



Distribution of Distal Femoral Cut Angle for TKR in Indian Population

Authors

Pradeep Dubey¹, Milind Patil²

¹Fellow in Arthroplasty Reviaval Bone and Joint Hospital Thane

²Consultant Orthopedic Surgeon Reviaval Bone and Joint Hospital Thane

Abstract

Objective: To find out the angle of distal femoral cut in total knee arthroplasty in a Indian population.

Methods: Radiographs of the lower limbs from 123 patients (104 women and 19 men) were studied, with 165 knees having an indication of total knee arthroplasty. The anatomical axis, and mechanical axis of femur is marked and angle were calculated. The angle of the femoral cut was determined from the meeting point between the femoral anatomical and mechanical axes. The distribution degree of femoral valgus was compared between men and women

Results: The ideal femoral valgus angle ranged from 3 to 9 degrees, with a mean of 6.2 degrees. Comparing men and women, there was no statistically significant difference regarding the ideal femoral valgus

Conclusions: The mean angle between the femoral mechanical and anatomical axes was 6.2 degree. Preoperative coronal alignment and sex had n influence on the distal femoral cut.

Keywords: Knee arthroplasty, Alignment in arthroplasty, Femoral cut.

Introduction

Osteoarthritis is the second most common rheumatologic problem and it is the most frequent joint disease with a prevalence of 22% to 39% in India⁽¹⁾. For grade 4 osteoarthritis of knee total replacement (TKR) is only effective treatment. The results of TKR are excellent which needs proper pre op evaluation and planning. For a successful TKR, achievement of normal limb alignment is must. Various study has shown relation between the success of total knee arthroplasty (TKA) and restoration of the normal limb alignment^[2,3,4]. In normal knees, the distal femoral joint surface is at valgus angle of around 9 degree and tibial joint surface is at a varus angle of approximately 2 to 3° in relation to the

mechanical axis. But keeping tibial surface in varus leads to collapse of tibial component^[5] so that it should be at neutral angle from ground and femoral component should be placed along mechanical axis of femur

Incorrect alignment of TKA has been identified as a cause of long-term complications, including accelerated wear^[6,7] premature mechanical loosening of the implant^[8,9] and patellofemoral problems^[10,11,12] such as patella-femoral instability and patellar fracture.

Aims and Objective

To measure angle between anatomical and mechanical axis of femur in Indian population for ideal distal femoral cut in TKR

Material and Methods

We have done study in revival bone and joint hospital thane between July 2016 to December 2016 to measure required distal femur valgus cut angle by calculating angle between mechanical and anatomical axis (Q).

Inclusion criteria

- Patients posted for TKR operations
- Primary osteoarthritis

Exclusion criteria

- Secondary osteoarthritis
 - Osteoarthritis of the hip
 - Ipsilateral hip prosthesis
 - Previous femoral osteotomy
 - Previous tibial osteotomy
- Extra-articular deformity

Radiographic Evaluation

The radiographic evaluation was done on antero-posterior (AP) radiographs of the lower limbs with weight-bearing on both feet. All the radiographs were produced at the imaging examination centre of our service. The examinations were performed with the patients positioned with their limbs at neutral rotation and maximum extension.

In all the radiographic examinations, we defined: (1) the anatomical axis of the femoral diaphysis; (2) the mechanical femoral axis;

Mechanical Axis of femur

Femoral mechanical axis runs from the head of the femur to the centre of intercondylar notch of the distal femur (fig 1) ^[13] In total knee replacement distal femur cut should be perpendicular to it.

Anatomic Axis of femur

A line drawn proximal to distal in the intramedullary canal bisecting the femur in one-half is anatomical axis^[13] (Fig. 1). For distal femoral cut intramedullary jig is gold standard, which is introduced slightly medial and posterior to the centre of the notch so that intramedullary rod is along is the anatomical axis of femur. The ideal distal femoral cut angle corresponded to the

intersection between the anatomical axis and the femoral mechanical axis (Fig. 1).



Fig. 1 Radiograph of the lower limbs. (1) Femoral anatomical axis. (2) Femoral mechanical axis. (3) Ideal femoral valgus.

Measurement of the angle formed between the femoral anatomical axis and mechanical axis is done with goniometer and used as distal femoral valgus cut.

