairs. Indications of lower external flexion moments (KFM) and lower external adduction moments (KAM) during stair ascent and descent although no significant differences were found for KAM. This study presents case studies of subjects with lateral knee OA in which medial and lateral knee contact forces (KCF), accounting for the combined effect of intersegmental, musculotendon and ligament forces, are calculated while stair ascending and descending. We hypothesize that subjects with lateral knee OA will present reduced loading on the lateral compartment trying to decrease the pain, particularly during descending stairs.

Methods

Four patients with knee OA at lateral compartment (mean age of 66.5±5.4 and BMI of 28.0±4.3 kg/m2) were recruited. Patient classification was based on Magnetic Resonance Imaging (MRI) demonstrating articular cartilage degeneration, subchondral BMLs and presence of osteophytes (Table 1). Hip and Knee disability and Osteoarthritis Outcome Score questionnaires assessed knee and hip pain. Nine healthy subjects, with no signs of knee OA as determined using MRI or complaint of pain, have also participated (mean age of 49.7±13.2 and BMI of 27.4±3.7 kg/m2).

Motion analysis was performed while ascending and descending a staircase consisting of seven steps at self-selected speed. A 10-camera 3D motion capture system (Vicon) synchronized with four force platforms (embedded in the middle of the staircase) recorded the 3D position of 34 reflective markers according to an extended Helen Hayes protocol, at 100 Hz and measured ground reaction forces at 1,000 Hz (Kistler).

A multi-body right knee model with 6 DoF for each tibiofemoral and patellofemoral joints was used. The 3D model consisted of 14 ligament bundles as nonlinear elastic springs. Cartilage contact pressures and forces were computed using an elastic foundation model. The knee model was incorporated into a generic multibody lower extremity musculoskeletal model that includes 44 muscle-tendon units. An enhanced static optimization routine was used to calculate the muscle forces. KCF were normalized to body weight (BW).

Results

Patients with lateral knee OA reduced first peaks KFM and KAM while ascending stairs (Figure 1). Decreased first peak KCF were found at the lateral (0.807±0.127 xBW) and medial (1.712±0.499 xBW) compartments (Table 2). However, during the second half of the stance phase, these patients showed higher KCF on both compartments. For descending stairs (Figure 2), reduced peak KFM but increased KAM were observed during the first peak. A clear reduction of lateral compartment KCF compared to controls was found, except at the first peak.

Conclusions

Our hypothesis that subjects lateral knee OA would present reduced peak loading on the lateral compartment during stair negotiation is confirmed. During stair ascent, patients with lateral knee OA indeed presented reduced KCF in the lateral compartment during first half of the stance phase while ascending stairs due to reduced KFM. However, during the second half of the stance phase, elevated KCF were found approximating peak loading during the first half of the stance phase in control subjects. This despite the decrease in KFM and similar KAM. This discrepancy supports the idea that external moments are not a one by one indicator of the knee joint loading. During stair descent, pronounced reduction of the lateral compartment loading was found, in agreement with the increased KAM and reduced KFM. During stair descent, higher lateral compartment loading was found in both control and OA subjects compared to stair ascent. This finding therefore confirms stair descent to be a more demanding task for the lateral compartment of the tibiofemoral joint. In future work it is intended to increase the number of patients, include medial OA patients and to assess different strategies in stair negotiation.

TABLES

Table 1 - Classification of the patients.

		Lateral OA			
Leg		Right		Left	
Compartment		MC	LC	MC	LC
OA score	Cartilage	0.5	1.5	0.5	0.75
	BML	0.5	1	0.5	0.75
	Osteophyte	0.75	2	0.5	1.25
	Total	1.75	4.5	1.5	2.75
HOOS		97.2 (3.2)			
KOOS		57.7 (12.1)			

Table 2 - Peak contact forces during stance phase in control, medial and lateral knee OA groups while ascending and descending stairs.

