Patient with Anterior Knee Pain After Total Knee Arthroplasty Show Altered 3D Knee Kinematics: Case Control Study

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INTRODUCTION:

About 8% of total knee arthroplasty (TKA) patients report anterior knee pain after surgery. Once known causes of anterior knee pain such as infection, implant loosening, or rotational error have been ruled out, it is often difficult to understand the source of symptoms and how to manage them. Since altered knee kinematics has been associated with patient symptoms in populations with other knee pathologies, the aim of this study is to compare 3D knee kinematics during gait of painful TKA patients to an asymptomatic (AS) TKA group and a control group. We hypothesised that the painful TKA group would exhibit kinematic characteristics previously reported in patients diagnosed with patellofemoral (PF) pain syndrome such as, dynamic flexion contracture, functional valgus, or an externally rotated tibia in regards to the femur.

METHODS:

Nineteen painful TKA patients, reporting a pain level higher than 6 out 20 on the Western Ontario and McMaster Universities Arthritis Index (WOMAC) pain scale, calculated from the Knee Injury Osteoarthritis Outcome Scale (KOOS), and 20 asymptomatic TKA patients were included in this study. The same posterior-stabilized knee implant combined with patella resurfacing was done for all patients. A clinical and radiological work up was done at a mean follow up of two years post-surgery for both TKA groups to exclude those with previously reported known causes of pain (in example: loosening, malrotation, infection, and clinical instability). Seventeen healthy participants were also recruited to form a control group. Each participant underwent a 3D knee kinematic assessment during treadmill walking and filled out the KOOS as a patient reported outcome measure. A power analysis established that 17 patients per group were needed to measure a difference of 4° in flexion during the gait loading phase between the two TKA groups (α=0.05 and β=0.2). Both Student T-test and ANCOVA, with age and BMI as co-factors, with a P-value set at 0.05 were used to compare groups.

RESULTS:

Patient demographics and KOOS scores are presented in Table 1. Computed tomography (CT) scan evaluation revealed for the painful TKA group a neutral mean combined tibial and femoral component rotation (1.4°±7.0° of internal rotation), while the AS TKA group was externally rotated (7.3°±6.1°) ($P<0.01$). There was no evidence of infection, aseptic loosening, or abnormal instability. Painful TKA group adopted a stiff knee gait characterized by an absence of flexion movement during the loading phase of the gait cycle with maximum loading flexion reaching 14.1°±5.7° for the painful group and 18.0°±6.6° for AS group $P<0.05$. Interestingly, both TKA groups showed lower flexion movement during loading and swing phase compared to the control group $P<0.01$ (see * in Figure 1). The painful TKA group also demonstrated a mean neutral functional lower-limb alignment during stance phase compared to the AS TKA group that exhibited a slight varus functional alignment (4.1°) ($P<0.05$). Painful TKA group presented a valgus functional alignment compared to AS TKA group during terminal stance phase and push off phase ($P<0.05$) (see Figure 2).

DISCUSSION AND CONCLUSION:

Patient reported outcomes confirmed poorer results for the painful TKA patients in all sub-scales of the KOOS (pain, symptoms, function, and quality of life) compared to both the control group and the AS TKA group. Based on AS group CT scan evaluation, results of the present study support previous reports stating that excessive implant external malrotation is well tolerated by patients. Stiff knee gait characterized by a lack of flexion movement to absorb body weight during loading was previously reported in patients with PF pain syndrome. It was suggested that patient might adopt this strategy to reduce pain since the loading phase requires a quadriceps eccentric contraction while increasing knee flexion, and therefore, increasing significantly PF loads. The valgus functional lower-limb alignment in the painful TKA group during terminal stance could help explain symptoms. Indeed, a valgus functional lower-limb alignment is known to increase the Quadriceps angle and lateralize the patella, which increases PF stresses.

Kinematic assessment showed that although neither TKA group fully restored normal gait patterns, the painful TKA group show adaptive gait strategy to limit symptoms, and show functional frontal plane alignment differences providing new insight on origin of symptoms. Future studies should assess if addressing the valgus functional alignment in painful TKA patients through conservative treatments can help reduce symptoms.

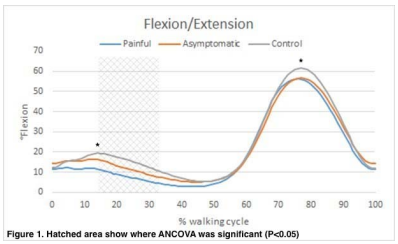

Figure 1. Hatched area show where ANCOVA was significant (P<0.05)

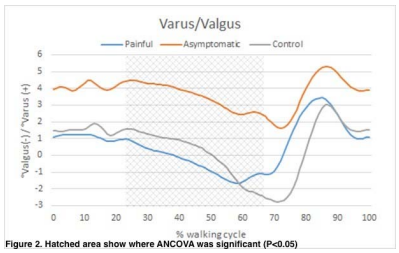

Figure 2. Hatched area show where ANCOVA was significant (P<0.05)

Parameters	Asymptomatic Mean(SD)	Painful Mean(SD)	T-Test P	Control Mean(SD)	ANCOVA P
n (subjects/knees)	20/24	19/21		17/17	
Sex (%)					
Woman	54.2	57.1	N.S	35.3	N.S
Man	45.8	42.9	N.S	64.7	N.S
Age (year)	69.9 (7.9)	65.0 (8.3)	P<0.05*	56.8 (8.1)	P<0.001*
BMI (Kg/m²)	28.3 (3.6)	31.6 (5.3)	P<0.05*	26.0 (3.8)	P<0.01*
Walking pace (m/s)	0.7 (0.2)	0.8 (0.3)	N.S	0.7 (0.3)	N.S
Time from surgery (year)	2.1 (0.3)	2.0 (0.4)	N.S	N/A	
Questionnaires					
KOOS pain	90.0 (11.2)	59.5 (17.7)	P<0.001*	93.1 (15.1)	P<0.001*
KOOS symptom	84.4 (16.0)	62.1 (21.1)	P<0.001*	91.7 (11.6)	P<0.001*
KOOS ADL	90.0 (10.3)	60.9 (16.3)	P<0.001*	94.0 (14.7)	P<0.001*
KOOS sport	55.0 (23.2)	23.3 (19.1)	P<0.001*	87.2 (22.3)	P<0.001*
KOOS QoL	82.3 (21.1)	43.5 (29.3)	P<0.001*	86.7 (24.4)	P<0.001*
Implant malrotation					
Tibial rotation (°)	7.8 (5.4)	0.8 (6.8)	P<0.001*	N/A	
Woman	7.4 (6.8)	-2.6 (4.1)	P<0.01*	N/A	
Man	8.3 (3.6)	2.5 (7.6)	P<0.05*	N/A	
Femoral rotation (°)	-0.5 (2.3)	-2.1 (2.6)	N.S	N/A	
Woman	0.7 (1.8)	-0.5 (2.6)	N.S	N/A	
Man	-1.8 (2.3)	-3.0 (2.2)	N.S	N/A	
Combined rotation (°)	7.3 (6.1)	-1.4 (7.0)	P<0.001*	N/A	
Woman	8.1 (7.6)	-2.9 (4.1)	P<0.01*	N/A	
Man	6.6 (4.1)	-0.5 (8.4)	P<0.05*	N/A	

Table 1: Group' characteristics N/A: Not Applicable, N.S: Not significant (P > 0,05) For implant malrotation : negative vule means excessive internal rotation and positive value means excessive external rotation in regards to normal values.