The measurements were always made by two evaluators at different times using the same instruments with precision of the order of millimeters.

Results

123 patients (19 men and 104 women) were studied, with a total of 165 limbs. The patients' mean age was 67 years, with a range from 58 to 86. Surgery was performed on the right side in 89 cases and on the left side in 76 cases.

151 knees presented alignment with varus angles between 3° and 20° (mean 8.4°; standard deviation 3.5°). 9 knees presented preoperative alignment with valgus angles between 2.7° and

10° (mean 6.6°; standard deviation 3.1). Neutral preoperative alignment was observed in 5 cases. The ideal femoral valgus angle ranged from 3° to 9°, with a mean of 6.2°. Fig. 2 shows the distribution of the ideal distal femoral cut for the patient studied

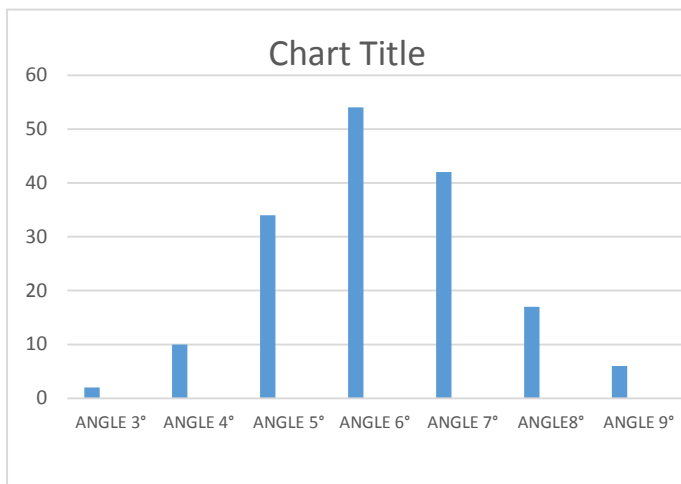


Fig. 2 Distribution of the numbers of patients among different femoral cut angles.

The male patients presented an ideal distal femoral cut of 6.8° (range from 4.0° to 9°), while for the women, 6.1° was the ideal angle for the distal femoral cut (range from 3.0° to 9.0°).

Discussion

The ideal distal femoral valgus angle is critical for limb alignment, so, precise radiographic standards need to be used in radiographs, especially with regard of external rotation of the lower limbs while taking radiograph. Radiographs with external rotation of limb produce larger femoral valgus angles because of the anatomical bowing of the femur along the sagittal axis. Because of this, only radiographs with correct rotation, were included in which the lesser trochanter did not appear and the patella was centralized on the knee^[14] Extra-articular deformity also alter angle unpredictably so excluded from the study. To gain neutral alignment of the lower limb is one of the objective of TKR, through making bone cuts perpendicularly to the mechanical axes of the femur and tibia^[15] It is a common practice among many surgeons to use the same distal femoral cut

angle for all patients and to assume that there is minimal variation in the angle between the mechanical and anatomical axes of different patients' knees. In our study we found wide distribution of angle from 3 to 9 degree though mean angle was 6 degree Despite a tendency for the distal femoral cut to be greater in men than in women (6.8° versus 6.1°), there was no statistical difference between the groups, which is concordant with the current literature^[16, 17, 18]. The preoperative coronal alignment of limb did not significantly correlate with the distal femoral cut in this study. This value was affected by only anatomical factors of the femur. Tibial factor does not affect distal femoral cut On the other hand, Deakin et al.^[19] has shown a relationship between the distal femoral cut and the alignment of the lower limb, which should be less than 6° in valgus cases and greater than 6° in severe varus cases.

Conclusion

The mean angle between the femoral mechanical axis and the femoral anatomical axis was 6.2°. But there is wide distribution of angle from 3 to 9 degree so distal femoral cut angle should be individualised. There is no significant differences in male and female population.

