

# 12-year functional outcome of patients undergoing Total knee replacement with Under-correction of Varus Deformity

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## Abstract

**Introduction:** Tricompartmental knee osteoarthritis is a common, progressively debilitating condition. Total knee replacement has been established as the best modality of treatment in such cases. With 58% of arthritic knees having a varus deformity, literature is still bleak in terms of substantial long-term follow-up studies directed towards establishing the most proficient correction technique of these deformities.

**Methods:** 75 consecutive knees with degenerative osteoarthritis, who underwent total knee replacement between January 2009 and December 2011 were evaluated at a mean postoperative follow-up of 12.5±1 years. All of these patients underwent uniform, monitored rehabilitation. Radiological analysis using plain radiography, and functional outcome analysis using KOOS questionnaire was done at terminal follow-up. A retrospective analysis of the nature of deformity correction or postoperative limb alignment was done using immediate post-operative radiographs. Data was compiled on the SPSS-24 software and analyzed using Welch's t-test.

**Results:** The mean age of patients was 64.02 years (Range: 49-79 years). 54 (72%) female and 21 (28%) male knees were evaluated. There was no noteworthy difference between the sides of affliction, with the left knee affected in 37 (49.3%) cases, and the right knee in 38 (50.7%) cases. Patients were segregated into three groups based on retrospective radiological analysis of postoperative femorotibial alignment, namely Varus (n=59, mean varus=2.03°), Rectus (n=5), and Valgus (n=11, mean valgus=1.55°). The varus group had statistically insignificant (p>0.05), albeit better mean KOOS than the rectus and valgus groups (92.8 vs 92 vs 91.36) at terminal follow-up. A higher number of cases were able to kneel, and sit cross-legged in the varus group. There was no radiological sign of implant loosening or need for revision in any of the observed cases, irrespective of the group.

**Conclusion:** At a mean 12.5-year follow-up, patients who underwent under-correction of varus deformity had a favorable functional outcome and were able to carry out all the functional activities including the ability to sit cross-legged and kneel as adeptly as their counterparts. There was no sign of radiological complication in any case. Hence, under-correction of varus deformity during Total knee replacement provides excellent long-term functional, radiological, and implant related outcomes.

**Keywords:** Long-term, under-correction, varus, TKR, KOOS

## Introduction

Tricompartmental osteoarthritis of the knee joint is a common and potentially debilitating condition. The mainstay of treatment for end-stage knee osteoarthritis is knee replacement, and this procedure is effective in most cases.[1] There has been an ever-increasing upward trend in the demand of total knee replacement (TKR) procedures [2].

Traditionally, TKR was performed to relieve chronic pain and restore basic functions to allow patients to return to their activities of daily living. Recently, patients' expectations have increased to include more demanding activities such as sports, leisure activities, physically demanding jobs, and kneeling after undergoing TKR.[3,4]

Patient selection has always been considered pivotal in achieving good results after the procedure. Patients with severe

destruction of the knee joint associated with progressive pain and impaired function are ideal candidates for TKR. Although many patients have good outcomes after TKR, approximately 20%-30% of patients report long-term pain, functional limitations, and dissatisfaction with the outcome of their surgery. [5,6,7] Although less in number, studies have shown difficulty with more challenging activities, such as kneeling in patients after the surgery.[8]

Detailed functional outcome analysis, especially in terms of patient's ability to kneel and sit cross-legged are some of the features of this study along with qualitative analysis using Knee osteoarthritis outcome score (KOOS). The patients were even evaluated based on 10-year survival to implant exchange as the failure. On evaluating the KOOS score, the radiographs of these patients were then retrospectively analyzed for the nature

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**Table 1: Postoperative corrected Hip Knee Ankle angle/Q angle**

Post-operative FTA *	Varus	Rectus	Valgus
<b>Knees (n=75)</b>	59 (78.67%)	5 (6.67%)	11 (14.67%)
<b>Mean</b>	2.03°	-	1.55°
<b>Range</b>	1°-3°	-	1°-2°

\*FTA: Femoro-Tibial alignment

of deformity correction and its correlation with the KOOS score and radiographs.

