



# Valgus Patients Would Benefit More Than Varus Patients From Total Knee Arthroplasty

James P Waddell<sup>1</sup>, Mehdi Moayedfar<sup>2,\*</sup> and Mahmoud Jabalameli<sup>2</sup>

<sup>1</sup>Division of Orthopaedic Surgery, Department of Surgery, St Michael's Hospital, University of Toronto, Toronto, Canada

<sup>2</sup>Bone and Joint Reconstruction Research Center, Shafa Orthopedic Hospital, Iran University of Medical Sciences, Tehran, Iran

\*Corresponding author: Shafa Orthopedic Hospital, Baharestan Sq., Tehran, Iran. Tel: +98-2133542000-8. Fax: +98-2133542020, Email: moayedfar.m@gmail.com

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## Abstract

**Background:** There is no consensus regarding the effect of the type of deformities (valgus or varus) on the functional outcome of total knee arthroplasty (TKA). We aimed to compare the TKA outcome in varus and valgus patients to find whether different angulations of the knee could affect the functional outcome of the TKA.

**Methods:** In total, 55 valgus and 53 varus osteoarthritic knees with matched age, gender, BMI, tibiofemoral angle, comorbidities, type of prosthesis, and follow-up duration were included in the study. The mean follow-up of patients was  $4.5 \pm 1.7$  years. The knee society score (KSS) was calculated for each knee at the latest follow-up. In addition, the western Ontario and McMaster Universities arthritis index (WOMAC) was assessed for each patient several times during the study in order to monitor the course of treatment.

**Results:** The total KSS was significantly higher in varus knees than in valgus knees, with the values of  $82.80 \pm 10.16$  versus  $78.61 \pm 10.7$ , respectively ( $P = 0.023$ ). Varus patients had a significantly better preoperative WOMAC index than valgus patients (with a score of  $51.2 \pm 4.05$  vs.  $42.21 \pm 4.12$ ) ( $P = 0.012$ ). At the final follow-up, varus patients still had superior WOMAC although this difference was not statistically significant ( $P = 0.722$ ). Interestingly, the WOMAC change in the first and final evaluations was significantly different in the two study groups, with 22.06 in varus and 30.14 in valgus patients ( $P < 0.001$ ).

**Conclusions:** According to our results, the type of deformity could affect the long-term TKA outcome. In this regard, valgus patients would benefit more than varus patients from this surgery.

**Keywords:** Varus, Valgus, Total Knee Arthroplasty, Outcome

## 1. Background

Total knee arthroplasty (TKA) has been established as a reliable therapeutic approach for pain relief, modification of lower limbs lengthening, and functional recovery of arthritic knees (1). Several parameters including preoperative, perioperative, and postoperative factors may affect patients' satisfaction and knee functional outcome following TKA. Factors such as age, sex, BMI, and some radiographic characteristics of patients including anatomical tibiofemoral features are considered as the preoperative determinants of the TKA outcome. Tourniquet time, cutting thickness of femoral and tibial components, patellar thickness before and after resurfacing, etc. are considered the perioperative determinants and factors including anatomical tibiofemoral alignment, tibial component alignment, patellar tracking, the range of motion, etc. are known as the postoperative determinants of TKA result (2-4).

Inward and outward angulations of the distal segment

of a bone or joint, called 'varus' and 'valgus', respectively, may also be considered as the preoperative determinants of the TKA outcome. In spite of the acknowledged effect of postoperative mechanical axis of the knee and surrounding soft tissue structures on the functional outcome of TKA (5), the effect of the type of deformity (valgus or varus) on the functional outcome of TKA is not well understood and more evidence is needed to better evaluate the effect of valgus and varus deformity on the TKA outcome. Hence, we aimed to compare the TKA outcome in patients with valgus and varus deformities in order to find if different angulations of the knee could affect the functional outcome of the TKA.

## 2. Methods

In a retrospective study, performed at St. Michael's hospital in Toronto between 2005 and 2013, 122 knees from 115 patients with varus and valgus knee disorders were included in this investigation. In order to reduce the effect of

clinico-demographic differences on the final outcome, we tried to match the patients according to age, gender, BMI, tibiofemoral angle, comorbidities, type of prosthesis, and follow-up duration. Advanced osteoarthritis was present in all included knees.

