



## AN IN VIVO ANTHROPOMETRIC STUDY ON FEMORAL AND TIBIAL MORPHOLOGY AND COMPARISON WITH THREE DIFFERENT IMPLANT SYSTEMS IN INDIAN POPULATION: AN EFFECTIVE INDIGENOUS STUDY. “TRANSFORMATION FROM ACCURACY TO PRECISION IN TOTAL KNEE ARTHROPLASTY”

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### Abstract:

**Background:** Total Knee Arthroplasty is very successful procedure with almost 98% of successful outcomes. The ease of surgical techniques and wide range availability of Implants made this surgery very competent and encouraging. Most of the Implants have been studied and designed in various countries. In our study we measured our Indian Knees intra operatively and assessed the anthropometry of wide popular implant systems which are used across the world (SMITH & NEPHEW, DEPUY, ZIMMER).

**Materials and Methods:** We studied 151 patients who underwent Total Knee Replacement in our hospital and measured intraoperatively the native anatomy measurements of femur and tibia of Indian Population and compared with the dimensions of Femoral and Tibial components of Femur and Tibia of Genesis II, SMITH & NEPHEW, DEPUY, ZIMMER implant system.

**Results:** There was a huge variability between the patient anatomical parameters and the actual implant kept except for femur MCAP, LCAP, Tibia ML in Depuy.

**Conclusion:** We conclude by saying that there is a significant mismatch of Measurements between the femur native human anatomy and components of Implant systems. Therefore there is a wide scope of generating the appropriateness of Implant designs and Dimensions according to Indian Native Human Anatomy in the field of Total Knee Arthroplasty.

**Key Words:** Anthropometry, Total Knee Arthroplasty, Femoral Component, Tibial component, Indian Population, Indian Knee

## **Introduction:**

Total Knee Arthroplasty is one of the most effective and revolutionary procedure in the field of modern orthopaedics. It had undergone many evolutionary changes over the years and yet it is still to be fulfilled. With the advent of many tremendous evolutionary changes, myriad of fine implantation designs and newer techniques came into the limelight. There is always a vacuum for the Effectiveness, Preciseness, Implant design of Choice atleast nearing to Human Anatomic Knee despite a wide range variety of Implant Manufacturers all over the World<sup>1</sup>. In this path of desire and imagination of restoring well functional Anatomic knee in Indian Population we did this study in Indian Population for the Effective accuracy, Preciseness and Implant of Choice in the field of Arthroplasty.

## **Materials and Methods:**

We studied 151 patients of Indian Population in our Hospital who underwent Total Knee Arthroplasty for a period of one year from April 2024 to April 2025. We measured native femur and tibia measurements of patients intraoperatively and compared with the Implant dimensions. In Femur and tibia we measured Mediolateral measurements and AP measurements with the help of Vernier Callipers. After collecting the data, the data has been statistically analyzed by Unpaired t test.

## **Statistical Analysis:**

More than 4/5<sup>th</sup> of the study population's MAP diameter was matching to the patients anatomy. All others did not match. 89% of the participants ML diameter and 62 % of the femur AP diameter was higher than the prosthesis. So, overall 87% of the participants trochlear width and 99.3% of participants trochlear height was lesser than the prosthesis.

The overall mean was compared with the mean of the prosthesis overall, for males and females separately. Except for trochlear height in smith and depuy, and trochlear width in zimmer, all other results were statistically significant stating that there was a considerable difference between actual patient anatomy measurements and the prosthesis. When compared for female alone, the trochlear height and weight alone was not significant for all the types of prosthesis while all other measurements were significant. Similar results were obtained for males. Additionally femur ML was not significant for Depuy and smith.

Since each prosthesis type has a different measurement and also each prosthesis has different sizes, we compared the patient mean for the particular subtype of prosthesis implanted. There was a huge variability between the patient anatomical parameter and the actual implant kept except for femur MCAP, LCAP, Tibia ML in Depuy.

## **Results:**

Our statistical analysis proved that the femoral components dimensions and Tibial components of patient's anatomy and Implants anatomy are significantly mismatched. We found there is a significant morphological mismatch in the femoral side between commonly used implants and Indian knees femoral morphology.

