TOE OUT GAIT AND REDUCTION OF KNEE OSTEOARTHRITIS PAIN

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INTRODUCTION

Osteoarthritis (OA) commonly affects the knee joint. The medial compartment is affected 2.5 times more than the lateral [1,2]. During stance phase, an adduction moment acts on the knee that is thought to increase compression in the medial compartment. Individuals with knee OA often walk with a toe-out gait, which seems to reduce pain during weight-bearing. In toe-out gait, the leg is externally rotated with the toe angled laterally to line of progression.

The common explanation for this pain reduction reasons that toeing out moves centre of pressure laterally, orienting the ground reaction force (GRF) so that it passes through the knee joint. This would reduce the moment arm of GRF in the frontal plane, reducing knee adduction moment and medial compartment compression. However, this mechanism would not produce a reduction of adduction moment in early stance when the centre of pressure is under the heel.

This study suggests another mechanism Toeing-out rotates the anatomy of the knee and transforms a portion of the adduction moment into a knee flexion moment, thus reducing the compression on the medial compartment.

METHODS

Prior to corrective surgery (high tibial osteotomy), gait analysis was performed on 125 patients (98 males; mean age=46.8 yrs) with knee joint OA primarily affecting the medial compartment. Patients walked at a self-selected speed while three-dimensional kinetic and kinematic data were collected bilaterally. The inverse dynamic method calculated resultant knee moments in both laboratory-fixed and the tibia-fixed frames of reference. Patient progression coincided with the lab x-axis. The perpendicular distance from GRF line of action to knee joint centre (moment arm) was also calculated in each frame.

RESULTS

The moment arms and moments experienced in the lab-fixed and tibia-fixed frames of references are shown in Figure 1. With no toe-out angle, these frames would be coincident. Figure 1 shows that by toeing out an average of 10.6° on the affected limb, the flexion-extension moment arm and moment are increased in the tibia-fixed frame and the adduction-abduction moment arm and moments are reduced.

Table 1 shows a comparison of the peaks values of adduction and flexion moment arms and moments for the affected and unaffected limbs.

CONCLUSIONS

Toeing-out has been shown to rotate the anatomy of the knee such that a portion of the knee adduction moment is transformed into a flexion moment. Flexion moments are carried by the musculature of the knee, thereby reducing the compressive loading in the medial compartment. Such a reduction of medial compartment loading could be responsible for the reported pain relief experienced by patients with OA of the knee during walking gait.

REFERENCES

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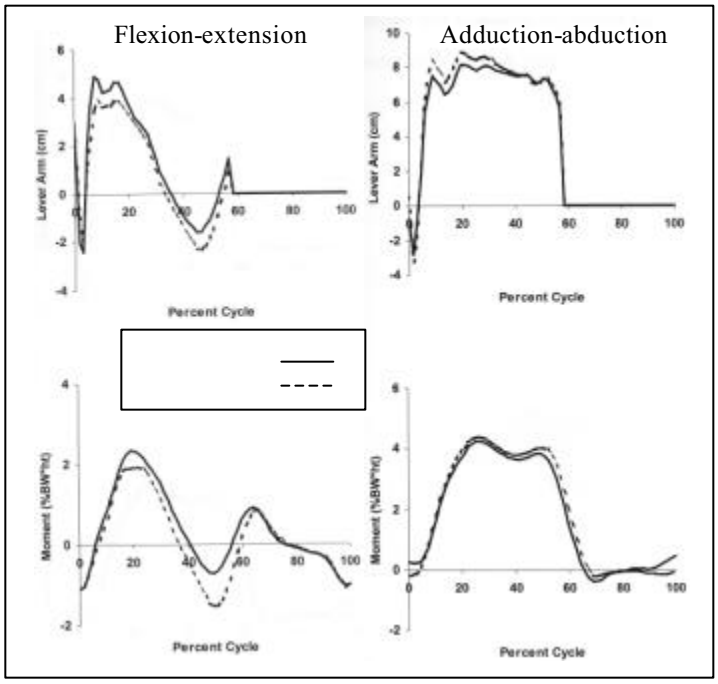

Figure 1: Flexion (left) and adduction (right) moment arms (top) and moments (bottom) in the lab-fixed (dashed line) and tibia-fixed (solid line) reference frames.

Table 1: Mean (SD) peak adduction moment (AM), peak extension moment (EM), peak flexion moment (FM), peak frontal moment arm (FPL), peak sagittal extension moment arm (SPEL), peak sagittal flexion moment (SPFL) and toe-out angle (TOE). Note that the flexion and extension moments and moment arms are increased in the tibial frame for the affected knee, while the adduction moment and moment arm are reduced.

	Laboratory Frame of Reference							Tibia Frame of Reference						
	A.M	E.M	F.M	FPL	SPEL	SPFL	Toe	A.M	E.M	F.M	FPL	SPEL	SPFL	Toe
Affected	3.07	2.18	1.72	6.17	4.55	2.01	10.6	2.94	2.24	1.96	5.80	4.68	3.58	n/a
	(1.0)	(1.3)	(0.7)	(2.1)	(3.4)	(1.8)	(6.5)	(0.9)	(1.3)	(1.0)	(2.0)	(3.5)	(1.9)	
Unaffected	2.72	2.55	1.91	5.43	4.65	1.64	12.6	2.59	2.56	2.15	5.11	4.70	2.97	n/a
	(0.9)	(1.4)	(0.8)	(1.6)	(3.4)	(1.9)	(8.3)	(0.9)	(1.4)	(0.9)	(1.5)	(3.5)	(1.9)	