

# Variance of Alpha Angle with Use of Intramedullary Guide – Long or Short Intramedullary Alignment Guide (IAG)

Sandeep Krishna Avulapati<sup>1\*</sup>, Avinash Bajjuri<sup>2</sup>, Tejaswi Dussa<sup>3</sup> and Venugopal SM<sup>4</sup>

<sup>1</sup> Assistant Professor, Department of Orthopaedics, Sri Venkateswara Medical College, Tirupati, India.

<sup>2,3</sup> Assistant Professor, BIRRD Hospital, Tirupati, India.

<sup>4</sup> HOD, Department of Orthopaedics, BIRRD Hospital, Tirupati, India.

\*Corresponding Author: Sandeep Krishna Avulapati, Assistant Professor, Department of Orthopaedics, Sri Venkateswara Medical College, Tirupati, India.

DOI: <https://doi.org/10.58624/SVOAOR.2024.04.063>

Received: December 07, 2023 Published: January 02, 2024

## Abstract

**Introduction:** Total Knee Replacement is common surgery to treat osteoarthritis in present day. This is important to restore the daily activities of living and at times it also helps to patients to go further with daily activities of earning in their old age. This surgery also reduces the burden of old people in the society. With advancements in TKR surgery, every aspect of alignment of prosthesis needs to be measured to determine acceptability of implant. Further this can help in refinement to improve the movement and acceptance of implant, better patient satisfaction.

**Aim:** We here by propose null hypothesis that use of long or short Intramedullary Alignment Guide (IAG) during the distal femur cut cannot influence the alpha angle of femur.

**Materials and Methods:** This is a radiological evaluation study done in BIRRD (T) Hospital. All the patients admitted into BIRRD for TKR in unit III were evaluated pre operatively. Surgery was performed by different surgeons based upon their training and using of IAG (short or long). There were no indications for use of short or long IAG. This is totally based on surgeon preference on using. Later alpha angle was measured post operatively.

**Observation and Results:** A total of 243 patients were included into the study. Data was collected based the surgeons experience and preference in use of long and short IAG device. There were 96 and 147 patients were long and short IAG devices used respectively. It was found that alpha angle of  $93.6^\circ (\pm 2.7)$  and  $93.4^\circ (\pm 3.04)$  respectively with long and short IAG.

**Conclusion:** We found that there is no significant statistical difference in alpha angle with use of long and short IAG during femur cuts in TKR. Hence null hypothesis is accepted.

**Keywords:** Alpha angle, TKR, Long and short intramedullary guide, Femur IAG, Distal femur cut, Valgus and varus cut.

## Introduction

India, a country with 1.4 billion population. With rise in aging population, age related degenerative osteoarthritis knee will be one of major contributor to orthopedic OPD. Total Knee Replacement for the same is common surgery. TKR reduces pain, improves Daily Activities of Living, and at times may contribute towards Daily Activities of Earning.

The main aim of TKR is maintenance of neutral mechanical axis and perpendicular joint line. Classical and anatomical alignment needs to be maintained.<sup>1</sup> The same TKR starts with distal femur cut. Here intramedullary femoral alignment was proved to be more accurate.<sup>1</sup> Intramedullary arrangement of rod into femur is kept at  $5^\circ$  valgus to mechanical axis to maintain accurate distal femur cut.

There are many studies shows the variation of alpha angle with same 5-degree valgus cut. Our study was intended to find out whether there is any influence on alpha angle with comparative use of short/long IAG during distal femur cut. We were in view that long IAG has two compact points with one at entry point and other at isthmus. This can result on alpha angle more near to 95°(range of 93°-97°). This contrasts with short IAG which has compactness at entry point of femur.

**Aim**

Null Hypothesis proposal: Use of short and long intramedullary in distal femur cut during procedure cannot influence Alpha angle post-operatively.

**Materials and Methods**

This is study carried out in BIRRD (T) Hospital. All patients who underwent TKR during period from January, 2022 to October, 2022 in one unit were included into the study. The study is radiological assessment of Post operative X-rays. Use of short or long IAG during distal femur cut is surgeons’ preference and requirement during the procedure. The same is noted. Patient included into study after fulfilling inclusion and exclusion criteria.