### Material and Methods

This was a retrospective, single centre study, conducted at Orthopaedic Arthroscopy Knee and Shoulder (OAKS) clinic, Mumbai. Patients operated between January 2009 and December 2011 and evaluated in the year 2021 were included. 77 consecutive knees in 49 patients were operated on in that time frame for osteoarthritis. 2 patients operated for Total knee replacement in single knees died at 5 and 9 years postoperatively secondary to co-morbidities and COVID-19 infections respectively, and hence were lost to follow-up. Hence, the final sample size of the study was 75 knees (n=75), in 47 patients (N=47).

The mean time interval between surgery and terminal follow-up was 12.5 years (Range: 9.5-11.5 years).

### Inclusion Criteria

1. Patients with degenerative tricompartmental osteoarthritis knee
2. Patients who consented for the study.
3. Patients with normal distal neuro-vascular status.

### Exclusion criteria

1. The patients having any post-traumatic osteoarthritis
2. Patients diagnosed with inflammatory arthritis.
3. Patients undergoing revision total knee replacement
4. Any past surgical history
5. Patients who did not consent for the study, were excluded from the study.

Patients were explained in detail about the study at the time of follow up and informed written consent was taken from the patient.

### Operative technique

The modified midvastus approach was taken in all the patients and implantation was done using routine sliding implant insertion technique while substituting the Posterior cruciate ligament. All the patients were operated by a single orthopedic surgeon. Irrespective of the implant and respective referencing system, flexion and extension gap balancing was done

**Table 3: Functional outcome assessment based on the ability to kneel and sit cross-legged.**

Post-operative FTA *	Varus	Rectus	Valgus
Difficulty in kneeling(N=47)	5 (10.64%)	1 (2.13%)	3 (6.38%)
Difficulty in sitting cross-legged(N=47)	4 (8.51%)	2 (4.26%)	4 (8.51%)

\*FTA: Femoro-Tibial alignment

**Table 2: KOOS score quantification and average**

Post-operative FTA *	n=75	Varus	Rectus	Valgus
<b>Mean KOOS<sup>#</sup></b>	92.53±2.86	92.8±2.83	92±2.55	91.36±3.11

\*FTA: Femoro-Tibial alignment

#KOOS: Knee injury and Osteoarthritis Outcome score

accurately. However, the preoperative varus deformity was either under-corrected, fully corrected, or overcorrected. All the patients underwent uniform rehabilitation protocol. In case any postoperative event responsible for failure of the implant occurred, like infection, trauma, or aseptic loosening, it was reported in the study.

### Method of Assessment

The Knee injury and Osteoarthritis Outcome score (KOOS score) [9], the ability to kneel and sit cross-legged, as well as radiological assessment in terms of implant loosening and anteroposterior telemetry was done. KOOS score is a functional outcome scoring system wherein qualitative patient measures are transformed to a 0–100 scale, with zero representing extreme knee problems and 100 representing no knee problems as is common in orthopedic assessment scales and generic measures. Scores between 0 and 100 represent the percentage of total possible score achieved. It analyses the functional outcome in terms of symptoms, stiffness, pain, functions of daily living, functions in sports and recreational activities, and quality of life.

Radiological quantification was done by comparing the Pre-operative, Immediate Postoperative, and terminal follow-up radiographs in anteroposterior and lateral weight-bearing views. Anteroposterior telemetry was done to determine the mechanical axis of the lower limb (HKA angle) in the immediate postoperative radiographs. Radiographs were also evaluated to identify any lucent lines, and other signs of infection or aseptic loosening. [Figure 1]

Function was assessed in terms of ability to kneel, ranges of motion, flexion deformity and sitting cross-legged. [Figure 2, 3]

All the patients underwent the procedure of Total knee replacement by a single surgeon irrespective of the implant system used. Patients were evaluated using the same protocol at their respective terminal follow-up. If at all any implant exchange had to be undertaken, it was noted in the records. Implant-related complications or trauma to the operated knee were recorded, if any. All the data was compiled on the SPSS-24 software system, and retrospective analysis was then done by clinico-radiological correlation between the KOOS score and postoperative tibiofemoral alignment (varus, rectus or valgus) as seen in immediate postoperative radiographs. Welch's t-test was used to run the statistical analysis of the groups.

