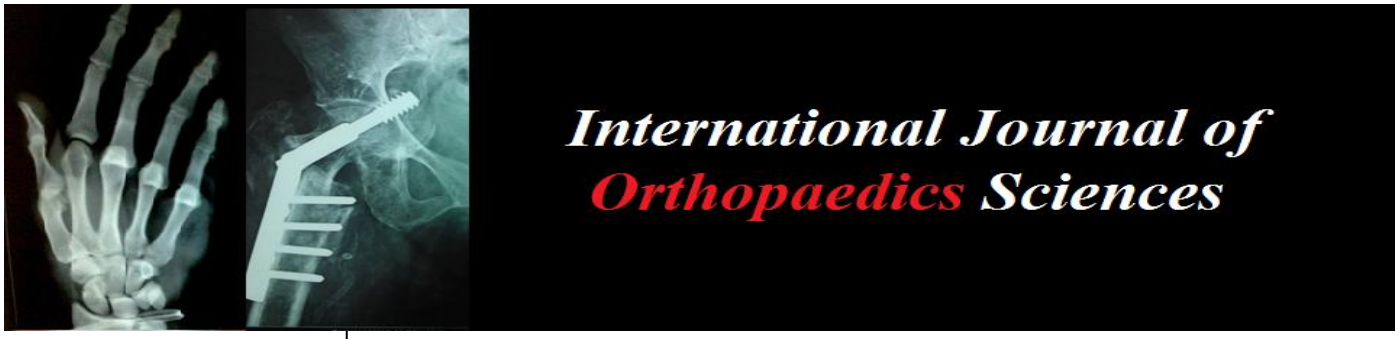

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The effect of anatomical tibia vara on the coronal alignment of tibial component in total knee arthroplasty: A radiographic analysis

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Abstract
Survivorship in total knee arthroplasty depends on the restoration of the coronal alignment of its components. Failure to restore this may decrease the longevity of TKR. The prevalence of tibia vara in patients with osteoarthritis of the knee undergoing TKA is quite high. We wanted to assess the effect of the varus angulation in the proximal metaphysis of the tibia on tibial component malposition in the coronal plane in patients undergoing total knee replacement. Patients who underwent TKA for primary osteoarthritis of the knee and with more than two years of follow-up were included. The extra-articular tibial deformity was assessed by measuring the angle between the anatomical and mechanical axis of the tibia. The coronal alignment of the femoral and tibial components was measured using lateral distal femoral angle and medial proximal tibial angle.Preoperatively,73 (90.12%) patients were having a neutral tibial anatomical axis and 8(9.9%) patients were having varus angulation in the proximal tibia.Postoperatively,18(22.2%) patients had a neutral mechanical axis. There were 14(17.2%) patients with more than 3 degrees of varus mechanical axis and 41(50.6%) patients had less than 3 degrees of varus mechanical axis alignment. 2 (2.5%) patients had more than 3-degree valgus mechanical axis and 6 (7.4%) had less than 3 degrees valgus mechanical axis. Postoperatively, out of 8 patients with pre-operative tibia vara, only 2(25%) patients had neutral placement of the tibial component. 6 (75%) had both tibial and femoral component malalignment. Out of the 73 patients with pre-operatively neutral tibial axis, 40(54.7%) patients had both tibial and femoral component malalignment. 8 (11%) patients had only tibial and 9(12.3%) patients had only femoral component malalignment. In 16 (19.1%) patients, there was no malalignment of both. There was no significant relationship between the tibial anatomical axis malalignment and the tibial component alignment in patients undergoing TKA for primary osteoarthritis.

Keywords: tibia, vara, knee, arthroplasty, oseoarthritis, malalignment, Indian, constitutional varus

Introduction
The survivorship of total knee arthroplasty (TKA) depends on the restoration of the coronal alignment of its components. The implant is placed perpendicular to the mechanical axis of the lower limb. The failure to restore this relationship may decrease the longevity of TKR [1]. Varus or valgus malalignment in osteoarthritis of the knee can be due to intraarticular or extra-articular factors. During the time of TKA, we aim to restore the mechanical axis to as neutral as possible by keeping the implants perpendicular to it[2].In the majority of cases, we will not give much importance to correction of the extra-articular deformities in the tibia or femur if it is less than 10 degrees in the coronal plane [3].

Osteoarthritis of the knee usually affects the elderly. There is a high prevalence of osteoporosis and osteomalacia in the elderly population. The prevalence of hypovitaminosis D in the adult population of India is about 30-90% [4]. The varus and valgus deformity associated with osteoarthritis can exacerbate the varus and valgus deformity of the proximal tibia in an elderly patient with osteopenia. The prevalence of tibia vara in patients with osteoarthritis of the knee undergoing TKA has been seen as high as 58% in one study [5].

Eccentric loading of the tibia component can occur in coronally malaligned implants. This can affect the kinematics and the stress concentration at the tibial baseplate- cement-bone

interface. This will ultimately lead to early loosening of the implant [6].