**Inclusion criteria**

- Age of patients > 50 years
- All varus knees
- Grade III/IV Osteoarthritis of Kellegren and Lawarance Classification

**Exclusion Criteria**

- Age < 50 years
- Valgus knees
- Rheumatoid arthritis
- Grade I /II osteoarthritis
- Severe Flexion deformities of knee
- Severe osteopenia and osteoporosis

Standard laid down procedure and protocol for TKR was followed. Results were tabulated and analyzed.

**Observations and Results**

A total of 243 patients were included into study. All patients underwent TKR. No random allocation was done. Based on surgeon preference long or short femoral alignment rod used was collected. Average age of patients was 58.7years. There were 106 male and 137 females patients in the study.

We found statistically no significant difference between two samples two samples in both T and Welch T test as presented in the table. 2

**Table 1:** Showing sample size, mean alpha angle, standard deviation, standard error of mean, Range of alpha angle in long and short alignment rods using during distal femur cut.

	Long IAG	Short IAG
Sample size	96	147
Mean alpha angle	96.613°	94.435°
Standard deviation	± 2.72°	± 3.09°
Standard error of mean	0.278	0.255
Range found	87.1°-101.9°	84.6°- 100.4°

**Table 2:** Showing Welch T test and T test of significance using for statistical analysis – showing no statistical significance.

Test of Significance	Welch T Test	T Test
Mean difference between groups	0.178	0.176
Standard error of Difference	0.377	0.388
95% confidence limits	0.566 – 0.921	0.586 – 0.941
T value	0.470	0.478
Df	220	241
T value	0.638	0.647
p value <0.05		

**Table 3:** Showing angle variations between two groups and significance statistically.

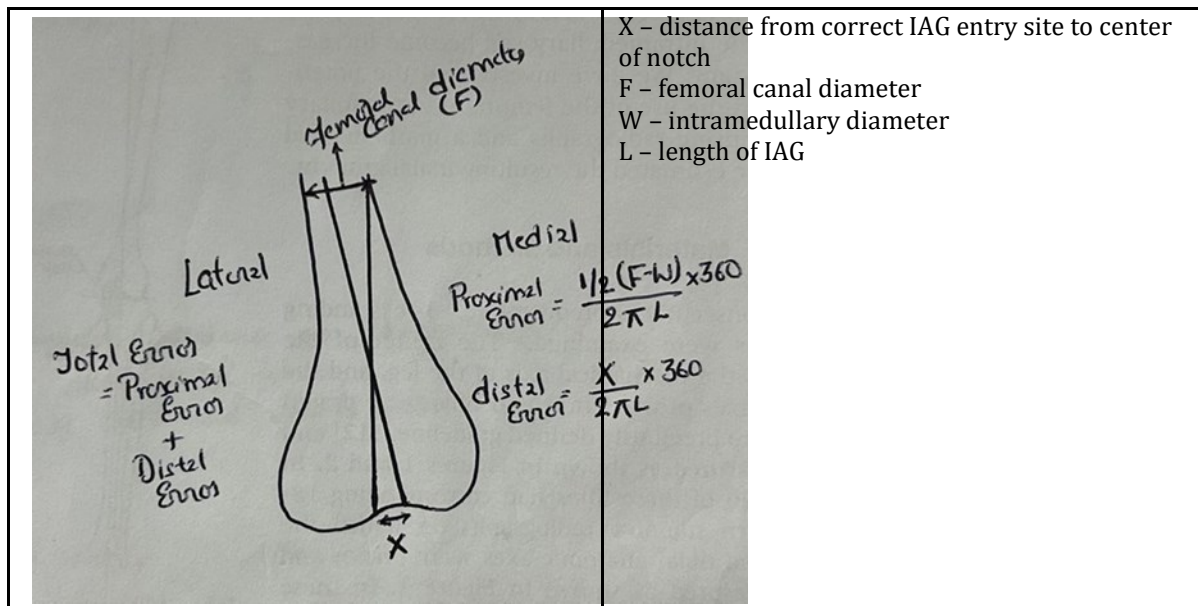
Angle variation	Long IAG	Short IAG
96° ± 2°	36	31
<94°	44	86
>96°	16	30
Chi Square test Value		7.8451
p <0.019		P < 0.05

## Discussion

TKR is an important surgery for osteoarthritis knee. It is a end stage treatment, for osteoarthritis.<sup>2</sup> With improvement and refinement of surgical techniques, quality of materials used, physiotherapy, early mobilization of patient after surgery, early achievement of DALY's, it has become promising surgery.<sup>2</sup> Pain free period with good analgesia per and post operatively has resulted in good mobilization.