### Results

The mean age of patients included in the study was 64.02 years (Range: 49-79 years). Out of 75 knees operated, 21 (28%) patients were male and 54 (72%) were female patients. The left knee was affected in 37 (49.3%) cases, and the right knee in 38

(50.7%) cases. There was no noteworthy difference between the sides of affliction. Out of the 47 patients (N=47), 19 (40.43%) patients had undergone single sitting bilateral total knee replacement. Nine (19.15%) patients had undergone staged bilateral total knee replacement and 19 (40.43%) patients were operated on for a single knee. Out of the 19 patients operated on single knees, ten patients were operated on right knee and nine patients were operated on left knee.

On radiological evaluation, not a single radiograph showed signs of infection or aseptic loosening of the implant. Scanograms were evaluated to see for loss of FTA by comparing with the immediate post-operative scanograms. The 59 (78.67%) patients in the varus alignment group had a mean varus of  $2.03^\circ$  (Range:  $1^\circ$ - $3^\circ$ ), while the 11 (14.67%) patients in the valgus alignment group had a mean valgus of  $1.55^\circ$  (Range:  $1^\circ$ - $2^\circ$ ), while the remaining five (6.67%) knees had been kept in rectus. No loss of FTA was noted in any group. [Table 1]

Functional analysis of the patients was done using a KOOS score questionnaire filled in by the patients themselves. The mean KOOS score in 75 knees was found to be  $92.53$  (SD:  $2.86$ ). The mean KOOS score of the varus group was better, albeit statistically insignificant, as compared to the rectus and the valgus group (varus vs rectus vs valgus:  $92.8 \pm 2.83$  vs  $92 \pm 2.55$  vs  $91.36 \pm 3.11$ ). 15 knees (20%) scored between 95-100, 49 knees (65.33%) scored between 90-94, and 11 knees (14.67%) scored between 85-89. [Table 2]

In Indian patients, the ability to sit cross-legged and kneel are crucial for carrying out day to day activities. Consequently, the patients were assessed based on their ability to perform these activities. The number of patients who found difficulty in kneeling in the varus, rectus, and valgus group were five, one, and three respectively. Difficulty in sitting cross legged was seen in two patients of the rectus group, four each in varus and valgus groups respectively. [Table 3]

No patient had to undergo revision surgery, or developed any of the aforementioned clinical complications up until their terminal follow-up. Survival to implant exchange was 100% in our study. All cases showed intact bone-cement and cement-implant interface. There was no sign of implant-loosening in any case.

## Discussion

TKR has been a go-to treatment modality for tricompartmental osteoarthritis ever since its inception. Surprisingly still, the number of studies assessing the long term functional outcome studies of this procedure are scarce. Additionally, despite a number of TKRs done worldwide, the debate with respect to the degree of correction of the varus deformity in these patients lingers on. This study was undertaken with the purpose of filling this void in the literature with regards to the long-term functional outcome of TKR irrespective of the implant system used in patients undergoing under-correction of varus, as compared to those who underwent a complete correction, as well as an over correction

of the varus deformity.

The demographic and epidemiological distribution of our sample size (n=75 knees) remained congruent with the literature, with the male to female ratio at 3:7, and both the sides affected in a 1:1 ratio. The mean terminal follow-up of our study populations was  $10.5 \pm 1$  years which surpasses most of the currently published studies and is a significant period to assess the long-term results of surgery based on power analysis. Considering that the functional outcome of a procedure is the result of a complex interplay, between the implant design, patient characteristics and the surgeon performing the implantation. All the surgeries were performed by a single surgeon. This helped in circumventing the interpersonal confounding. All surgeries were performed with keen attention to the degree of exposure, accurate gap balancing, minimizing surgical trauma to the extensor mechanism of the knee, careful implant size selection, postoperative pain control, medications, and a comprehensive rehabilitation program focused on tempering the stiffness of the knee joint, as well as focused strengthening of the respective muscle groups [10]. To bring this into effect, the patients were followed up for the first four weeks postoperatively to work on mobilization, muscle strengthening, and gait training.

