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ORIGINAL STUDY

Tibial component in total knee replacement : the effect of overhang and sizing on outcome

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The aim of this study was to find a relationship between tibial overhang, malpositioning and oversizing, and the functional outcome. 188 patients were included in this retrospective study. All patients completed an Oxford knee score questionnaire at mean follow-up of 5 years. Anteroposterior radiographs of the total knee replacements were reviewed for medial and lateral overhang and oversizing.

Lateral overhang was seen in 32.9% of patients with a mean Oxford knee score of 24.7. However lateral overhang proved no significant correlation with the functional outcome. Oversizing was seen in 31.9% of patients and, with a mean of 25.6, oversizing did have a correlation with Oxford Knee score.

This study confirms that neither medial or lateral overhang of the tibial component influences functional outcome, independent of the severity of overhang. Oversizing the tibial component however, does show worse functional outcome scores at a 5 year review.

Keywords : Total knee arthroplasty, tibial component, oversizing, lateral overhang.

INTRODUCTION

The total knee replacement (TKA) has proven its value as a solution in the osteoarthritic knee for both pain and function *(5)*. Residual pain is, however, still a great concern to many orthopaedic surgeons and has been proven a major source of dissatisfaction for a substantial amount of patients *(3)*. One of the possible sources of pain is soft tissue irritation and impingement due to oversizing and malpositioning of the components *(3,4,10)*. Femoral component overhang has shown to increase the risk of residual pain but the use of narrower, femoral implants did not always improve results questioning the need for implant design adaptation *(4,8)*.

Considering the tibial side Chau et al. clearly stated that overhang of the tibial component in cemented unicompartmental knee replacements (UKA) leads to worse knee outcome scores *(6)*. Literature has yet to prove similar findings in TKA and has only ambiguously stated that although oversizing can lead to detrimental outcome results, medial and lateral overhang is irrelevant to the overall outcome *(1,3,4,10)*.

Because of this ambiguity in results between tibial component in UKA and TKA, and between femoral and tibial overhang in TKA, we conducted this study. The objectives were to prove that both

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mediolateral overhang and oversizing of the tibial component are relevant to the outcome score and quantify the amount of overhang necessary to negatively influence the results.

PATIENTS AND METHODS

In order to complete our objectives a retrospective, cohort-based review was undertaken. A database consisting of all patients with TKAs, performed by all knee specialists in a single center and with a complete 5 year postoperative Oxford Knee Score (OKS), was used for the selection of our study population. We collected data concerning patient demographics (age, BMI, gender) along with TKA related factors (prosthesis sizes, oversizing, undersizing, lateralization, presence of osteophytes). Post-operative AP radiographs were digitally reviewed using the PACS imaging system. Patients were exclusively included in our study cohort if the radiograph matched certain criteria, which were determined before inclusion and checked independently by two experienced observers: no rotation, demonstrated by an equal amount of tibial tray visible each side of a midpoint drawn through the keel of the prosthesis, x-ray beam appeared parallel to the plane of the flat surface of the tibial tray. Solely radiographs which were performed immediately post-operative and until the time of data collection were taken into consideration for analysis. Only one radiograph – matching our criteria – out of multiple post-operative images was selected per patient.

Measurements were performed independently by the two primary authors. Since there were no disparities >0.5mm between the two reviewers, the mean of our measurements was utilized for our analysis. Overhang was measured as the length of prosthetic material outside the boundaries of a vertical line extending from the cortex of the most proximal part of the tibial plateau. We recorded whether this overhang was medial or lateral and if due to tibial tray, bony cement or a combination of the two. Any osteophytes larger than 3mm were noted. Undersizing was recorded as well.

To be able to relate the OKS to real life, comparable metric units, all measurements needed to be corrected for radiographic magnification. The width of the tibial tray was measured and the magnitude of magnification was calculated for each radiograph. Since every patient's implant sizes was known, we were able to accurately define the percentage of magnification of each radiograph using the actual tibial component dimensions from the manufacturer (Smith and Nephew, London, United Kingdom).

Overhang was taken into account in our statistical analysis in two separate ways. First off in a non-quantified approach as 2 groups: group 1 having no overhang and group 2 having overhang >0mm. Secondly in a graded/quantified manner: No overhang, mild (0-2.9mm), moderate (3-6mm) or severe (>6mm) overhang.

Patients who had received further surgery or sustained major lower limb trauma after the index operation were excluded from completing the OKS and entering the study group.

Statistical analysis was done using SPSS version 22 (IBM Corporation, Chicago, United States). Interobserver variance was determined using the Intraclass interobserver correlation analysis. Patient demographics and surgery related factors were characterized through descriptive statistics and correlated with the OKS through parametric statistics (ANOVA, univariate ANCOVA). A p-value <0.05 was deemed significant.

RESULTS

A total of 188 patients matched our inclusion criteria and were able to be included in this study. Sex was evenly distributed (51.1% male - 48.9% female). The mean age was 70.5 years, with a BMI of 30.6 kg/m². (Table 1) Patients were operated on by or under supervision of different senior knee consultants through a medial parapatellar arthrotomy. All implants were Genesis II type by Smith and Nephew. Measurements were done independently by two senior orthopaedic registrars with an Intraclass interobserver correlation of 0.99.

