Section: Orthopaedics

Original Research Article

# COMPARISON OF POSTERIOR TIBIAL SLOPE& METAPHYSIO-DIAPHYSEAL ANGLE IN SUBJECTS WITH KNEE PAIN WITH AND WITHOUT OSTEOARTHRITIS

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ABSTRACT

**Background:** Osteoarthritis (OA) is a progressive degenerative joint disorder and a leading cause of pain and disability, particularly among the elderly. Structural parameters like the posterior tibial slope (PTS) and metaphysio-diaphyseal angle (MDA) have been found to influence knee biomechanics, joint stability, and surgical outcomes. Alterations in these angles may accelerate cartilage degeneration and influence osteoarthritic progression.

**Materials and Methods:** This was a comparative radiographic study conducted on adult patients to evaluate variations in PTS and MDA between osteoarthritic and non-osteoarthritic knees. Standard lateral knee radiographs were analysed using established anatomical landmarks to calculate both PTS and MDA. Inclusion criteria ensured appropriate visualisation of tibial landmarks, while exclusion criteria ruled out previous surgeries or fractures. Measurements were made using the posterior tibial cortex for PTS and the anatomical axis for MDA. Statistical analysis included correlation coefficients and ROC curves to evaluate diagnostic relevance.

**Results:** The study demonstrated significantly higher mean PTS and MDA values in osteoarthritic knees compared to controls. A positive correlation was observed between increased PTS and reduced range of motion. ROC analysis showed good sensitivity and specificity of these parameters in predicting OA, particularly with a threshold PTS > 10.5° and MDA > 3.5°. These anatomical deviations were more pronounced in patients with advanced radiological grading of OA.

**Conclusion:** Posterior tibial slope and metaphysio-diaphyseal angle are significantly altered in osteoarthritic knees and serve as radiographic predictors of disease progression. Their inclusion in preoperative evaluation may guide early diagnosis and tailored surgical planning, especially in total knee arthroplasty.

**Keywords:** Osteoarthritis, Posterior Tibial Slope, Metaphysio-diaphyseal Angle, Knee Joint, Radiographic Analysis, Range of Motion, Biomechanics.

## INTRODUCTION

Osteoarthritis (OA) is a chronic degenerative disorder that has become increasingly prevalent in the modern era. It is a leading cause of pain, disability, and reduced quality of life in affected individuals.[1] OA is characterised by progressive structural and functional deterioration of the joints due to complex biomechanical, biochemical, and inflammatory processes.

In the Indian population, 80% of individuals with knee pain are diagnosed with OA, of which approximately 20% experience significant limitations in daily activities, and 11% require special

care. It is projected that by 2025, nearly 80% of individuals over 65 years in India will exhibit signs of OA, making it a major public health concern.[2]

In the biomechanical analysis of the knee joint, the posterior tibial slope (PTS) and metaphysio-diaphyseal angle (MDA) have emerged as significant parameters influencing joint stability and OA progression. The PTS is the angle formed between the vertical axis of the tibial anatomical shaft and the tibial plateau.[4]

The correlation between PTS and MDA is of great clinical interest. Studies have demonstrated a moderate to strong correlation (r = 0.62 – 0.72) between these two angles, suggesting that their combined effect influences knee joint alignment, OA progression, and post-surgical stability.

## MATERIALS AND METHODS

**Study Design:** Cross-sectional study

**Duration Of Study:** 18 months (April 2023 to September 2024).

**Study Population:** Patients attending the department of orthopaedics in RRMCH,
Bangalore.

**Study Area:** Rajarajeswari Medical College and Hospital, Bangalore.

**Inclusion Criteria**

- Patients over 40 years of age presenting with complaints of pain in their knee joint

**Exclusion Criteria**

- History of acute trauma
- History of prior surgeries in the knee
- Patients refusing to give written informed consent.

**Estimation of Sample Size**

YAMANE EQUATION: (FOR KNOWN POPULATION SIZE) (SAMPLE SIZE)

n = N/ 1 + N e2

Where N =Population size

e = margin of error

(For 95 % confidence level, Margin error -0.05) Cases satisfying the inclusion criteria admitted in RRMCH, Bangalore during the study period of April 2023 to September 2024 will be included. According to the hospital statistics, an average number of 100 patients per year satisfying the inclusion criteria have undergone various surgical modalities in previous two years. Hence, I intend to study about 150 cases during the study period.

**Standardised Procedure**

The X-ray tube is positioned with a 10° caudal tilt, confirmed using a level pitch and slope locator before imaging. The plexiglass frame is placed against the Bucky tray, ensuring proper alignment of the X-ray beam between the knees.

