

Knee contact forces during gait in post-traumatic versus non-traumatic early stage osteoarthritis patients

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Summary

About 25% of patients with early stage knee osteoarthritis (KOA) progress fast and will become in need of a knee replacement surgery.[1] As previous joint trauma 1) alters intra-articular joint mechanics, and 2) is a risk factor for fast progressing osteoarthritis,[2] higher knee joint contact forces (KCF) could be expected in a post-traumatic early KOA group when compared to non-traumatic peers. In this study, we evaluated KCF during gait in 17 and 14 KOA patients of both groups, respectively. Results revealed no significant differences in peak KCF, suggesting that KOA progression cannot be explained through gait alterations at an early stage of the disease.

Introduction

KOA is a multifactorial degenerative joint disease that can be classified in different subgroups, with different disease onset mechanisms, such as non-traumatic (NTOA) and post-traumatic KOA (PTOA). PTOA has been suggested as an important risk factor for fast progressing KOA [2] and for affecting the entire joint, whereas NTOA will mostly affect the medial compartment.[3] Comparing pathomechanical risk factors at an early stage in both subgroups, could help reveal progression differences between them at a later stage and inform therapeutic interventions.[4] As such, the aim of this study was to explore if KCF are higher in a PTOA group compared to a NTOA group.

Methods

Data of a NTOA cohort (n=14, 7 men; 74.96kg±14.19kg; 1.71m±0.09m; 58±4years; KOOS pain 78±14) and a PTOA cohort (n=17, 11 men; 74.65kg±13.12kg; 1.72m±0.07m; 42±11years; KOOS pain 91±8) with early symptomatic KOA was analyzed for this cross-sectional study. Early KOA is defined by knee pain, joint line tenderness or crepitus and a Kellgren and Lawrence grading <2 on X-ray imaging. The PTOA group underwent ACL reconstruction with a hamstring autograft (>5 years ago), the NTOA group had no major preceding trauma. All patients performed walking trials overground, barefoot at a self-selected speed. The examined side was the knee with ACL reconstruction (PTOA) or the clinically most affected knee (NTOA).

Ground reaction forces and marker trajectories (plug-in gait model) were recorded with a Vicon motion capture system. Surface electromyography was used to measure muscle activation of 10 major muscle groups of the legs. These signals inform the biomechanical model. All data was processed and filtered via the OpenSim JAM workflow [5] KCF were calculated (EMG-informed approach). Two peaks

of KCF can be distinguished during the stance phase of normal gait. Independent samples t-tests were used to compare the results between a NTOA and a PTOA population.

Results and Discussion

There were no differences detected in peak values (Table 1), which suggests a more detailed investigation of KCF is necessary through the entire gait cycle. Also, walking at self-selected speed could be insufficiently demanding to highlight group differences in knee pathomechanics. The NTOA group walked significantly faster than the PTOA group although expressing non-significant lower contact forces.

Table 1: Mean (SD) of peak KCF data for the PTOA and the NTOA population. TKCF = total knee contact forces, MKCF = medial knee contact forces, LKCF = lateral knee contact forces, BW = Body Weight.

Peak 1	PTOA (n=17)	NTOA (n=14)	p
TKCF (Nm/BW)	4.00 (0.55)	3.70 (0.55)	0.1522
MKCF (Nm/BW)	1.89 (0.48)	1.79 (0.53)	0.5985
LKCF (Nm/BW)	2.27 (0.51)	2.11 (0.55)	0.4192
Peak 2			
TKCF (Nm/BW)	4.33 (0.65)	4.07 (0.72)	0.3238
MKCF (Nm/BW)	2.05 (0.67)	1.88 (0.59)	0.4959
LKCF (Nm/BW)	2.32 (0.59)	2.23 (0.81)	0.7214
Gait Speed (m/s)	1.17 (0.11)	1.31 (0.16)	0.0113

Conclusions

Peak KCF are not different in early PTOA and early NTOA. Possibly, no biomechanical differences can be seen between these 2 subgroups in the early stages of disease. However, KCF should be investigated more in detail and more challenging tasks such as walking at higher speed or stair ambulation may be needed to reveal differences.

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References

- [1] Amiri P et al (2023) *Knee*, **41**: 245–256
- [2] Driban JB et al (2014) *Art Care Res*, **66**,11: 1673-1679
- [3] Stein V et al (2012) *Rheumatol Int*, **32**, 5: 1197-1208
- [4] Luyten FP et al (2018) *Semin Arthritis Rheum*, **47**, 4: 457-463
- [5] Smith C et al (2014) *J Knee Surg*, **29**,2: 99-106