10 Patients out of the 188 (5.3%) had the correct tibial implant size but lateralization of the component. A total of 60 tibial trays (31.9%) were measured as oversized and 9.0% was considered as undersized. The mean OKS of the entire population was 23.7 at a 5 year follow-up.

Table 1. — Patient and Total Knee Replacement characteristics

Patient characteristics	
Mean age (years)	70.5 [min. 42.0 - max. 89.0 ; SD 8.2]
Mean BMI (kg/m²)	30.6 [min. 18.8 - max. 46.9 ; SD 4.8]
Gender distribution	
Female	96 (51.1%)
Male	92 (48.9%)
TKA right side	94 (50.0%)
Mean Oxford Knee Score	23.7 [min. 12.0 - max. 53.0 ; SD 9.6]
Mean OKS Male	22.0 [min. 12.0 - max. 48.0 ; SD 9.0]
Mean OKS Female	25.2 [min. 12.0 - max. 53.0 ; SD 9.9]
TKA characteristics	
Mean overhang (mm)	1.2 [min. 0.0 - max. 7.1 ; SD 1.9]
Female (mm)	1.4 [min. 0.0 - max. 7.1 ; SD 1.9]
Male (mm)	1.0 [min. 0.0 - max. 5.7 ; SD 1.8]
Lateral overhang	62 (32.9%)
Oversized	60 (31.9%)
Female	39 (20.7%)
BMI (kg/m²)	30.5 [min. 18.8 - max. 41.5 ; SD 4.5]
Undersized	17 (9.0%)
Female	4 (2.1%)
BMI (kg/m²)	33.5 [min. 22.3 - max. 40.6 ; SD 4.8]
Lateralized	10 (5.3%)
Female	2 (1.1%)
BMI (kg/m²)	28.1 [min. 22.6 – max. 35.4 ; SD 3.4]

BMI= Body mass index, TKA= Total knee arthroplasty, OKS= Oxford knee score, min.= minimum, max.= maximum, SD= Standard Deviation maximumOxford knee score, min= minimum,

Six patients (3.2%) had medial overhang with a mean of 0.2 mm. Lateral overhang was seen in 62 patients (33.0%), 24 male and 38 female. The mean overhang was 3.5 mm. Among the 62 lateral overhanging tibial trays, 52 were oversized and 10 were lateralized. Mean OKS at 5 year follow up was 24.8. Only one patient had combined medial and lateral overhang. Mean age of the patients with overhang was comparable to the overall population (71.1 years old)

Grading the amount of lateral overhang and dividing them accordingly into 3 groups, group 1 (1-2.9 mm overhang) had 27 patients (43.5%, mean OKS of 23.9), group 2 (3-5.9 mm overhang) consisted of 32 patients (51.6%, mean OKS of 24.8) and group 3 (≥6 mm overhang) only contained 3 patients (4.8%, mean OKS 32.0)

Oversizing was present in 60 patients (31.9%), of which 86.7% (n=52) of these patients had lateral overhang of the tibial tray. Demographics were comparable with a mean age of 71.0 years, but with a gender distribution of only 35,0% male (n=21) and 65,0% female (n=39). The mean OKS was 25.6

Female patients scored significantly worse on the OKS than men (Female mean OKS 25.2 vs male mean OKS 22.0, $p=0.022$). BMI and age proved to have no significant impact on the outcome score.

Parametric statistical analysis of the OKS result showed no difference in outcome between patients with or without lateral overhang. Mild, moderate and severe overhang did not significantly influence the outcome, nor could a correlation between the amount of overhang (expressed in millimeters) and the OKS be demonstrated. With a p-value of 0.059 in an ANOVA analysis of the effect of oversizing the tibial tray, oversizing did seem to have an effect on the functional outcome. However this association was not significant. With the knowledge that gender significantly influenced the functional outcome, we corrected our analysis by including gender as a covariate in an ANCOVA univariate analysis. After the inclusion of this fixed factor, the effect of oversizing on the OKS, our functional outcome measure, became statistically significant. (Table 2) Thus, while overhang and undersizing of the TKA did not significantly correlated with worse functional outcomes, oversizing however did influence the OKS.

Table II. — The effect of TKA placement on the Oxford Knee Score

	N (%)	Mean OKS	p-value
Overhang 2 group analysis			0.270*
No overhang	126 (67.0%)	23.1 [min. 12.0 - max. 53.0 ; SD 9.5]	
Overhang	62 (33.0%)	24.8 [min. 12.0 - max. 44.0 ; SD 9.9]	
Overhang graded analysis			0.373*
No overhang	126 (67.0%)	23.1 [min. 12.0 – max. 53.0 ; SD 9.5]	
Mild (0-2.9 mm)	27 (14.4%)	23.9 [min. 12.0 – max. 44.0 ; SD 9.8]	
Moderate (3-6 mm)	32 (17.0%)	24.8 [min. 12.0 – max. 44.0 ; SD 9.8]	
Severe (>6 mm)	3 (1.6%)	32.0 [min. 19.0 – max. 43.0 ; SD 12.1]	
Oversizing			0.059*
No oversizing	128 (68.1)	22.8 [min. 12.0 – max. 53.0 ; SD 9.4]	
Oversizing	60 (31.9)	25.6 [min. 12.0 – max. 44.0 ; SD 9.8]	
Gender corrected			0.039*†
Lateralized			0.015*
Not lateralized	178 (94.7%)	24.1 [min. 12.0 – max. 53.0 ; SD 9.6]	
Lateralized	10 (5.3%)	16.5 [min. 12.0 – max. 27.0 ; SD 5.1]	