Average values of Femur(Mediolateral:73.28mm, Medial AnteroPosterior:57.58mm, Lateral Anteroposterior:60.79mm, Trochlea width:37.7mm, Trochlear Height:27.7mm), Tibia(Mediolateral-70.18mm, Medial Anteroposterior: 48.58mm, Lateral Anteroposterior:41.65mm), Patella average is 22mm. We observed more variations in femur components and native femur whereas tibia morphology and the component has no much difference. Indian females were found to have significantly smaller dimensions of femur and tibia than Indian males and both had smaller aspect ratios than the Western population.

| P - Values       | Zimmer      | Depuy       | S & N       |
|------------------|-------------|-------------|-------------|
| Tibia AP         | 0.37529255  | 5.7931E-149 | 0.147136996 |
| Tibia ML         | 0.000762564 | 0.001619437 | 0.613167409 |
| Trochlear Height | 0.722288245 | 1.6965E-117 | 1.36555E-78 |
| Trochlear Width  | 5.48257E-47 | 2.67163E-77 | 4.70884E-37 |
| Femur LAP        | 1.60586E-05 | 8.92422E-11 | 1.99824E-29 |
| Femur ML         | 2.1724E-39  | 4.82146E-38 | 1.99824E-29 |
| Femur MAP        | 7.29479E-05 | 0.258026358 | 0.001413045 |

As p-values are proving satisfactory results to most of the variables among the three implant systems(ZIMMER,DEPUY, Smith and Nephew), they are doing well in Indian Population despite all odds of Anatomy in our study.

### Discussion:

As Total Knee Arthroplasty has been revolutionary and most in demand surgical procedure with very good functional outcomes the demand for the most effective, accuracy and precise tools is high to restore normal functional anatomic knee. In this view point, there are myriad of manufacturers across the globe generating various implant designs and implants. But there is no study compared with Indian native anatomic knee and Implant design. Most of the times we are forced to mould our knee to match the implant designs to prevent the future complications.

