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Baseline varus deformity is associated with increased joint loading and pain of non-operated knee two years after unilateral total knee arthroplasty

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ABSTRACT

Background: The goals of this study were (1) to document the gait pattern of patients with unilateral knee osteoarthritis (OA), (2) to determine the knee adduction moment (KAM) changes in the non-operated knee, and (3) to identify the predictors of change in KAM in the non-operated knee.
Methods: The study recruited 23 patients with advanced unilateral knee OA. The preoperative Kellgren–Lawrence (KL) grade of the non-operated knee was one or two; non-operated knee pain, rated using a numeric rating scale (NRS), was less than three out of 10 points. We used a commercial gait analysis system to evaluate kinetics and kinematics. Radiological and gait measurements at the two-year follow-up were compared with baseline data.
Results: The preoperative asymmetrical gait cycle characterized by elongation of the stance phase of the non-operated knee became symmetrical after TKA. The average KAM of the non-operated knee increased ($P = 0.010$) and it was best predicted by the baseline mechanical axis of the non-operated knee. If the baseline mechanical axis was varus four degrees or above (varus group), the average KAM increased by 0.64 (% body weight × height, $P = 0.015$), while for varus less than four degrees (non-varus group), KAM was unchanged. The KL grade was increased in the varus group ($P = 0.020$) but it was unchanged in the non-varus group. Average pain NRS score was also higher ($P = 0.044$) in the varus group.
Conclusions: Close follow-up is necessary for patients with a baseline varus deformity of the non-operated knee because of the higher possibility of developing pain, subsequent arthritis and increased joint loading of the non-operated knee.
Level of evidence: III, retrospective cohort study.

1. Introduction

Arthroplasty surgeons often encounter patients with unilateral advanced knee osteoarthritis (OA) [1,2]. In these cases, total knee arthroplasty (TKA) can be performed for the arthritic knee, while the less-affected contralateral knee is treated conservatively. Clinicians often consider the fate of the non-operated knee, because the OA often progresses, requiring subsequent TKA within a few years [3–5].

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The fate of the non-operated knee in unilateral knee OA is generally the progression of symptomatic OA, which is seen in about 33% of patients at two years, 49.2% at five years, and 80% after 12 years [2,6,7]. However, little is known of the fate of the remnant knee after TKA. Several authors have reported that the chance of subsequent TKA is five to 47%, depending on the risk factors [6,8–11] and believe that the altered joint loading of the non-operated limb could also lead to progression of OA [3–5,11].

As the functional performance after unilateral TKA can be predicted from the non-operated knee [12], it is important to understand the biomechanical changes in this specific situation. However, the natural history of the non-operated knee and the biomechanical changes are poorly understood. This information may help clinicians with patient counseling and planning.

To date, knee adduction moment (KAM) has been recognized as a good clinical surrogate for medial joint loading [13,14]. It is associated with future cartilage loss, symptoms of arthritis and associated with implant durability after TKA [5,13–18]. KAM is also recognized as a stable marker for medial joint loading [19]. It showed no change in the two-year follow-up study of patients with early arthritis [19]. Therefore, evaluating the change of KAM in the non-operated knee after unilateral TKA allows us to objectively evaluate the effect of unilateral TKA biomechanically on the opposite knee. In this study, we used a commercial gait analysis system to evaluate the KAM changes two years after unilateral TKA.

The goals of this study were (1) to document the gait patterns of unilateral knee OA patients, (2) to determine the KAM changes in the non-operated knee, and (3) to identify the predictors of change in KAM in the non-operated knee. The authors hypothesized that unilateral TKA would provide a unique biomechanical environment for the non-operated knee and it may change the KAM of the non-operated knee as the biomechanics of the operated knee changes. We also hypothesized that the KAM of the non-operated knee can be predicted by baseline radiologic or biomechanical data.

2. Materials and methods

Data were prospectively collected from 92 female patients with unilateral advanced OA who had undergone unilateral TKA. Only women were included to remove the confounding effect of sex in gait interpretation [20,21]. In particular the KAM, the main variable of the study, was reported to be higher in females and it could be a possible confounding factor [20,21]. Unilateral knee OA was defined as follows: (1) at the time of TKA, the Kellgren–Lawrence (KL) grade of the non-operated knee was one or two (both the patellofemoral and tibiofemoral compartments); and (2) the non-operated knee pain quantified using a numeric rating scale (NRS) was less than three out of 10 points during daily activities. We excluded 69 subjects for the following reasons: (1) neuromuscular involvement of the lower extremities or spine problems that limited the activities of daily living (n = 16); (2) knee arthritis other than degenerative arthritis, such as inflammatory arthritis or traumatic arthritis (n = 14); (3) follow-up loss or refusal to participate in the two-year follow-up gait analysis (n = 13); (4) hip or ankle arthritis on radiography (n = 12); (5) traumatic meniscus tear of the non-operated limb during follow-up (n = 6); (6) any prior bony surgery, such as a tibial osteotomy in the lower extremity (n = 5); and (7) postoperative complications (n = 3). Ultimately, 23 women who underwent unilateral TKA and had no walking disability were included in the analysis. The result of unilateral TKA was measured with The Western Ontario and McMaster Universities Arthritis Index (WOMAC) and Hospital for Special Surgery score (HSS) and it was successful (Table 1) [22]. Radiological and gait measurements at the two-year follow-up after TKA were compared with the baseline preoperative data. The pain NRS score of the non-operated knee was evaluated and the response to the question “Did your non-operated knee function change after the unilateral TKA?” was evaluated using a five-point Likert scale: 1, definitely got worse; 2, got worse; 3, stayed the same; 4, improved; and 5, definitely improved.

Table 1
Clinical outcomes and demographic data.

	Preop (n = 23)	Postop (n = 23)	*P*
	Mean (SD)	Mean (SD)	
Age (years)	67.1 (5.7)	69.1 (5.7)	<**0.001**
Height (cm)	152.5 (4.1)	152.3 (4.1)	**0.367**
Weight (kg)	62.4 (9.4)	62.9 (7.5)	**0.480**
HSS	77.1 (12.7)	91.3 (3.7)	<**0.001**
WOMAC Pain	4.7 (4.1)	1.1 (1.3)	<**0.001**
WOMAC Stiffness	2.8 (2.1)	0.8 (1.2)	<**0.001**
WOMAC Physical function	28.3 (12.2)	11.5 (4.2)	<**0.001**
WOMAC total	35.9 (17.1)	13.4 (5.6)	<**0.001**
Average Pain VAS score of non-operated knee	0.73	1.64	**0.013**
KL grade of operated knee	Gr 3: 3, Gr 4: 20	N/A	N/A
KL grade of non-operated knee	Gr 1: 10, Gr 2: 13	Gr 1: 9, Gr 2: 9, Gr 3: 4, Gr 4: 1	**0.035**

HSS, Hospital for Special Surgery score; KL, Kellgren–Lawrence; SD, standard deviation; VAS, visual analog scale; WOMAC, The Western Ontario and McMaster Universities Arthritis Index. Bold text indicates statistical significance.

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