

## Role of Preoperative Hip-Knee-Ankle Scannogram Xray in predicting the distal femoral cut to achieve correct postoperative alignment after TKR surgery

Hitesh Dawar<sup>1</sup>, Deepak Raina<sup>1</sup>, Pushkar Chawla<sup>1</sup>

<sup>1</sup>Department of Orthopaedics, Indian Spinal Injuries Centre, Sector C, Vasant Kunj, New Delhi - 110070, India.  
Institute Where Research Was Conducted: Indian Spinal Injuries Centre, Vasant Kunj, New Delhi, India.  
University Affiliation: National Board of Examinations, New Delhi, India.  
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### Address of Correspondence

Dr. Hitesh Dawar  
Consultant Orthopaedic Surgeon, Department of Orthopaedics, Indian Spinal Injuries Centre, Sector C, Vasant Kunj, New Delhi-110070, India.  
Email: hiteshdawar@gmail.com



### Abstract

**Background:** Accurate limb alignment is one important factor for long term survival in total knee arthroplasty. In many centers around the world, using computer aided navigational systems to ensure accurate implant placement is still a big logistical and economic difficulty. A conventional method to aid accurate implant placement is needed, especially in developing countries. We determined the reliability of predicting correct intraoperative femoral cuts on the basis of preoperative Hip-to-Ankle Xrays, to achieve a proper postoperative alignment.

**Method and Result:** In 39 limbs, the distal femoral cut was predicted preoperatively, whereas in 30 limbs, eyeballing was used to take this cut. Postoperative long-leg views were taken to analyse accuracy of implant placement. 82.05 % (32/39) of the predicted group limbs' mechanical axii were corrected to within mid-fifth of the knee joint as compared to 26.77 % (8/30) of the eyeballing group, with a p-value of < 0.001.

**Conclusions:** This study clearly established a role of Hip-Knee-Ankle Xrays in determining an accurate postoperative alignment. so that this could be used instead of Computer aided navigational systems for TKR surgeries.

**Keywords:** Hip-Knee-Ankle Scannogram Xray; Scannogram; Long limb xray; Total Knee replacement; Navigation.

## THESIS SUMMARY

### Introduction

Total knee replacement is a commonly performed surgery. The instrumentation and implantation methods are fairly similar for different types of implants available, and the learning curve for non complex cases is rather flat. The procedure is being performed right from smallest of the orthopaedic centres, to the biggest of the hospitals. Accurate limb alignment is one important factor for long term survival in total knee arthroplasty. In many centers around the world, using computer aided navigational systems to ensure accurate implant placement is still a big logistical and economic difficulty. A convenient method to aid accurate implant placement is needed, especially in developing countries.

### Materials and Methodology

The study was conducted at a single centre during a period of one and a half year, from Jan 2010 to June 2011. During this period, patients planned up for total knee replacement surgery were evaluated as per the preoperative protocol mentioned in the methodology below. All consecutive 103 limbs from 71 patients were evaluated, out of which 69 limbs from 40 patients were included in this study, which were operated upon by two well experienced arthroplasty surgeons.

#### Inclusion Criteria

Patients undergoing primary total knee replacement for osteoarthritis of the knee

#### Exclusion Criteria

- Post Traumatic primary total knee replacement.
- Primary total knee replacement for tumour surgery.

- Patients with more than 15 degree flexion deformity.
- Patients who cannot stand up for Hip-knee-ankle Xrays.

## Methodology

Step 1 – Preoperative HKA (Hip-Knee-Ankle) orthoscannograms were taken.

Step 2 – Marking and evaluation of the axii and angles were done, which included Mechanical axis

of the limb, Angle between distal femoral axis and mechanical axis , Angle between the condylar line and the mechanical axis of femur , and Femoral bowing.

Step 4 – The angle between distal femoral axis and mechanical axis was taken as the predicted cut

angle and reported to the operating surgeon and first assistant before the surgery

Step 5 – The intraoperative femoral cut was recorded for the operated limb. The tibial cut was taken

perpendicular to the Mechanical axis of the tibia in coronal plane by the use of an extramedullary

jig.

Step 6 – The limbs were categorised into 2 groups, on the basis of the intraoperative femoral cut

taken, Predicted group, and Surgeon's choice group

Step 7 – Postoperative HKAX ray was done at 6 weeks

Step 8 – In postoperative H-K-A orthoscannogram, the knee joint was divided into 3 and 5 equal

parts respectively, and postoperative mechanical axis of the limb from centre of the femoral head to

the centre of the ankle joint was marked. Observations were noted as to whether the marked axii

passed through the mid third or not, and whether through the mid fifth or not.

All angles and axii pre and postoperatively were measured by an independent observer, who was either involved in the pre and postoperative care or in the surgery as a second assistant. He was not directly involved in taking the femoral cut; to reduce the bias.

The possible reasons for the surgeon to choose a different cut from the one predicted varied from short height of the patient, to the short length of the femora and limb, to the individual judgement based on "eyeballing". These factors were not studied.