Our objective is to assess the effect of the varus angulation in the proximal metaphysis of the tibia on tibial component malposition in the coronal plane in patients undergoing total knee replacement.

Materials and Methods

A cross-sectional study was conducted between 2012 to 2015 amongst patients who had undergone TKA in our department. All patients after total knee replacement above the age of 50 years were included. Patients who underwent TKA for primary osteoarthritis of the knee and with more than two years of follow-up were included. Patients with rheumatoid arthritis, post-traumatic arthritis, and patients who had undergone high tibial osteotomy or revision TKA were excluded. The preoperative data were collected from the hospital records and postoperative measurements were done during the final follow-up.

The mechanical axis of the lower limb is a line drawn from the center of the femoral head to the center of the ankle joint in a standing hip-knee-ankle X-ray (orthoscanogram). In a normal person, it should pass through the center of the knee joint. In the varus knee, the line will pass medially and in a valgus knee laterally to the center of the knee joint [7]. The anatomical axis of the femur extends from the center of the trochanter to the center of the knee joint and that of the tibia extends from the center of the knee joint to the center of the ankle joint. The anatomical axes of the femur and tibia are the diaphyseal midline of these two long bones. The anatomical and mechanical axes are the same for the tibia. There is a 6 degree valgus between the anatomical and mechanical axis of the femur [8].

The extra-articular tibial deformity is assessed by measuring the angle between the anatomical and mechanical axis of the tibia [9]. The coronal alignment of the femoral and tibial components is measured using lateral distal femoral angle and medial proximal tibial angle respectively [10].

Since there is no prevalence data available for TKA in India, we have taken the prevalence as 50%. With a prevalence of 50%, a 95% confidence level, precision of 12, and a power of 80%, the sample size calculated was 70. We used a convenient sampling method. We collected the data of 105 patients who had undergone TKA with a minimum follow-up of 2 years after the surgery. 14 patients had TKA done for rheumatoid arthritis,4 had flexion deformity greater than 15 degrees, 3 had post-traumatic arthritis and 3 had undergone HTO and were excluded. We included the remaining 81 patients in our study.

The pre-operative and post-operative varus and valgus alignment of the femoral and tibial components were measured. Postoperatively the lateral distal femoral angle (LDFA) and medial proximal tibial angle (MPTA) were measured to find the varus and valgus alignment of the tibial component. The data was entered into Excel version 15 and descriptive analysis was done and the level of significance was assessed using the chi-square test.

We had obtained institutional ethics committee approval for conducting this study. We had also obtained consent from the patient/relatives for the study and its publication

Result

There were 81 patients in our study.42 were males and the remaining were females.31 patients were in the age group 50-59 and 39 were in the 60-69 age group. 11 patients were aged above 70 (Table 1).

Preoperatively,73 (90.12%) patients were having a neutral tibial anatomical axis and 8(9.9%) patients were having varus angulation in the proximal tibia (Table 2). Postoperatively, 18(22.2%) patients had a neutral mechanical axis. There were 14(17.2%) patients with more than 3 degrees of varus mechanical axis and 41(50.6%) patients had less than 3 degrees of varus mechanical axis alignment. 2 (2.5%) patients had more than 3-degree valgus mechanical axis and 6 (7.4%) had less than 3 degrees valgus mechanical axis (Table 3). Postoperatively, out of 8 patients with pre-operative tibia vara, only 2(25%) patients had neutral placement of the tibial component. 6 (75%) had both tibial and femoral component malalignment. Out of the 73 patients with pre-operatively neutral tibial axis, 40(54.7%) patients had both tibial and femoral component malalignment. 8 (11%) patients had only tibial component malalignment and 9(12.3%) patients had only femoral component malalignment. In 16 (19.1%) patients, there was no malalignment of both tibial and femoral components.

There was no significant relationship between the tibial anatomical axis malalignment and the tibial component alignment in patients undergoing TKA for primary osteoarthritis (p-value 0.54)

Table 1: Demographic charecteristics

Age (yrs)	Males	Females	Total
50-59	18	13	31
60-69	19	20	39
>70	5	6	11
Total	42	39	81

Table 2: Implant component malalignment (varus/valgus)

Preop tibial anatomical axis		Implant component alignment (varus/valgus)			
		Both malaligned	Tibial component malaligned	Femoral component malaligned	Both normal
Varus angulation in proximal tibia	8	6(75%)	0	0	2(25%)
Neutral anatomical axis	73	40(54.7%)	8(11)	9(12.3%)	16(19.1%)
Total	81	56.8%	9.9%	11.1%	22.2%

P value 0.54

Table 3: Postoperative mechanical axis

Postop mechanical axis		Number	Percentage
Neutral		18	22.2%
Varus	>3 degree	14	17.2%
	<3 degree	41	50.6%
Valgus	>3 degree	2	2.5%
	<3 degree	6	7.4%

