

Retrospective Evaluation of the Femoral Rotational Asymmetry: An Observational Study

Ramkumar Singhal¹, Madhuri Agrawal^{2*}

¹Assistant Professor, Department of Anatomy, Government Medical College, Barmer, Rajasthan, India.

^{2*}Assistant Professor, Department of Pathology, Government Medical College, Barmer, Rajasthan, India.

ABSTRACT

Background: Femoral component malrotation is a cause of pain, stiffness, patellofemoral complications and component failure in total knee arthroplasty (TKA). Hence; the present study was undertaken for retrospectively assessing Femoral Rotational Asymmetry.

Materials and Methods: Screening of a total of 145 patients was done. Therefore, overall, a total of 290 knees were scanned. Natural depression of the medial epicondyle was not obvious on CT was categorized as an "indistinct" medial epicondylar sulcus. Separate data record was maintained for assessing the CT scans. Major anatomical landmarks used as reference points in the present study were: Lateral epicondyle, Medial epicondylar sulcus and Posterior condyles. All the records were transferred into computer and were assessed by a software program. Region of interest points (RP) were used for marking the anatomical landmarks chosen in the present study.

Results: A total of 290 knees were scanned. Mean degree of Whiteside's line was +2.7°, while mean degree of sulcus line was +1.4°. Mean degree of posterior condylar line was -2.2°, whereas average Sulcus line and Posterior condylar line was –

0.3 Average Sulcus line and Posterior condylar line. Outlier rate for Whiteside's line was 52 percent, while outlier rate for sulcus line was 24 %. Outlier rate for posterior condylar line was 35 percent.

Conclusion: For the assessment of rotational alignment of the trochlear groove, the Sulcus line technique is more precise in comparison to Whiteside's Line.

Keywords: Asymmetry, Femoral, Rotation.

*Correspondence to:

Dr. Madhuri Agrawal,
Assistant Professor,
Department of Pathology,
Government Medical College, Barmer, Rajasthan, India.

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INTRODUCTION

Femoral component malrotation is a cause of pain, stiffness, patellofemoral complications and component failure in total knee arthroplasty (TKA). Current recommendations suggest that the combination of two or more anatomical landmarks or the use of preoperative CT scans may be necessary to improve accuracy. Recent research has described the benefits of the use of the sulcus line (SL) over the traditional anteroposterior axis, also known as Whiteside's line (WL). The SL allows the rotational alignment of the trochlear groove to be more accurately isolated than previous techniques.¹⁻³

Many contributing factors have been suggested as a possible cause of patellofemoral pain, including an increased Q angle, patella alta, abnormal or excessive foot pronation, quadriceps femoris (vastus medialis) muscle weakness, diminished flexibility of the hamstring and rectus femoris muscles, malalignment of the femur, and weakness of the hip.²⁻⁴ Hence; under the light of above mentioned data, the present study was undertaken for retrospectively assessing Femoral Rotational Asymmetry.

MATERIALS AND METHODS:

The present study was conducted in the Department of Anatomy, Government Medical College, Barmer, Rajasthan, India and it included retrospective assessment of the femoral rotational asymmetry. Ethical approval was obtained from the ethical committee of the institution and written consent was obtained after explaining in detail the entire research protocol. Screening of a total of 145 patients was done. Therefore, overall, a total of 290 knees were scanned.

Inclusion Criteria:

- Patients who underwent hip replacement surgery,
- Patients in which preoperative knee CT scans were available,
- Patients with absence of knee arthritis
- Patients in which image quality of the scans was obscured by any artifact

Natural depression of the medial epicondyle was not obvious on CT was categorized as an "indistinct" medial epicondylar sulcus.

Separate data record was maintained for assessing the CT scans. Major anatomical landmarks used as reference points in the present study were:

- Lateral epicondyle,
- Medial epicondylar sulcus and
- Posterior condyles

All the records were transferred into computer and were assessed by a software program. Region of interest points (RP) were used for marking the anatomical landmarks chosen in the present study. All the results were recorded in Microsoft excel sheet and were analyzed by SPSS software. Univariate regression curve was used for assessment of level of significance.

Table 1: Rotational landmark angles assessed in relation to surgical epicondylar axis (SEA)

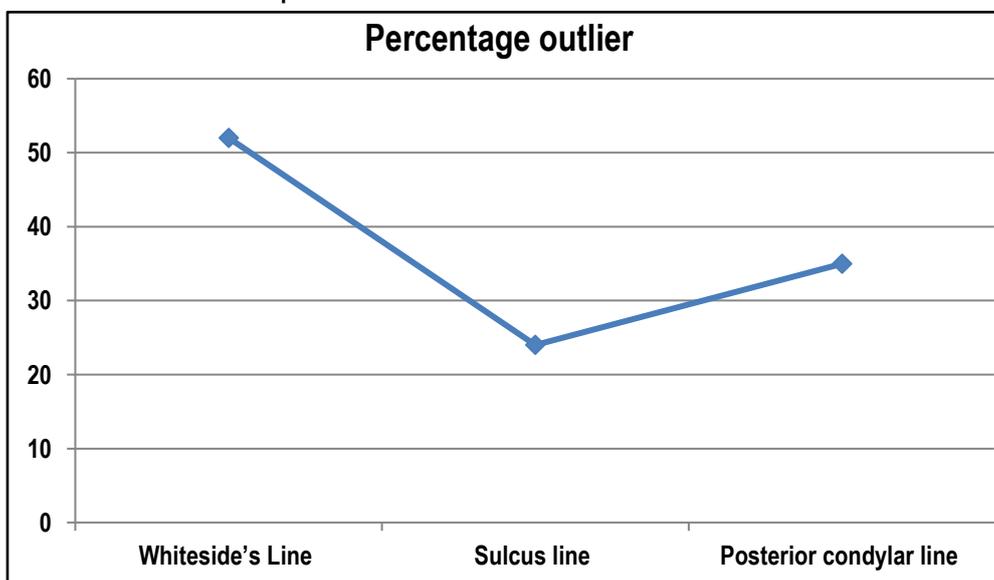
Landmark	Mean (Degree)	SD (Degree)
Whiteside's Line	+2.7	3.2
Sulcus line	+1.4	2.9
Posterior condylar line	-2.2	1.9
Average Sulcus line and Posterior condylar line	-0.3	1.6