To start, we were in opinion that use of long, and short intramedullary guide can influence Alpha angle of femur implant in TKR. In a Research work done by Stephen Redd et.al, They have provided Total Error in TKR due to IAG in the process.<sup>1</sup>This was represented in picture 1. We tried to eliminate distal error with 8mm drill bit and using 8mm intra-medullary guide.

We tried to calculate proximal error, expecting certain facts available in literature. Average femur length in Indian population was around 42cm (43.54cm/43.42cm left and right respectively), 41.66cm, 43.38cm respectively in various studies.<sup>5,6,7</sup>We can assume femoral isthmus at about proximal 3<sup>rd</sup> and Middle 3<sup>rd</sup> junction. Average length of femoral IAG will (maximum length of 220mm and minimum length of 150mm), it may not reach up to isthmus in our Indian population. If IAG 8mm and drill of 8mm used, distal error assumed to be zero, proximal error was estimated. We assumed intramedullary diameter from 8-12mm in Indian population.<sup>7</sup>From this we assumed our alpha angle reference in two populations. This is shown in table No.1.



**Figure 1:** Showing proximal, distal, and total error estimation in TKR. Estimation done in accordance with Stephen Reed et.al,<sup>1</sup>

**Table 4:** Showing Proximal error estimation and variance of alpha angle estimated before the start of study, real estimated obtained in study.

Length of IAG (8-12mm intramedullary femur diameter)	Estimated proximal error	Estimated error in alpha angle	Real estimates in alpha angle in the study	Range of alpha angle expected
220mm	0.26 <sup>0</sup> -1.04 <sup>0</sup>	94 <sup>0</sup> - 96 <sup>0</sup>	96.6 <sup>0</sup> ± 2.72 <sup>0</sup>	89.56 <sup>0</sup> -100.44 <sup>0</sup>
150mm	0.38 <sup>0</sup> -1.5 <sup>0</sup>	93.5 <sup>0</sup> - 96.5 <sup>0</sup>	94.4 <sup>0</sup> ± 3.09 <sup>0</sup>	88.82 <sup>0</sup> -101.18 <sup>0</sup>

Variation of alpha angle is dependent upon many factors<sup>1,2</sup>

1. Entry point of intramedullary guide in intercondylar notch. (medial / lateral) (anterior/ posterior)
2. Entry point diameter. (Variation from 8-10mm)
3. IAG diameter. (8-10mm)
4. Short / long intramedullary diameter.

In our study we used distal femur entry point as 4-5mm medial to intercondylar notch, and 8-10mm above PCL insertion. This was based on study done by Stephen C et.al.,<sup>1</sup> Some studies may vary 9.2mm anterior to and 3.6mm medial to Anterior Intercondylar notch.<sup>4</sup>

Literature review shows no clear research work comparing long and short alignment rod for femur and its impact on alpha angle.

In study (Bradley T et.al,) initially they had opinion that use of short intramedullary guide in post THA patients may alter both anatomical and mechanical axis. They thought that this may lead to malalignment of femoral implant in TKR. On contrary they found that there was no statistically no significant difference and influence on Alpha angle on use of long and short IAGs during distal femur cut. Control group (long IAG) was having valgus of 6.23<sup>0</sup> (range of 0.7<sup>0</sup> - 10.7<sup>0</sup>). Study group with short IAG had valgus angle of 5.81<sup>0</sup> (range of 1.4<sup>0</sup> - 10<sup>0</sup>). Study population was compelled to use short IAG for distal femur cut as all the patients in this group are post THR group.<sup>3</sup> We to started the study with similar opinion, but found no significant statistical difference between two groups. In our study it was 96.6<sup>0</sup> (± 2.72<sup>0</sup>) (long) and 94.4<sup>0</sup> (± 3.1<sup>0</sup>) (short).