All radiographic evaluations were performed with weight-bearing radiographs and 45° merchant views, and the assessment of the anatomical ‘tibiofemoral angle’ was defined as the angle between the longitudinal axis of the femur and tibia. The knee deformities were categorized according to the preoperative anatomical tibiofemoral angle as valgus (angle > 10°), neutral (angle between 0° and 10° valgus), and varus (angle < 0°). All patients who had undergone TKA for confirmed valgus or varus deformity were included in the study. Loss of follow-up led to the exclusion of seven patients who refused to take part in postoperative follow-up sessions. Finally, 55 valgus and 53 varus knees were included in the study. The mean age of the patients was 64.9 ± 10.9 for the varus group and 65 ± 12.9 for the valgus group. The mean follow-up of patients was 4.5 ± 1.7 years. The demographic characteristics of patients are presented in detail in [Table 1](#). The baseline demographic characteristics of the patients were not significantly different in valgus and varus groups ([Table 1](#)).

The knee society score (KSS) for each knee and the western Ontario and McMaster Universities arthritis index (WOMAC) for each patient were assessed and analyzed ([www.orthopaedicscore.com](http://www.orthopaedicscore.com)). Since WOMAC can be used to monitor the course of the disease or to determine the effectiveness of anti-rheumatic medications, we evaluated it several times during the course of the study. However, the KSS was evaluated in the final follow-up session. The flow chart of the WOMAC index evaluation is shown in [Figure 1](#).

This study was approved by the institutional review board of our hospital and written consent was obtained from each patient for inclusion in the study.

### 2.1. Surgical Technique

The cruciate-retaining cemented prosthesis (Scorpio) was implemented in all patients without patella resurfacing. The medial parapatellar approach was also used in all patients. Intramedullary and extramedullary guides were used for femoral and tibial bony cuts, respectively, in both groups. All the surgeries were performed by a single surgeon.

### 2.2. Statistical Analysis

Statistical analysis was performed using IBM SPSS version 21 for windows. central tendency and variability for numeric variables were measured using mean and standard deviation, respectively. An independent *t*-test was used for the comparison of the KSS between varus and valgus groups. ANCOVA was used for the evaluation of the

WOMAC results between the two study groups, with treatment as a factor and baseline as a covariate. *P* value < 0.05 was considered significant.

## 3. Results

In total, 46 patients in the varus group suffered from unilateral and seven patients suffered from bilateral deformity. In addition, 52 and three patients suffered from unilateral and bilateral valgus disorders, respectively.

The KSS was evaluated in the final follow-up session for the patients who were still in contact. In this regard, 47 patients with valgus and 42 patients with varus deformity were evaluated, which included 51 and 48 knees, respectively.

In order to perform the KSS assessment, the variables of each knee such as alignment after TKA, pain walking, pain stairs, medial/lateral instability, anterior/posterior instability, and flexion contracture were evaluated. The alignment was measured using X-ray. Medial/lateral instability was measured in full extension, and anteroposterior instability was measured at 90 degrees.

Our results demonstrated a statistically significant difference between the two study groups based on the KSS variable. In this regard, the mean scores of pain walking and pain stairs were significantly higher in the varus group than in the valgus group of the knees ( $P \leq 0.001$  and  $P = 0.008$ , respectively). The flexion variable as part of a range of motion was significantly superior in the valgus group, as well ( $P = 0.037$ ). Moreover, medial/lateral instability and anterior/posterior instability were superior in varus and valgus knees, respectively, although they were not statistically significant ( $P = 0.438$  and  $P = 0.32$ , respectively). The total KSS was significantly higher in varus knees than in valgus knees, with 82.80 ± 10.16 versus 78.61 ± 10.7, respectively ( $P = 0.023$ ) ([Table 2](#)).