## Result

Two groups were formed – 39 knees were taken in predicted group, and 30 knees were taken in surgeon's choice group. The mean age of the patients included in our study was  $64.11 \pm 8.69$  years, the mean age of patients in surgeon's choice group was 64.27 years, whereas the mean age for the predicted group was 63.96 years.

11 patients underwent a TKR for a single limb as compared 29 patients who underwent TKR for both the limbs, so the sample size of the study consisted of 69 knees in 40 patients. 34 knees out of the total of 69 were

left sided, and 35 were right sided. The preoperative deformity in 66 limbs was varus with flexion, whereas it was valgus with flexion in 3 cases.

Preoperative analysis revealed that the mean of the DF-MA angle, or the angle between distal femoral anatomical axis and the femoral mechanical axis, which was used to predict the distal femoral cut, was calculated for both groups separately, and was found to be 7.67 degrees in surgeon's choice (S) group, and 7.14 degrees in predicted group (P).

Postoperatively, analysis of the predicted group revealed that out of the 39 patients, the postoperative mechanical axis of the limb passed through mid-third in 37 of them; through mid-third and mid-fifth in 32 of them; in 2 of the limbs, the postoperative mechanical axis lied outside the mid-third of the knee joint itself.

Analysis of the surgeon's choice group revealed that out of the 30 patients, the postoperative mechanical axis of the limb passed through mid-third in 27 of them; through mid-third and mid-fifth in 8 of them; in 3 of the limbs, the postoperative mechanical axis lied outside the mid-third of the knee joint itself.

On comparison of the postoperative mechanical axis, correction to within mid-third was similar in both the groups, with 94.87 % (37/39) inliers in predicted group and 90.00 % (27/30) inliers in the surgeon's choice group; on statistical analysis by Fischer's Exact test, this data revealed a p-value of 0.63, which was not statistically significant. It was observed that 82.05 % (32/39) of the predicted group limbs' axii were corrected to within mid-fifth as compared to 26.77 % (8/30) of the surgeon's choice group; on statistical analysis by chi square test revealed a p-value(mid fifth) of  $< 0.001$ , which was very highly statistically significant.

## Discussion

The anatomical axes of the femur and the tibia form a valgus angle of  $6 \pm 2$  degrees. The mechanical axis of the lower limb is defined as the line drawn on a standing long leg anteroposterior radiograph from the center of the femoral head to the center of the talar dome and typically should project through the center of the knee joint, described as a "neutral"; it is in 3 degrees of valgus from vertical axis of body. Anatomical axis of femur is in 6 degrees of valgus from mechanical axis of lower limb and 9 degrees of valgus from true vertical axis of body. Anatomical axis of tibia lies in 2 to 3 degrees of varus from vertical axis of body.

Numerous studies have shown a correlation between long-term success of TKR and restoration of near-normal limb alignment postoperatively. Malalignment of total knee prostheses has been implicated in long-term difficulties, including instability, patellar fracture, stiffness, accelerated polyethylene wear, and implant loosening. [12,13,14,18]

It is well established that with the use of computer aided navigational systems, the postoperative near normal limb alignment can be achieved with significant accuracy. [19,20] On an extensive literature review, we found that there were no studies, in which the intraoperative femoral cuts, or the correction of limb axis had been predicted on the basis of preoperative evaluation; whereas there were a number of studies in

which the comparison was done between the correction achieved postoperatively when the implantation was done using the computer aided methods as compared to conventional techniques, but in none of these studies were any measures defined to improve the accuracy of implantation, or to predict the intraoperative cuts to be taken. Also, the use of these systems is not possible everywhere, and in all cases, due to cost and logistical factors involved. A cost effective conventional and a scientific method to predict the angle of femoral cut accurately was sorely missed.

We reviewed the literature, and formulated a study, well understanding the need for long leg views [7]; standardised the method of taking the Xrays for evaluation, and the defined the measurements to be done on those Xrays [9,10,11]

We concluded that the hip-knee-ankle long leg orthoscannograms can be used to evaluate and predict the intraoperative femoral cut, to achieve correction in the post operative limb alignment, with a very high statistically significant predictability (p-value < 0.001).

There were limitations to our study, the most glaring of them being that only a small sample size of only 69 limbs was taken divided into 2 groups; also an element of bias was introduced as even when the operating surgeon took a different cut from the one which was predicted, he was already in the knowledge about the preoperative evaluation and predicted cut value which might have influenced the surgeon's decision; also that the study considered success and failure in the post operative correction only radiologically, and clinical results were not examined.

We recommend on the basis of our study that evaluation of all patients with knee osteoarthritis to be done with long leg views for accurate assessment of the lower limb axis; to use of long leg views for calculation and prediction of the intraoperative femoral cuts, especially in centres or cases where use of computerised systems is not possible. We also suggest further long term randomised controlled clinical studies to examine whether the implantation with the aid of analysis of pre operative long leg views affected the postoperative clinical results and comprehensive comparative studies to evaluate whether the long leg views could actually be used as a substitute to computerised systems.

### Clinical Importance

Long leg views (HKA Scannograms) are must for accurate assessment of the lower limb axis, and can be used for calculation and prediction of the intraoperative femoral cuts for TKR surgery.

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