The Bucky height is adjusted so the film centre aligns with the tibiofemoral joint line. A coin is taped 18 inches from the bottom of the plexiglass frame to assess magnification and verify side markers.

Participants stand barefoot, with both knees facing the film cassette at a 72-inch film-to-focus distance (FFD). Weight is evenly distributed, with toes touching the plexiglass front plate and heels resting against the foot angulation support for consistent positioning. To ensure reproducible knee flexion, the knees and thighs must press against the front plate, and participants are asked to lean forward so that their thighs also make contact with the frame, aligning the tibial plateau at a 10° caudal angle For the PA view, image quality is assessed by ensuring superimposition of the anterior and posterior tibial plateau edges. If the tibial plateau nearly touches or overlaps the distal femoral condyle, the X-ray is repeated at 5° and 15° beam angles. For the lateral view, the knee is centered on the film, and the central ray is
directed perpendicular to the joint without angling the tube. The beam is centered on the flexed knee joint, ensuring even weight distribution. Essential anatomical landmarks, including the tibial tubercle, upper patella border, patellar front, and upper fibula end and the contours of the femoral condyles must nearly overlap; if they are separated by ≥1 cm, the lateral view is considered excessively rotated.


**Figure 1: Posterior tibial slope by "mechanical axis"**


**Figure 2: MDA**

# RESULTS

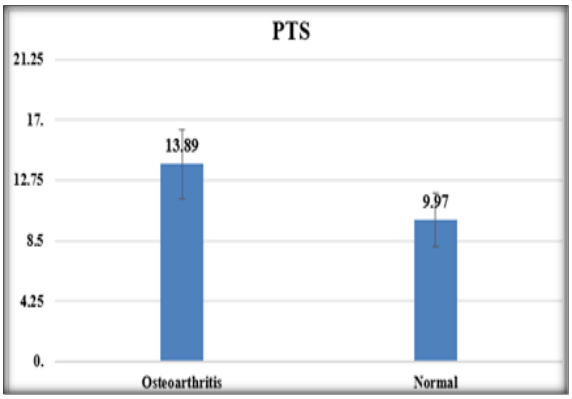
**Table 1: PTS**

| PTS | Group | | P VALUE |
|---|---|---|---|
| | Osteoarthritis | Normal | |
| MEAN | 13.89 | 9.97 | <0.05 |
| SD | 2.457 | 1.91 | |

**Table 2: MDA**

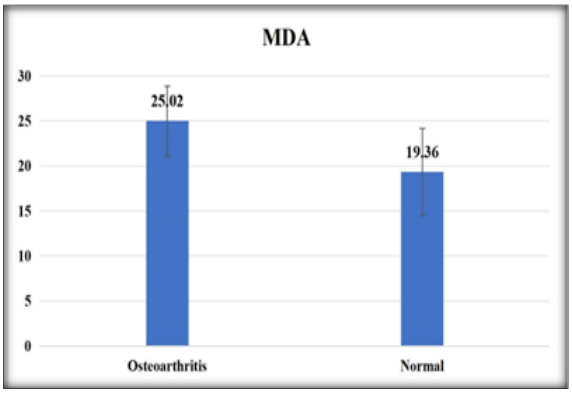
| MDA | Group | | P VALUE |
|---|---|---|---|
| | Osteoarthritis | Normal | |
| MEAN | 25.02 | 19.36 | <0.05 |
| SD | 3.844 | 4.812 | |

The mean Metaphysio-diaphyseal Angle was substantially greater in the OA group (25.02° ± 3.844) compared to the normal group (19.36° ± 4.812), and this difference was statistically significant ($p < 0.05$). This suggests that MDA could serve as an anatomical marker related to osteoarthritis, perhaps indicative of altered joint or bone alignment patterns that predispose to or reflect disease presence.




**Graph 1: PTS**

The average Posterior Tibial Slope was notably higher in the OA group (mean = 13.89° ± 2.457) than in the normal group (mean = 9.97° ± 1.91), with a statistically significant p-value of <0.05. This finding implies that an increased posterior tibial slope may be a morphological feature associated with osteoarthritic changes in the knee, potentially influencing joint mechanics and load distribution.