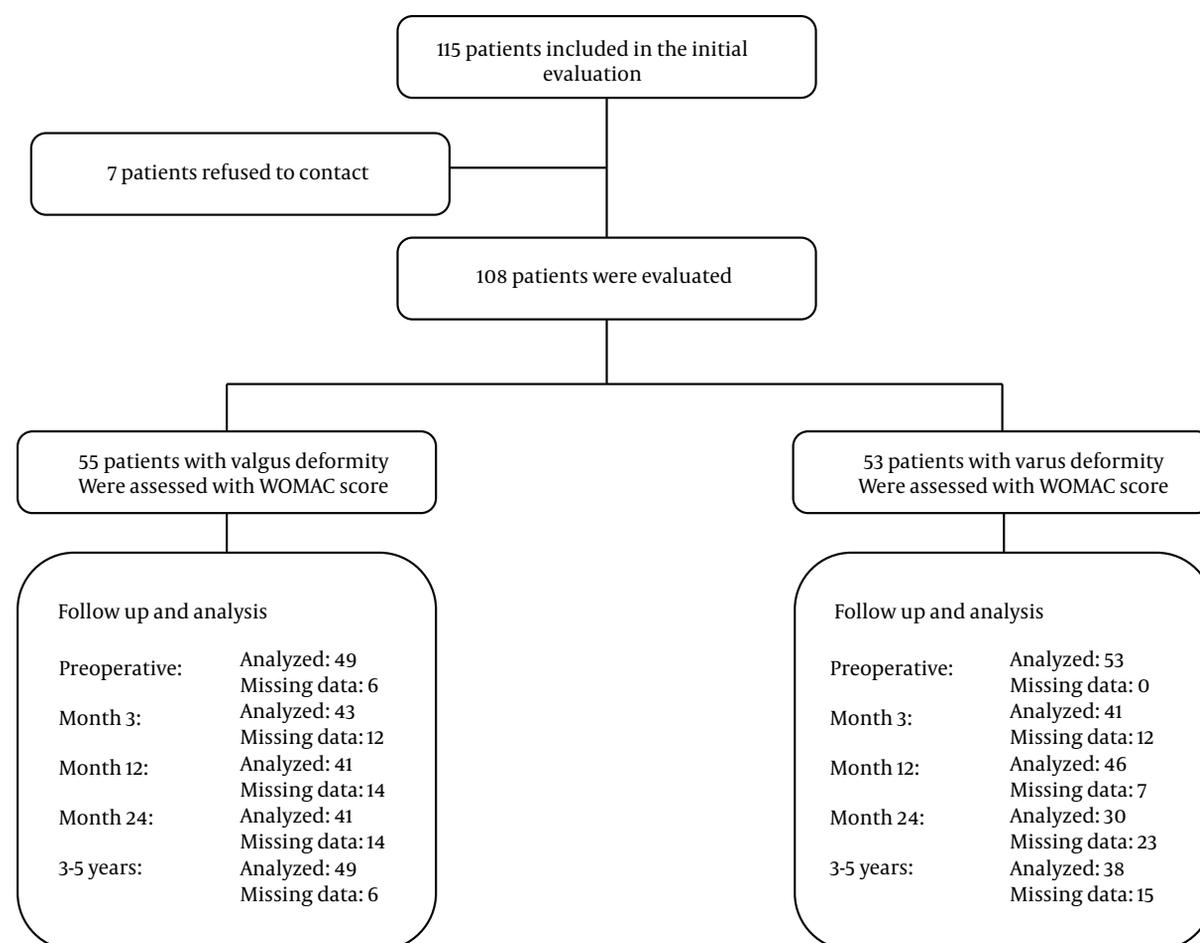
The recovery process was also evaluated by WOMAC from the preoperational period to more than 5 years after TKA for each patient regardless of uni/bilateral deformity. Statistical analysis of both varus and valgus groups showed a significant difference in preoperative WOMAC between varus and valgus groups ( $P = 0.012$ ). In this regard, varus patients had a significantly better WOMAC index preoperatively with the score of 51.2 ± 4.05 than valgus patients did with a score of 42.21 ± 4.12. At the final follow-up, valgus patients still had a lower WOMAC although this difference was not statistically significant ( $P = 0.722$ ). Interestingly, the WOMAC change in the first and final evaluations was significantly different in the two study groups, with 22.06 in varus and 30.14 in valgus patients ( $P < 0.001$ ) ([Figure 2](#)). The results of the WOMAC of preoperative and postoperative sessions are summarized in [Table 3](#).

**Table 1.** The Baseline Characteristics of Patients in Varus and Valgus Groups<sup>a, b</sup>

Characteristics	Deformity		P Value
	Varus	Valgus	
Age (y)	64.9 ± 10.9	65 ± 12.9	0.17
BMI (kg/m <sup>2</sup> )	32.4 ± 7.1	30.8 ± 6.1	0.26
Right/Left knee	28/32	28/30	0.31
Tibiofemoral angle (°)	9 ± 5.3	16 ± 6.4	-
Male/female	31 (58.49)/22 (41.51)	29 (52.7)/26 (47.3)	0.29
Follow-up (y)	4.7 ± 1.7	4.5 ± 1.7	0.25

<sup>a</sup> Values are expressed as mean ± SD or No. (%).

<sup>b</sup> P values < 0.05 were considered significant.

**Figure 1.** Flowchart of the study according to WOMAC assessments

#### 4. Discussion

Regarding TKA efficacy and increasing demand, many investigations are being conducted to better understand

the patient-related factors that contribute to the outcome for patients.