References

1. Epidemiology of knee osteoarthritis in India and related factors <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5017174/>
2. Bargren J.H., Blaha J.D., Freeman M.A. Alignment in total knee arthroplasty. Correlated biomechanical and clinical observations. Clin Orthop Relat Res. 1983;(173):178–183. [PubMed]
3. Bächis H., Perlick L., Tingart M., Lüring C., Zurakowski D., Grifka J. Alignment in total knee arthroplasty. A comparison of computer-assisted surgery with the conventional technique. J Bone Joint Surg Br. 2004;86(5):682–687. [PubMed]

4. Jeffery R.S., Morris R.W., Denham R.A. Coronal alignment after total knee replacement. *J Bone Joint Surg Br.* 1991;73 (5):709–714. [PubMed]
5. Tew M., Waugh W. Tibiofemoral alignment and the results of knee replacement. *J Bone Joint Surg Br.* 1985;67 (4):551–556. [PubMed]
6. Eckhoff D.G., Piatt B.E., Gnadinger C.A., Blaschke R.C. Assessing rotational alignment in total knee arthroplasty. *Clin Orthop Relat Res.* 1995;1995(318):176–181. [PubMed]
7. Wasielewski R.C., Galante J.O., Leighty R.M., Natarajan R.N., Rosenberg A.G. Wear patterns on retrieved polyethylene tibial inserts and their relationship to technical considerations during total knee arthroplasty. *Clin Orthop Relat Res.* 1994;299:31–43. [PubMed]
8. Hood R.W., Vanni M., Insall J.N. The correction of knee alignment in 225 consecutive total condylar knee replacements. *Clin Orthop Relat Res.* 1981;(160):94–105. [PubMed]
9. Moreland J.R. Mechanisms of failure in total knee arthroplasty. *Clin Orthop Relat Res.* 1988;1988 (226):49–64. [PubMed]
10. Berger R.A., Rubash H.E., Seel M.J., Thompson W.H., Crosssett L.S. Determining the rotational alignment of the femoral component in total knee arthroplasty using the epicondylar axis. *Clin Orthop Relat Res.* 1993;1993(286):40–47. [PubMed]
11. Arima J., Whiteside L.A., McCarthy D.S., White S.E. Femoral rotational alignment, based on the anteroposterior axis, in total knee arthroplasty in a valgus knee. A technical note. *J Bone Joint Surg Am.* 1995;77(9):1331–1334. [PubMed]
12. Figgie H.E. 3rd., Goldberg V.M., Figgie M.P., Inglis A.E., Kelly M., Sobel M. The effect of alignment of the implant on fractures of the patella after condylar total knee arthroplasty. *J Bone Joint Surg Am.* 1989;71(7):1031–1039. [PubMed]
13. Luo CF. Reference axes for reconstruction of the knee. *Knee.* 2004;11:251. doi: 10.1016/j.knee.2004.03.003. [PubMed] [Cross Ref]
14. Skyttä E.T., Haapamäki V., Koivikko M., Huhtala H., Remes V. Reliability of the hip-to-ankle radiograph in determining the knee and implant alignment after total knee arthroplasty. *Acta Orthop Belg.* 2011; 77(3):329–335. [PubMed]
15. Deakin A.H., Basanagoudar P.L., Nunag P., Johnston A.T., Sarungi M. Natural distribution of the femoral mechanical-anatomical angle in an osteoarthritic population and its relevance to total knee arthroplasty. *Knee.* 2012;19(2):120–123. [PubMed]
16. Rezende F.C., Ferreira M.C., Debieux P., Franciozi C.E., Luzo M.V., Carneiro M. É seguro o corte femoral distal em artroplastia total do joelho com 5 ° a 6 ° de valgo empiricamente na população geriátrica brasileira? *Rev Bras Ortop.* 2013;48(5):421–426
17. Hsu R.W., Himeno S., Coventry M.B., Chao E.Y. Normal axial alignment of the lower extremity and load-bearing distribution at the knee. *Clin Orthop Relat Res.* 1990;(255):215–227. [PubMed]
18. Tang W.M., Zhu Y.H., Chiu K.Y. Axial alignment of the lower extremity in Chinese adults. *J Bone Joint Surg Am.* 2000;82(11):1603–1608. [PubMed]
19. Deakin A.H., Basanagoudar P.L., Nunag P., Johnston A.T., Sarungi M. Natural distribution of the femoral mechanical-anatomical angle in an osteoarthritic population and its relevance to total knee arthroplasty. *Knee.* 2012;19(2):120–123. [PubMed]