ORIGINAL ARTICLE

Anthropomorphic mismatch between distal femurs and a standard total knee replacement system in Pakistani population

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Abstract

Aims: To compare the measurements of distal femurs of a Pakistani population and with the implants used.

Methods: The single-centre prospective cross-sectional study was conducted at the Indus Hospital, Karachi, from 01-06-2011 to 31-10-2011, and comprised total knee replacement patients. Surgeries were performed by the same team. Each measurement was taken after the resection of the trochlea (flush to the anterior femoral cortex), the distal cut and the anterior chamfer cuts. Measurements were taken intraoperatively with a sterile vernier calliper. SPSS 17was used to analyse the data.

Results: The mean age of the 33 patients in the study was 59.3±7years. There were 4(12.1%) males and 29(87.9%) females. A mismatch was found in per-operative measurements with the mean aspect ratio being 0.79±0.05and the standardised aspect ratio of the implants being 0.90 (SD±0.0).

Conclusions: There are differences between anthropomorphometry of our skeleton and Caucasian designed implants. This could have implications in the long term.

Keywords: Femoral morphopometry; Total knee replacement; Per-operative measurements; Aspect ratio; Pakistani population. (JPMA 64: S-8 (Suppl. 2); 2014)

Introduction

Knee arthritis is a constantly increasing problem worldwide and it is projected that the numbers of knee replacements will increase by 700% by the year 2030 in the United States of America alone.[1] Total Knee Replacements (TKRs) are highly successful interventions for knee arthritis.[2] The results of TKR have been reported by most series to have >90% good or excellent results.[3] Total joint replacements are more so called one of the most successful procedures in the history of surgery.[4]

The majority of these studies have been done on a western population and most of the implants are designed on the morphology of a Caucasian population. The results of a TKR may be adversely affected by a mismatch of the bone and component size. A study showed that femoral implant overhang of ≥3mm is associated with more severe pain two years postoperatively.[5] There have been reported variability in sizes between genders.[6] There is also documented anatomical variance between the Indian population and the available implants[7] which was done on radiological and cadaveric specimens only and not on live patients. In the quoted study, a statistically significant number of females (60.4%) had a smaller femoral Antero-Posterior (AP) measurement than the smallest size of the femoral implant available. The AP diameter of men ranged from a mean of 51.6±3.77mm to 64.42±4.43mm while that of females ranged from a mean of 52.01±2.25mm to60.59±1.56mm.[7] There is no data available from Pakistan covering this aspect although there is a large number of TKRs being done in the country with 1600 having been performed in 2010 alone, using Press-Fit Condylar (PFC) Sigma.

The current study was planned to measure and identify the anatomical variance in the distal femurs of a Pakistani population with the femoral component of the most commonly used TKR in the country. The results may influence the choice of implants used in our population and could help in formulating future guidelines.

Patients and Methods

The single-centre prospective cross-sectional study was conducted at the Indus Hospital, Karachi, from 01-06-2011 to 31-10-2011, and comprised patients undergoing TKR. After approval from the institutional review board, a sample of consecutive patients was inducted from among those who were of either gender ≥50 years of age undergoing elective TKR for degenerative joint disease (DJD) and inflammatory rheumatoid arthritis (RA).

The diagnosis was based on clinical grounds and only patients having Stage IV arthritis radiologically as per the Kellgren and Lawrence classification system[8,9] were included. Those not willing, having extensive deformities with bone loss, a flexion deformity ≥30 degrees and those

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with post-traumatic arthritis of the knee with intra-articular fracture were excluded. The same team of surgeons performed all surgeries. Each measurement was taken after the resection of the trochlea (flush to the anterior femoral cortex), the distal cut and the anterior chamfer cuts. All osteophytes were removed prior to measurements as these could influence the measurements. The distal cut was at 9mm from the most prominent distal condylar surface at a valgus angle of 7 degrees. Measurements were taken by sterile vernier calliper and recorded intra-operatively. If additional cuts were taken other than those mentioned above, the patient was excluded from the study.

Data was analysed using SPSS 17. Proportions were calculated for categorical data such as gender, side, pre-operative diagnosis of degenerative or inflammatory joint disease, while means and standard deviations (SD) were calculated for continuous ones such as age and AP measurements. We compared the mean anthropometric measurements to standard anthropometric measurements using the dependent samples t test. Level of significance was set at $p<0.05$. Additionally, the differences in the mean AP measurements were compared by gender.

The mean aspect ratio was calculated by dividing the mean AP measurements with the mean medio-lateral at the trans-epicondylar axis level (ML-TEA).

Effect modification by gender, diagnosis and side was sought by calculating the mean differences for each category separately.

Results

The mean age of the 33 patients in the study was 59.3±7years. There were 4(12.1%) males and 29(87.9%) females (Table-1). Overall, 22 (66.7%) patients were diagnosed with DJD; and 11(33.3%) were diagnosed with RA. Besides, 30(90.9%) patients had bilateral knee replacements, while 3(9.1%)had unilateral replacements. Right-sided TKRs were done in 16(48.5%) patients, and left-sided TKRs in 17(51.5%). The most frequently used femoral component was size 2.5, in 14(42.4%) patients, with sizes 2.0 and 3.0 were used in 7(21.2%) each. Size1.5 was used in 4(12.1%) patients, and size 4.0 in 1 (3.0%).