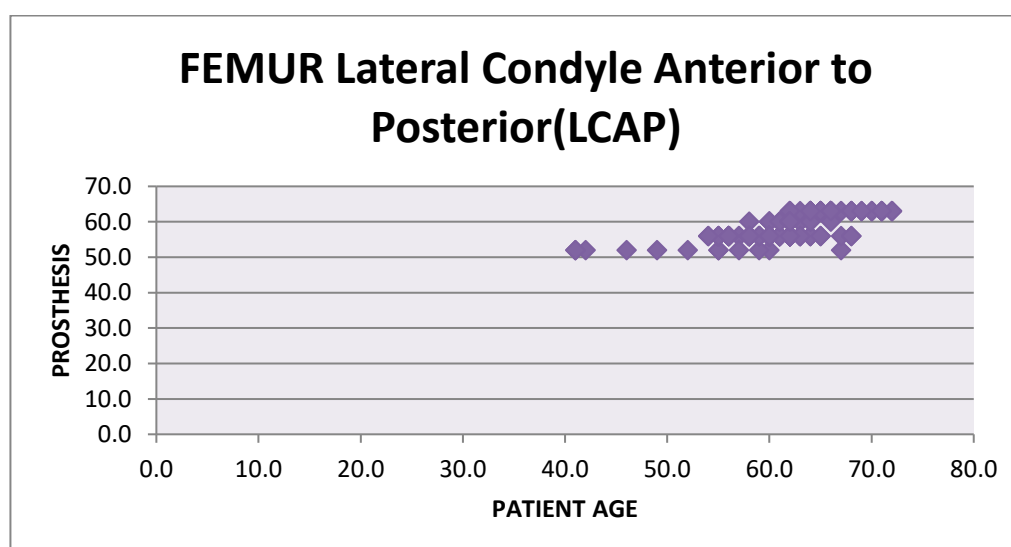
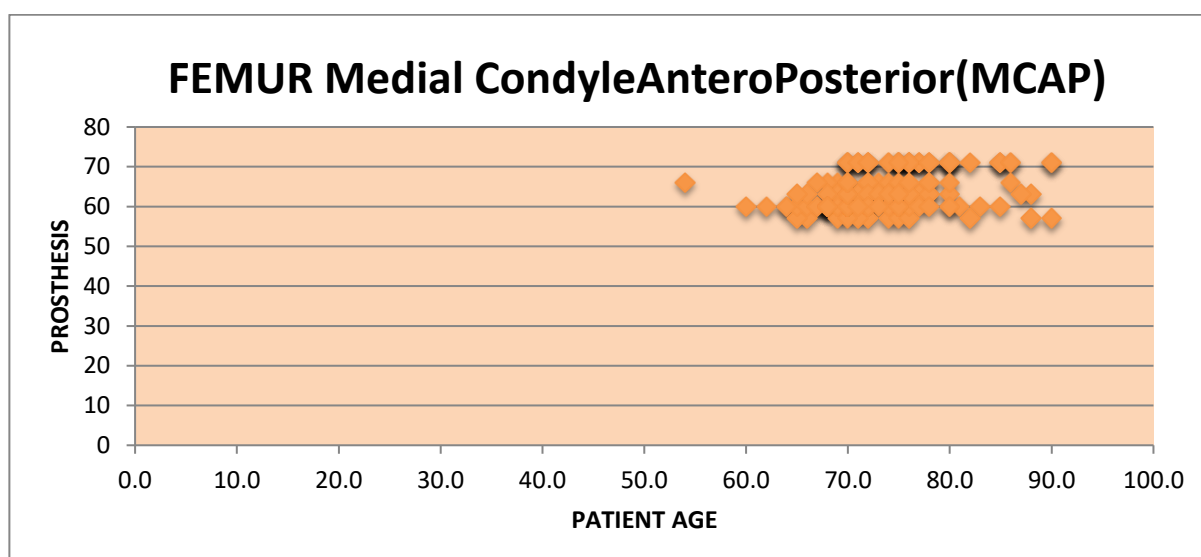
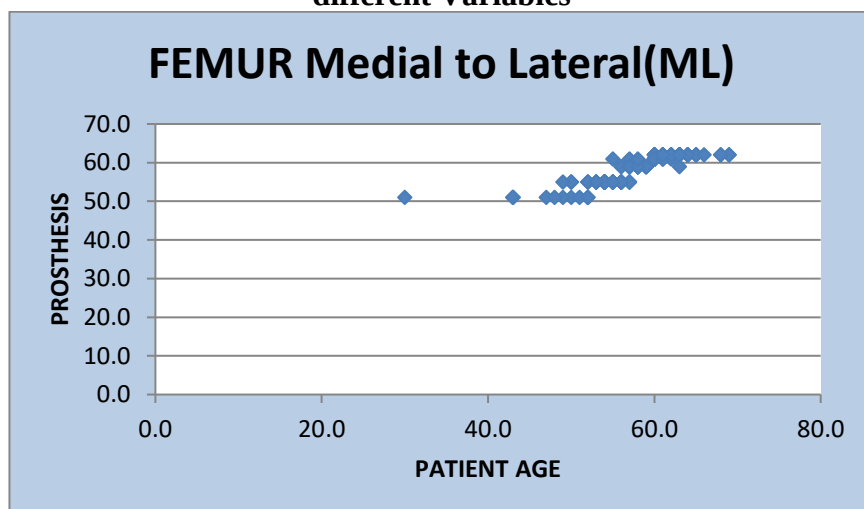
For long term survival of total knee arthroplasty, replaced prosthesis should match the knee size of the patient<sup>2</sup>. Maximal implant coverage on the bone surface minimizes the stress applied to the bone-implant interface<sup>3,4</sup>. Most TKA prosthesis designs are based on the anthropometry of western population, which differs from Asian knee morphometry<sup>5</sup>. Data of Indian knee morphometry of healthy and non osteoarthritic knee was lacking<sup>6</sup>.