Discussion

We aimed to find out the relationship between the proximal tibial anatomical varus malalignment and tibial component malpositioning in TKA done for primary osteoarthritis of the knee. Among the 81 patients, 67.9% were having a postoperative varus alignment and 9.8% were having valgus alignment. Only 14 patients had a significant varus

malalignment (more than 3 degrees). Similarly, only 2 patients had a significant valgus deformity (more than 3 degrees)

Pre and postoperative x-rays of all patients were analyzed. Preoperatively 9.9% of patients had varus angulation in the metaphysis of the proximal tibia. Postoperatively, the mechanical axis of the lower limb was calculated from orthoscanograms. The majority of patients were in varus alignment (67.9%) and the rest were in neutral mechanical alignment.

On the assessment of the alignment of the femoral and tibial components concerning the mechanical axis of the lower limb, in 56.8% of patients, both femoral and tibial components were malaligned. The femoral component alone was malaligned in 11.1% of cases. The tibial component alone was malaligned in 9.9% of cases and in 22% of cases both components were normally aligned.

The high rate of femoral component malalignment in our study maybe because we were taking a 5 degree of valgus distal femoral cut in all patients. The relationship between the anatomical axis and mechanical axis of the femur can vary between 8-9 degrees of valgus [7]. A preoperative templating can assess the exact degree of valgus for distal femoral cut during TKA. Probably this can reduce the valgus placement of the femoral component. We tried to find out whether there is any influence of tibial anatomical axis malalignment in the proximal metaphysis of tibia and coronal alignment of tibial component placement. There were 8 patients with tibia vara. But none had varus malpositioning of the tibial component. Among the 8 patients, 6 were having malpositioning of both tibial and femoral components. We could not find any significant relation

The neutral alignment of the weight-bearing axis can be achieved by placing the femoral and tibial components of TKA perpendicular to the mechanical axis. Femoral and tibial cuts are taken perpendicular to the anatomical axis and by inference their mechanical axis [11]. The intraarticular deformities like varus and valgus are corrected using measured bone resection or gap balancing [12]. Up to 3 degrees of varus or valgus malalignment from the neutral can be considered as a safe zone for placement of the implant [13]. But some surgeons have a different opinion regarding the optimal coronal alignment of the component position [14]. Green *et al* showed that more than 5 degrees of tibial component varus placement can produce stress concentration at the posteromedial part of the proximal tibia. This medial bone collapse is one of the predominant modes of tibial component failure in such cases [15]. For each degree of variation in mechanical varus, there is a 4 to 6-fold increase in failure of TKA [16]. According to Matziolis *et al*, the determination of ultimate TKA performance is a multifactorial affair and coronal alignment of the implant is only one among them [17].

Trauma, metabolic bone diseases, congenital deformity, and prior surgeries can lead to extra-articular deformities around the knee. If these deformities are not corrected by extra-articular procedures, either a proximal tibial or distal femoral wedge resection may be required to produce the overall limb alignment during TKA. This can lead to asymmetric ligament length and complex instabilities after TKA [18]. There is a common perception among the orthopedic community that the tibiae of the Asian population are more varus compared to the non-Asian population. This is due to acute medial tibial proximal angle and diaphyseal bowing. A computerized tomography study of 100 normal adult knees showed that the morphology of proximal tibia in Asian knees is inherently varus. This is contributed by medial proximal tibial angulation [19]. A significant number of patients undergoing TKA in India are having proximal tibial varus. This can lead to malpositioning of the tibia after TKA [5]. We also see a lot of patients with proximal tibial varus in patients undergoing TKA in our institution.

These anatomical variations should be evaluated before surgery so that this can help plan the operative technique before TKA [20]. In a retrospective study of 83 conventional TKA and 246 computer-assisted navigation TKA patients with extra-articular tibia vara, the postoperative alignment was assessed by hip knee ankle (HKA)angle on postoperative standing lower extremity view, Cho Y *et al* showed that there was no significant difference in postoperative alignment between conventional and computer-assisted TKA[21].Tibia vara can affect the aspect ratio of the resected tibial surface. The aspect ratio was found to be inversely correlated to the degree of tibia vara. The prosthetic designs currently available do not fit well into the resected surface in terms of aspect ratio [22].

Our study showed that there was no significant relationship between the tibial anatomical axis malalignment and the tibial component alignment in patients undergoing TKA for primary osteoarthritis. There were some limitations to our study. The sample size was small and it was a retrospective series. Two different senior orthopedic surgeons experienced in arthroplasty were doing the surgeries. We think that the surgical technique used by them may also have affected the outcome. We hope that in the future prospective multicentre studies can give us a definitive answer for the effect of proximal tibia vara on the component malpositioning in TKA

Conclusion

There was no significant relationship between the tibial anatomical axis malalignment and the tibial component alignment in patients undergoing TKA for primary osteoarthritis

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