A study done by Yong Liong Ou et.al, showed that there is significant difference was found between long and short alignment rod in TKR on Femoral Anatomical Axis (FAA) and Mechanical Axis (FMA) in male and female populations. At the same time shows no statistical significance among various length of lengths.<sup>8</sup>

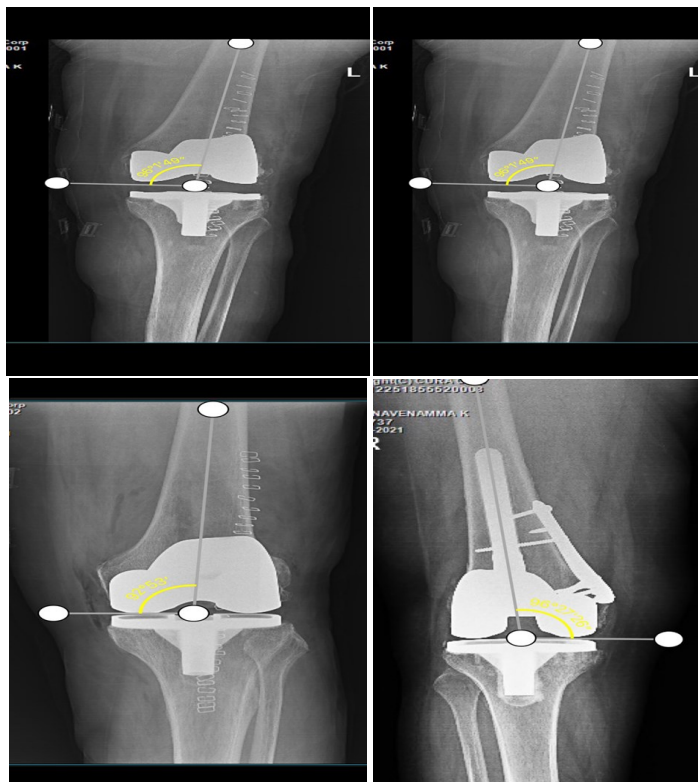
It was found that three-degree varus and valgus alignment of TKR femoral implant does give best stability.<sup>9</sup> In our study we found that maximum samples inside this three-degree varus and valgus as shown in table no.5.

**Table 5:** Showing distribution with 3<sup>o</sup>degree varus and valgus, varus, and valgus in both long and short alignment rods.

Angulation	Long intramedullary alignment rod	Short intramedullary alignment rod
92 <sup>o</sup> -98 <sup>o</sup>	65	95
>98 <sup>o</sup>	4	8
<92 <sup>o</sup>	27	44

It was found in study by Y Haruta et.al, that coronal deviation of alignment rod (200mm\*8mm) can result in variance of 0.8<sup>o</sup> ( $\pm$  0.2<sup>o</sup>) and 0.8<sup>o</sup> ( $\pm$  0.3<sup>o</sup>) medial and lateral respectively. This can result in change in distal femur cut variance at about 0.31/0.21 mm (M/L) and 0.26/0.21mm (M/L) on medial and lateral deviation of intramedullary alignment as measured in the study.<sup>9</sup> So we can expect a maximum of variation of 0.4<sup>o</sup> - 1.4<sup>o</sup> in alpha angle post TKR patients. But this is completely in complete disagreement to our values in the study. Our alpha angle variation is wide both the groups as shown in table no.1 (87<sup>o</sup>-101<sup>o</sup> in 220\*8mm) and (84<sup>o</sup>-100<sup>o</sup> in 150\*8mm)

Finally, we propose that alpha angle is not dependent on long or short intramedullary alignment rod, but is dependent upon many factors like young modulus of alignment rod, point of intramedullary entry made, medial and lateral deviation of alignment rod, adjustability of implant during implantation and dynamic adjustment thereafter during movement of knee post implantation, Cement layer adjustment in between implant and bone cut.



**Figure 2:** Showing how Alpha angle in various post-operative X-Rays in various post-operative TKR patients.

## Conclusion

Null hypothesis remains accepted.

## Conflict of Interest

The authors have no conflicts of interest to declare.

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**Citation:** Avulapati SK, Bajjuri A, Dussa T, Venugopal SM. Variance of Alpha Angle with Use of Intramedullary Guide – Long or Short Intramedullary Alignment Guide (IAG). *SVOA Orthopaedics* 2024, 4:1, 01-06.

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