Whiteside's line: Begins posteriorly at the centre of the intercondylar notch

Table 2: Outlier rate for each anatomical landmark

Landmark	Percentage outlier
Whiteside's Line	52 %
Sulcus line	24 %
Posterior condylar line	35 %

Graph 1: Outlier rate for each anatomical landmark



RESULTS

In the present study, a total of 290 knees were scanned. Mean degree of Whiteside's line was +2.7°, while mean degree of sulcus line was +1.4°. Mean degree of posterior condylar line was -2.2°, whereas average Sulcus line and Posterior condylar line was -0.3 Average Sulcus line and Posterior condylar line. Outlier rate for Whiteside's line was 52 percent, while outlier rate for sulcus line was 24 %. Outlier rate for posterior condylar line was 35 percent.

DISCUSSION

In the present study, a total of 290 knees were scanned. Mean degree of Whiteside's line was +2.7°, while mean degree of sulcus line was +1.4°. Mean degree of posterior condylar line was -2.2°, whereas average Sulcus line and Posterior condylar line

was -0.3 Average Sulcus line and Posterior condylar line. In a previous study, Newman CR et al measured the SL and assess its reliability relative to WL, in addition to measuring and classifying the FRA. A retrospective analysis of a series of 191 CT scans of nonarthritic knees was performed. Measurements were taken of rotational landmarks in three-dimensional reconstructions. The variability and outlier rate of SL was less than WL (P < 0.05), however, it was also greater than the posterior condylar line (PC) (P < 0.05). Averaging the PC + 3° and the SL did not change the rate of femoral malrotation relative to the surgical epicondylar axis (SEA) (P > 0.05), however it decreased the rate of change of the rotational alignment of the trochlear groove between the native knee and the prosthetic knee from 31% to 5% (P < 0.05). FRA was classified and was >5° in 56/191 (29%) of cases. The SL

technique is more accurate than WL for determining the rotational alignment of the trochlear groove. Nonarthritic femora have a high rate of rotational asymmetry. Identifying and classifying FRA in individual cases allows the femoral component to be inserted in a position which gives the best possible match to both the native posterior condyles and trochlear groove.¹⁰

Drawing the SL during surgery is technically relatively easy. However, it needs to be appreciated that it is not WL. It is best done by careful palpation leading up from the intercondylar notch. This vertical section is not affected by trochlear dysplasia and patellofemoral osteoarthritis which can obliterate the proximal section of the groove. Several studies have confirmed that the proximal section, which is referenced in WL, is prone to excessive variability. Therefore, the distal section of the trochlear, which largely runs in the appropriate axial plane, is used but the most proximal 1–2 cm of the groove is not referenced.⁹⁻¹⁰

In the present study, Outlier rate for Whiteside's line was 52 percent, while outlier rate for sulcus line was 24 %. Outlier rate for posterior condylar line was 35 percent.

Chao TW et al tested the hypothesis that averaging the SL and posterior condylar axis (PCA) will reduce femoral malrotation. The component was inserted at a position between the SL and PCA in 91 patients. An intraoperative photograph was taken showing the landmarks. These were compared to the component position achieved relative to the surgical epicondylar axis (SEA) on a postoperative CT scan. The component position was compared to the position achieved using the individual landmarks. Relative to the SEA, the final component position was 0.6° (SD 1.4°, range -3.8° to +4.0°), the coronally corrected SL position was -0.7° (SD 2.3°, -5.5° to +4.6°), the PCA position was 0.9° (SD 1.9°, -6.1° to +5.0°). Averaging the landmarks significantly decreased the variance of the component position compared to using the SL and PCA individually. The number of outliers (>3° from SEA) was also significantly less (p < 0.05) for the average position (2/84) when each was compared to the SL (16/84) and PCA (14/84) individually. In 21/84 (25%) of cases, there was more than 4° of divergence between the SL and PCA. Averaging the SL and the PCA decreases femoral component malrotation.¹¹

The predictability of hip rotation in gait from the measurement of anatomic deformity was assessed by Aktas S et al. Computed tomography (CT) measurements of femoral anteversion and physical examination data failed to predict the hip rotation in gait. However, tibial (CT) measurements and physical examination data highly correlated with tibial rotation in gait. They conclude the dynamic component of hip rotation during gait is significant, as anatomic deformity did not predict gait deviations.¹²

CONCLUSION

From the above results, the authors conclude that for the assessment of rotational alignment of the trochlear groove, the Sulcus line technique is more precise in comparison to Whiteside's Line. However; further studies are recommended.

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