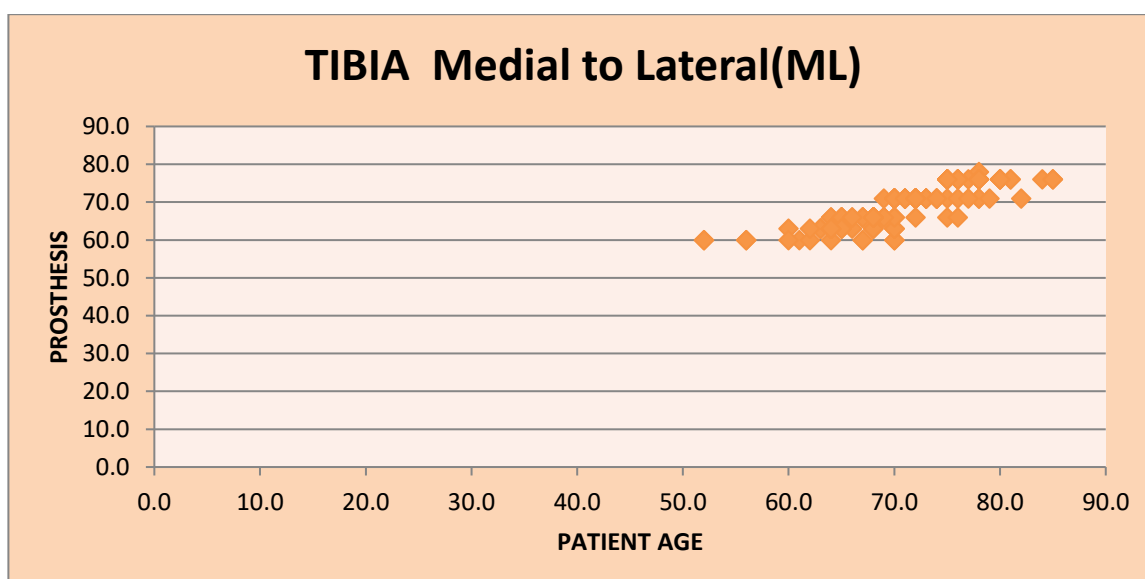
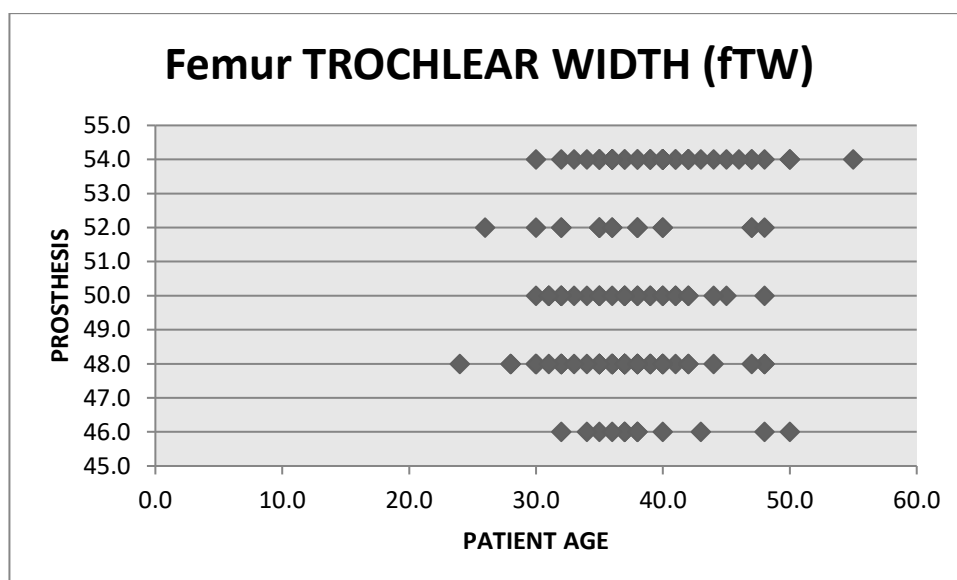
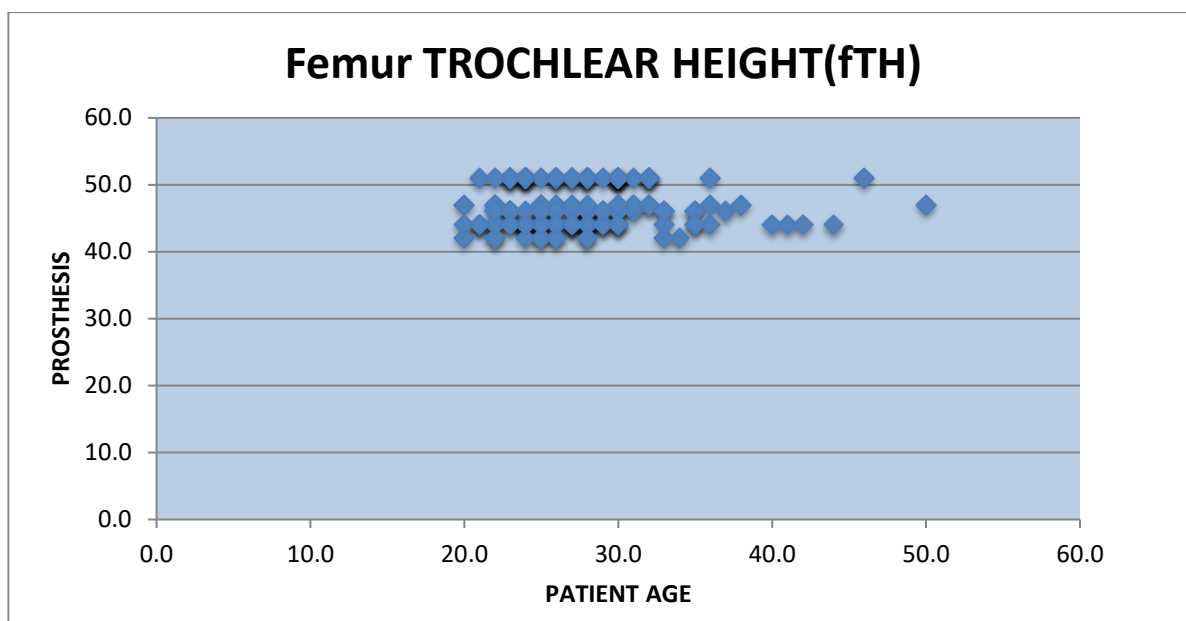
In our study we studied various Knees of Indian population, Intraoperatively we measured the dimensions of native anatomic knee and matched with GENESIS II, SMITH & NEPHEW IMPLANT SYSTEM, DEPUY PFC SIGMA, and ZIMMER BIOMET. During the sizing majority of times we need to cut more bone in order to accommodate the near implant component size to femur and tibia. In this context, we did compare the mismatch between the femoral and tibial components with patient's femur and tibia to know whether the mismatch is significant or not.