A number of recent studies have focused on the prediction of patients' outcomes based on various preoper-

**Table 2.** Comparative Analysis of KSS Parameters Between the Knees of Patients in the Two Groups After TKA

Factors	Disease Type		P Value
	Varus, N = 51	Valgus, N = 48	
Pain Walking	31.32 ± 1.41	30.15 ± 1.08	< 0.001 <sup>a</sup>
Pain stairs	13.23 ± 2.35	11.90 ± 2.31	0.008 <sup>a</sup>
Alignment	4.35 ± 2.73	11.48 ± 5.21	0.003 <sup>a</sup>
Antero-posterior	9.86 ± 1.04	9.71 ± 1.45	0.329
Mediolateral	14.48 ± 2.35	14.80 ± 2.17	0.438
Flexion	-0.044	-0.730	0.037 <sup>a</sup>
Total knee score	82.80 ± 10.16	78.61 ± 10.71	0.023 <sup>a</sup>

<sup>a</sup> Statistically significant.

**Table 3.** Comparison of the WOMAC Index Mean in the Pre/Postoperative Period

Time Point	Disease Type		P Value
	Varus	Valgus	
Preoperative	51.2 ± 4.05	42.21 ± 4.12	0.012 <sup>a</sup>
After 3 months	68.42 ± 3.18	64.25 ± 3.01	0.550
After 12 months	72.63	69.0 ± 8	0.264
After 24 months	74.01	70.63	0.153
After 3-5 years	73.26	72.35	0.722
WOMAC change	22.06	30.14	< 0.001 <sup>a</sup>

<sup>a</sup> Statistically significant.

ative patient characteristics, including radiographic findings, knee function scores, mental health, and socioeconomic status (6-12).

Based on our observations, it can be stated that the valgus and varus deformities of the knees could potentially affect the outcome of TKA and they might be considered as the preoperative determinants of outcome in this operation. However, the amount of evidence is not enough to reach any consensus on this issue.

Chou et al. retrospectively compared preoperative and postoperative parameters of TKA outcome in varus and valgus deformities using the midvastus approach. As many as 83 patients with valgus and 949 with varus were included in their study to be followed up for a mean period of 72 months. According to the KSS evaluation, their results did not show any significant difference between varus (KSS = 91.6) and valgus (KSS = 91.4) groups (4).

Karachalios et al. also performed a similar study in patients with severe varus and valgus with 5.5 years of follow-up after TKA. The postoperative KSS was 81.12 and 80.88 for varus and valgus patients, respectively, which was not statistically significantly different (13).

Kahn et al. also evaluated the outcome of TKA in relation to preoperative patient-reported and radiographic

measures. According to their report, no significant difference in the postoperative total WOMAC or change of WOMAC was observed between varus and valgus groups (14).

According to our results, the TKA outcome was significantly different in the varus and valgus groups. Based on the KSS evaluation, the varus knees of our study showed a significantly better outcome. WOMAC pre- and post-evaluations also showed to be superior in varus patients, confirming the results of KSS.

Interestingly, the preoperative WOMAC was significantly inferior in the valgus group while the WOMAC change was considerably superior in this group. It can be concluded that valgus patients would get more benefits from this surgery despite their inferior outcome compared to the varus group.

The absence of preoperative KSS prevented us from evaluating the KSS change after TKA, which may be considered as the biggest limitation of our study. Although postoperative KSS was superior in varus patients, this significant difference might have been biased by the lack of preoperative KSS. In other words, the KSS change in pre- and post-operation would provide more valuable information than postoperative KSS alone.

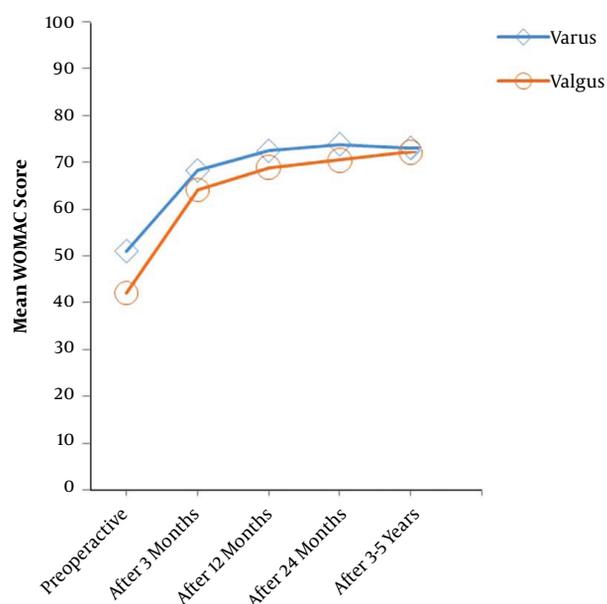


Figure 2. Liner graph of WOMAC index mean in the pre/postoperative period

#### 4.1. Conclusions

According to our results, it can be concluded that the type of deformity could affect the long-term TKA outcome. In this regard, valgus patients would benefit more than varus patients from this surgery. However, considering the observed discrepancy among different reports, further controlled evaluations are needed to more exactly assess the effect of knee angulation on the outcome of TKA.

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