	CONTROL		LATERAL OA	
	MC	**LC**	**MC**	**LC**
Ascending Stairs				
P 1	2.399±0.246	1.356±0.513	1.712±0.499	0.807±0.127
P 2	2.032±0.217	0.899±0.371	2.352±0.401	1.319±0.220
Descending Stairs				
P 1	2.014±0.490	1.284±0.410	2.478±0.562	1.339±0.415
P 2	2.112±0.330	1.900±0.567	1.834±0.550	1.284±0.524

MC and LC correspond to medial and lateral compartments, respectively.

FIGURES

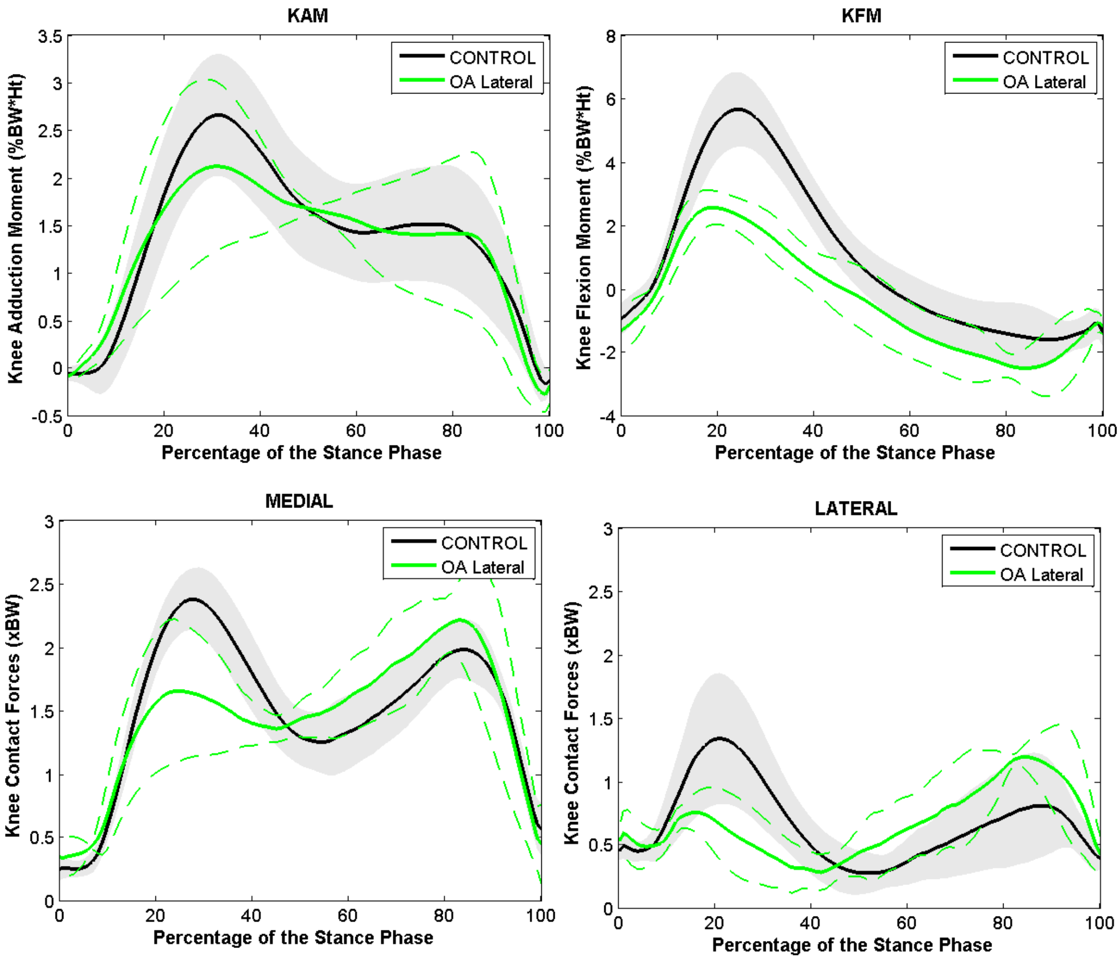

Figure 1 - Average KAM and KFM, and KCF on medial and lateral compartments during stance phase while **ascending stairs.**