In contrast to these observations in the aspect ratios of Indian patients, variations in aspect ratios of most implants were insignificant. For both the femur and tibia, it was found that the ML dimension was undersized with smaller AP and overhang was observed for larger AP dimensions. Thus our results suggest that Western implants may not be suitable for Indian patients<sup>7</sup>.

Therefore, our results suggested that there is a significant mismatch between the native anatomic femur and femoral components and there is no significant mismatch between native tibia and tibial components. For the effective better functional outcomes it is always ideal to preserve as much as bone is available. This mismatch and loss of bone always throw avoid for the genesis of early complications which compromise the outcome of Total Knee Arthroplasty.

### Scatter Plots Depiction of Prosthesis and Patient age with Three different Implant Systems of different Variables





## Femur and Tibial Components and Intra Operative patient Femur and Tibia Measurements



Femur Component Medial Measuring Femur Component Trochlea width to lateral Measurement



Femur Component Medial Condyl Femur Component Trochlear Height Measurement  
AnteroPosterior Measurement



Intra Operative picture of Knee

Femur Lateral Condyle AnteroPosterior Measurement

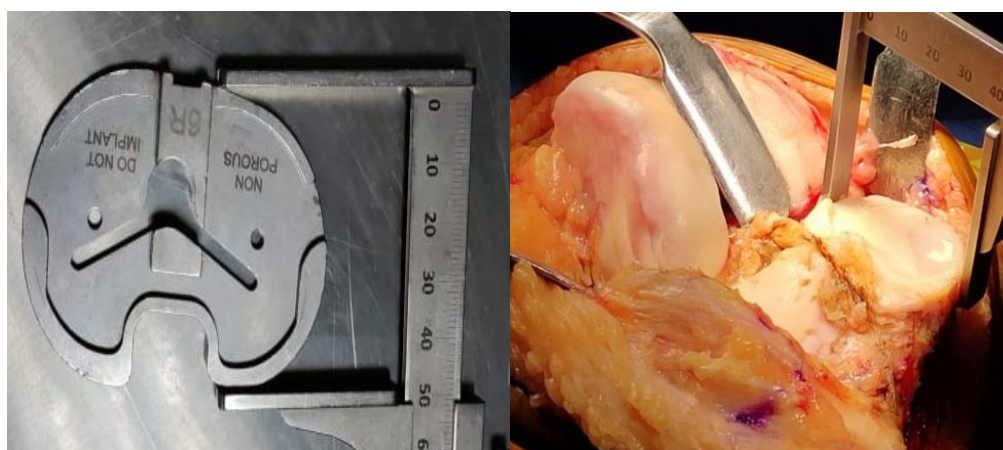
## Tibia Measurements



Tibial Component Medial to Lateral Measurement



Tibial component Medial Anteroposterior Measurement



Tibial Component Lateral Anteroposterior Measurement

The strengths of this study is Direct Observational study performed by one surgeon and with one implant system. The only limitation of this study is it is conducted in single centre. Therefore this study throws light on many studies to evolve and compare the mismatch of various knee systems used in Indian Population for effective functional outcomes with accurate design and dimensions and to restore native bone anatomy.

### **Conclusion:**

We conclude by there is mismatch of femoral anatomy and component sizes in different implant systems while performing Total Knee Arthroplasty in Indian Population. However tibial morphology and the component dimension didn't show significant difference in our study. This study will be helpful to innovate Implant designs and Dimensions from accuracy to precision according to Indian Native Human Anatomy for Total Knee Arthroplasty which can secure effective native anatomy and good clinical outcome. There is great need of innovation in accuracy of implant design and dimensions to be made which are appropriate for Indian Population for better functional outcomes and ease of doing Total Knee Arthroplasty.

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## References

1. Vaidya SV, Ranawat CS, Aroojis A, Laud NS. Anthropometric measurements to design total knee prostheses for the Indian population. *J Arthroplasty*. 2000; 15:79-85x.
2. Cheng CK, Lung CY, Lee YM, Huang CH. A new approach of designing the tibial base plate of total knee prosthesis. *Clin Biomech*. 1999; 14:112-7.
3. Insall JN. Surgical techniques and instrumentation in total knee arthroplasty. In: Insall JN, Windsor RE, Scott WN, editors. *Surgery of the Knee*. 2nd ed. New York: Churchill Livingstone. 1993, 739.
4. 5. Incavo SJ, Ronchetti PJ, Howe JG, Tranowski JP. Tibial plateau coverage in total knee arthroplasty. *Clin Orthop*. 1994; 299:81-5.
5. Shah DS, Ghyar R, Ravi B, Shetty V. 3D morphological Study of the Indian Arthritic Knee: Comparison with Other Ethnic Groups and Conformity of Current TKA Implant. *Open Journal of Rheumatology and Autoimmune Diseases*. 2013; 3:263-269.
6. Darshan Shah S, Rupesh Ghyar, Bhallamudi Ravi, Chintan Hegde, Vijay Shetty. Morphological Measurements of Knee Joints in Indian Population: Comparison to Current Knee Prostheses: *Open Journal of Rheumatology and Autoimmune Diseases*, 2014; 4:75-85.
7. Rahul Ramesh Kumar Agrawal, Tushar Ranjan Dalei and AV Gurava Reddy. Computer tomography 3D reconstruction based study of knee anthropometry of Indian population: Comparison with other ethnic groups and current TKA implants. *International Journal of Orthopaedics Sciences* 2017; 3(4): 242-249