The sole purpose of a TKR surgery is to reincorporate the patient back into his daily life and the society as an independent individual. This is gauged by the ability of the patient to carry out the activities of daily living (ADL) and the eventual quality of life (QoL). These, along with the essential components namely, degree of pain, swelling, stiffness, and freedom of range of motion (ROM) determine the overall outcome of the entire management protocol [11]. The evaluation of these criteria was done using the all-encompassing KOOS score, at the terminal follow-up of every patient [9]. The importance of ROM is highlighted by the fact that the routine activities of the Asian population demand kneeling, and sitting cross-legged. Considering the study population, all of these factors were independently assessed in this study, making it even more comprehensive.

Once the clinical evaluation was completed, radiological imaging was done using standing scanograms and weight bearing anteroposterior and lateral views of both the knees of all patients to look for signs of implant failure, or active aseptic loosening. Having documented the clinical and radiological outcomes of all the patients, retrospective analysis was done using immediate postoperative radiographs to check for the FTA. Subsequently, the study population was sorted into three groups whose radiograph showed varus under-correction (nv=59), rectus alignment or complete correction (nr=5), and valgus alignment or over correction (ng=11). A majority of radiographs showed varus under-correction (mean= $2.03^\circ$  (Range:  $1^\circ$ - $3^\circ$ )). The mean valgus in the over correction group was determined to be  $1.55^\circ$  (Range:  $1^\circ$ - $2^\circ$ ). No change in FTA was appreciated in any of the terminal follow-up scanograms as compared to their immediate post-operative counterparts.

We achieved an excellent mean KOOS score of  $92.53 \pm 2.86$  of



all the knees at their terminal follow-up. All the patients were able to return to their ADL swiftly and easily, at the same time, clocking an improvement in their QoL as compared to the pre surgical state. Despite there being some amount of documented backing for the case of under-correction of the varus deformity, there aren't enough long-term studies to validate the claim. Our long-term findings of the under-correction group were similar to other short-term, mid-term, and long-term studies, showing a mean KOOS score of  $92.8 \pm 2.83$ . Even though the difference in value was statistically insignificant ( $p > 0.05$ ) as compared to the rectus ( $92 \pm 2.55$ ) and the valgus group ( $91.36 \pm 3.11$ ), the KOOS score, ease of return to daily activities, and patient satisfaction with their QoL was higher when the varus deformity was left under-corrected. For all practical purposes however, a varus, rectus and a valgus alignment, all give comparable long-term results. The contemporary TKR designs have an excellent lifespan, but the functional outcome and patient satisfaction levels have still been found lacking in over 20% cases [12]. Postoperative mild varus alignment as well as neutral mechanical alignment of the lower limb led to excellent functional outcomes. For the clinical relevance, postoperative mild varus alignment of the lower limb is acceptable following TKR for varus-type osteoarthritis.[13]

In our study too, the majority of the knees were kept in minimal residual varus (2.03 degrees mean varus) in varus osteoarthritis knee. These patients were very comfortable in carrying out the routine activities including kneeling and cross-legged sitting.

There has been evidence of varus under-correction giving superior functional outcomes at three months. However, this was deemed to be temporary and both, under-correction and

neutral alignment achieved equally good outcomes at one year [14].

In our study, by following a strict set of protocols in surgery as well as rehabilitation, uniform outcomes were achieved. The adherence of all the patients to this regime, excellent functional outcomes can be obtained across all patients.

There are some limitations of this paper. The sample size could have been bigger. The catchment area for the samples was restricted to mainly the western geographical zone of India. Finally, all the surgeries were done by a single surgeon, hence replicability of the results may be difficult. However, there are very few studies in orthopaedic literature that tackle this debate, after more than a decade of the index surgery.

In conclusion, there is an almost complete return to ADL, and a notably improved QoL as measured by the KOOS score irrespective of the FTA. Control over pain, stiffness, and swelling in the long run is achievable if precedence is given to surgical exposure, respecting the soft tissue, accurate gap balancing, and a well-planned rehabilitation program. The long-term radiological results of varus alignment were found to be excellent too, with no evidence of implant loosening, exchange, or failure.

### Clinical relevance

Correcting the deformity by leaving the femoro-tibial alignment in minimal residual varus provides excellent clinical, functional, and radiological outcomes in degenerative osteoarthritis of knee. Despite statistically comparable results in all three types of deformity correction, patients with residual varus showed higher satisfaction rates even after more than 12 years of the index total knee replacement.

**Declaration of patient consent :** The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

**Conflict of interest :** Nil **Source of support :** None

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