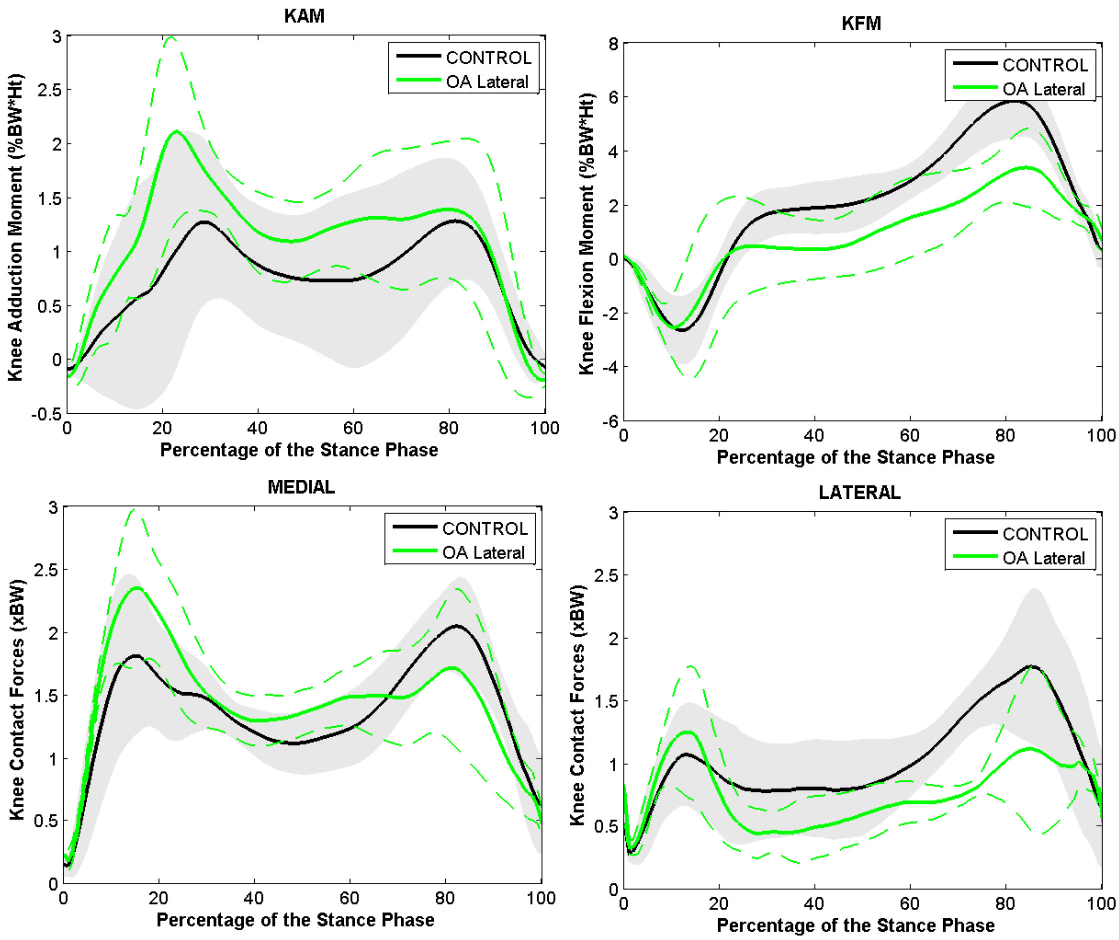

Figure 2 - Average KAM and KFM, and KCF on medial and lateral compartments during stance phase while **descending stairs.**