**Graph 2: MDA**

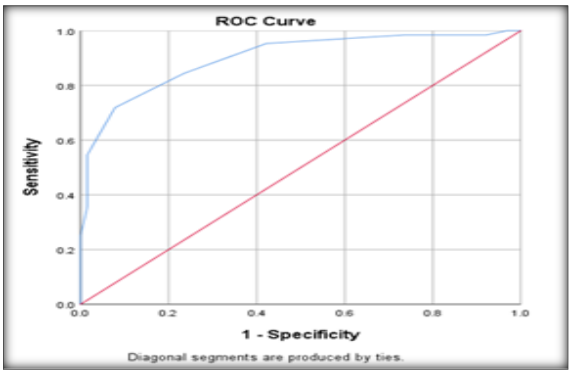



**Figure 3: ROC Curve of PTS in predicting osteoarthritis**

ROC analysis for PTS revealed a high area under the curve (AUC) of 0.900, indicating excellent diagnostic potential. The optimal cut-off score for predicting OA was determined to be 11°, with an outstanding sensitivity of 98.4% and specificity of 96.9%. The statistical significance ($p = 0.001$) and narrow confidence interval (95% CI: 0.846–0.953) underscore the robustness of PTS as a predictive marker for knee osteoarthritis.

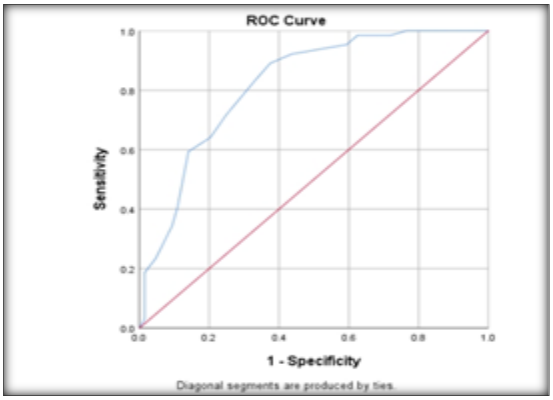



**Figure 4: ROC Curve of MDA in predicting osteoarthritis**

In the case of MDA, the ROC curve yielded an AUC of 0.82, which also signifies strong diagnostic utility. The chosen cut-off score was 22°, producing a sensitivity of 98.4% and specificity of 89.1%. The p-value of 0.001 and the 95% confidence interval (0.747–0.893) confirm the statistical and clinical value of MDA in predicting the presence of

osteoarthritis, although with slightly less discriminative power than PTS.

## DISCUSSION

Accurate measurement of anatomical parameters such as the posterior tibial slope (PTS) and the metaphysio-diaphyseal angle (MDA) has gained increasing relevance in the orthopaedic and radiological evaluation of knee joint pathology, particularly in the early diagnosis, progression assessment, and surgical planning for osteoarthritis (OA). These angles are not merely incidental radiographic observations but represent quantifiable structural changes that reflect underlying biomechanical adaptations and degenerative processes within the knee. The tibial slope plays a crucial role in determining anterior-posterior translation and joint stability, influencing load transmission across the tibiofemoral and patellofemoral compartments. Alterations in PTS can significantly affect ligament tension, meniscal contact forces, and kinematic behaviour of the knee joint during weight-bearing and flexion, thus becoming a potential predictor of disease initiation and progression.

Similarly, the metaphysio-diaphyseal angle serves as a geometric marker for alignment between the proximal tibial metaphysis and diaphysis. An increased MDA may reflect compensatory or pathological remodelling in response to uneven loading, varus-valgus deformities, or chronic instability. Both angles are particularly important in distinguishing osteoarthritic from non-osteoarthritic knees, as these parameters are often altered before gross radiological features like joint space narrowing or osteophyte formation become evident. More importantly, recent advances in imaging and digital radiography have allowed for more reproducible and precise measurement of these angles, enabling their integration into diagnostic algorithms and preoperative assessments.

Given their biomechanical significance and their evolving role in evidence-based orthopaedics, it is imperative to explore the relationship between these angular parameters and clinical osteoarthritis status. Studies that evaluate these measures across OA and non-OA populations not only enhance our understanding of disease etiology but also pave the way for more individualised interventions. The current study contributes to this growing body of literature by quantitatively analysing PTS and MDA values in patients with and without OA and by establishing cut-off values that can aid in the early diagnosis and stratification of knee osteoarthritis risk.

## CONCLUSION

Our study demonstrates that both posterior tibial slope (PTS) and metaphysio-diaphyseal angle (MDA) are significantly elevated in individuals with knee osteoarthritis compared to those without. The findings confirm a strong statistical association between increased morphological angles and the presence of osteoarthritic changes, with excellent predictive accuracy observed for both parameters. These results reinforce the hypothesis that altered tibial anatomy may not merely be a consequence but potentially a predisposing factor in the pathogenesis of knee osteoarthritis. Therefore, PTS and MDA hold promise as accessible, cost-effective radiological markers that can assist in early diagnosis, risk stratification, and potentially in guiding surgical decisions such as total knee arthroplasty planning. However, further research with improved design and broader scope is warranted to confirm these findings and to explore their utility in routine clinical practice.

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