The mean AP of the femoral size was 53.5±3.7mm,while the mean AP of the standard implants used was 58.2±2.8mm ($p<0.001$). This showed a difference of 4.7mm that is greater than our cut-off of 3mm and, therefore, showed incongruency. The mean AP among males was 57.88±3.8mm, and among the females it was 52.83±3.4 ($p<0.009$). As against the mean AP value for males, the mean AP for the implants used was 61±2.8mm($p<0.020$). The corresponding value for implants used in female patients was 57.86±2.6mm ($p<0.001$). The mean AP measurement of patients with DJD was 53.68±3.9mm while the mean AP of implants used in these patients was 58.59±2.4mm ($p<0.001$). The mean AP measurements of patients with RA was 53.0±3.4mm, while the mean AP of implants used in these patients was 57.5±3.4mm ($p<0.001$). The mean AP measurement of patients who underwent right-sided TKR was 53.5±4.3mm,while the mean AP of implants used in these patients was 58.59±58.6mm ($p<0.001$). The mean AP measurements of patients who underwent left-sided TKR was 53.5±3.2mm, while the mean AP of implants used in these patients was 57.9±2.8mm ($p<0.001$).

The mean aspect ratio was 0.79±0.05 while the standardised aspect ratio of the implants was 0.90(SD±0.0) (Figure).

Table-1: Patient demographics.

Age	Mean	Range
	59.3 (SD 7.002)	50-70 years
Gender	M= 4 (12.1%)	F= 29 (87.9%)
Diagnosis	DJD= 22 (66.7%)	RA= 11 (33.3%)
Side	Unilateral	Bilateral
	3 (9.1%)	30 (90.9%)

Table-2: Implant size used.

	Male	Female	DJD	RA
AP in patients (mm)	57.88 (SD 3.8)	52.86 SD (3.4)	53.68 SD (3.9)	53 SD (3.4)
AP of implants (mm)	61 SD (2.8)	57.86 SD (2.6)	58.59 SD (2.4)	57.5 SD (3.4)

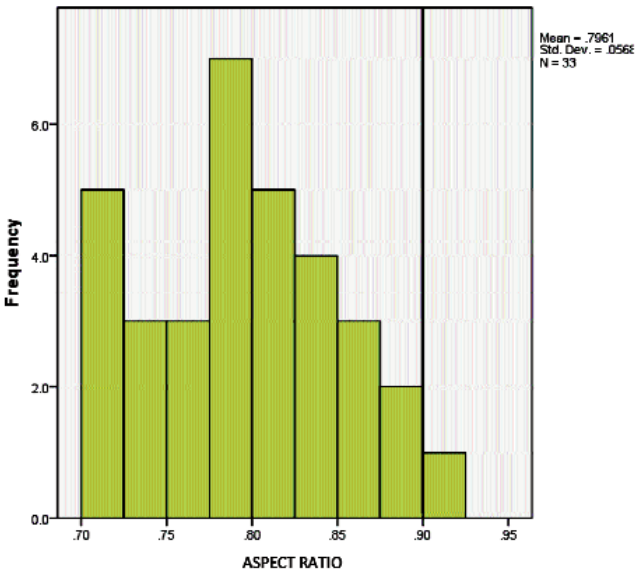

Figure: Aspect ratio.

Discussion

TKRs are highly successful interventions for knee arthritis[2] with most of the studies showing >90% good or excellent results.[3] The results of TKR are adversely affected by a mismatch of the bone and implant component sizes. Variability in sizes between genders is also a known fact.[6] Most of these studies have been done on a Caucasian population and the available implants have their sizes and dimensions designed accordingly. A cadaver-based study done in India reported an anatomical variance between an Indian population and the available implants.[7] No study on live patients has been done in our region with actual measurements being taken and compared with the available implant sizes.

The current study measured the distal femurs of our patients per-operatively after the relevant bone cuts had been taken in accordance with the closest appropriate size, and compared with the implant used which was most appropriate as per the sizing. It found a difference of 4.7mm between the mean AP measurements and the mean AP of the implants. Caucasian based studies have demonstrated that a mismatch in the AP dimension 3mm is associated with more severe knee pain at two-year follow-up.[5] We also calculated the aspect ratio (AP/ML-TEA) of the distal femurs of our patients, which was also found to be a mismatch. This demonstrates a mismatch in the dimensions of the distal femur as a whole and not only in the AP plane. Comparisons were also made between the measurements by gender, diagnosis and sides with a mismatch being calculated in all.

This study is the first of its kind in our region and provides an insight into the anatomical variance of the distal femurs in our population when compared with the Caucasian population and may explain one of the possible reasons of less-than-satisfactory results if it so happens in our population. However, the number of male patients was less (12.1%) in this study and although their measurements also showed a mismatch, but a larger male population would have had led to more conclusive interpretations for that gender. Also, only one specific system of TKR was evaluated in this study as this is the most widely used one at the moment. There are other systems available and in use and a comparison of their dimensions will give a more accurate evaluation of the incongruence of our population's knees to the available range of systems.

One major limitation of our study is that it did not assess outcome of patients with size mismatch.

This study demonstrated that there is a significant mismatch in the femoral component size of the most commonly used TKR system in our country and it may or may not be the most suitable in our environment.

This study can be used as a framework for a much larger, possibly a multi-centre, region-wide study in which the dimensions of different systems can be compared with our population using real time measurements, including the dimensions of the tibia and the patella, thus possibly provide a groundwork for future TKR guidelines pertinent to our population.

A question can be raised as to what is the relationship between the observed distal femur versus femoral component incongruence and its relevance to post-operative knee pain. The purpose of this study was to identify if there was any discrepancy present, and the relationship of pain with this observed discrepancy was beyond the scope of this study. The question, however, may lead to a future study with appropriate follow-up.

Conclusions

There were differences between anthropomorphometry of our skeleton and Caucasian designed implants. This could have outcome implications in the long term.

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