*p-value calculated for effect on the Oxford Knee Score (OKS)
†Correction through Univariate ANCOVA analysis with gender assigned as a fixed covariate.
OKS= Oxford Knee Score, Min.= Minimum, Max.= maximum, SD= Standard Deviation

DISCUSSION

To avoid undersizing and possible late subsidence of the tibial component in total knee arthroplasty, it is often seen that the choice and positioning of the implant leads to overhang and oversizing of the tibial tray. In this study, as much as 31.9% oversizing and 36.2% overhang was seen. If overhang was present, it occurred at the lateral side in 90.3%, to avoid medial overhang and friction with the medial collateral ligament (MCL) which could potentially lead worse results and to pain due to excessive MCL loading if overhang exceeds 2 mm as seen in unicondylar knee arthroplasty *(7,9)*.

No significant worsening of the OKS was seen in these patients with lateral overhang (OKS 24.8) compared to our entire study group (23.7). Quantifying the lateral overhang into mild (<3 mm), moderate (≥3 mm - <6 mm) and severe (≥ 6 mm) did not demonstrate any cut-off value which could be correlated to bad functional results. We did, however, noticed a gradual increase in OKS, which might suggest that if overhang exceeds a certain point the OKS would be significantly influenced. Group 3 contained only 3 patients which of course can attain to the reason why we see a drastic worsening of the functional outcome.

This lack of correlation between overhang and the OKS, suggests that overhang of the tibial component is less of an important factor in residual pain and overall outcome than the correct mediolateral positioning of the femoral implant. Mahoney et al. clearly suggested that approximately 39.0% of the outcomes of clinically important pain among knees with overhang and approximately 27.0% of all the outcomes of clinically important pain in his study were attributable to overhang *(8)*.

Oversizing lead in 86.7% to lateral overhang placing the tibial tray in close contact to the iliotibial band near it's insertion on Gerdy's tubercle and more often – due to correct rotational positioning – can lead to posterolateral overhang with damage to the popliteus tendon *(2,3)*. Oversizing was mostly seen in women (65.0%) and lead to an OKS of 25.6. Because of a statistically significant worse functional score in female patient (female OKS 25.2 vs male OKS 22.0) covariate analysis was necessary to show the true influence of oversizing. BMI and age were also taken into consideration as a covariant, but failed to show any significant influence on the functional outcome as an independent factor. The corrected analysis model with gender as a covariant suggests a worse functional outcome if tibial tray is oversized in male and female patients.

This study has several limitations: it is a retrospective analysis which does not allow analysis of pre-operative data as a potential influence on the outcome. Therefore we have included as many patients as possible to have a broad spectrum of different patients and data. Overhang and oversizing was measured on standard AP radiographs with only true lateral and medial as reference. The number of patients in the severe overhang group was inadequate for proper statistical findings.

In conclusion, the ambiguity between overhang and oversizing of the tibial component as an influencing factor in the outcome of total knee replacement has become more clearly elucidated with this study. We confirmed findings of previous research, however with longer follow-up of the functional outcome. Although we confirm in this study that lateral overhang is most often caused by oversizing and less by lateralization, it is only oversizing which significantly causes the outcome scores of the TKA surgery to decline. More research is definitely needed to explain these findings, both clinically and biomechanically.

REFERENCES

1. **Abram S, Marsh A, et al.** The effect of tibial component sizing on patient reported outcome measures following uncemented total knee replacement. *The knee* 2014 ; 21 : 955-959.
2. **Barnes CL, Scott RD.** Popliteus tendon dysfunction following total knee arthroplasty. *J Arthroplasty* 1995 ; 10 : 543-545.
3. **Bonnin M, Saffarini M, et al.** Oversizing the tibial component in TKAs: incidence, consequences and risk factors. *Knee Surg Sports Traumatol Arthrosc* 2015 ; 21.
4. **Bonnin M, Schmidt A, et al.** Mediolateral oversizing influences pain, function, and flexion after TKA. *Knee Surg Sports Traumatol Arthrosc* 2013 ; 21 : 2314-2324.
5. **Callahan CM, Drake BG, Heck DA, et al.** Patient outcomes following tricompartmental knee replacement. A meta-analysis. *JAMA* 1994 ; 271 : 1349-1357.
6. **Chau R, Gulati A, Pandit H et al.** Tibial component overhang following unicompartmental knee replacement – does it mater? *Knee* 2009 ; 16 : 310-313.
7. **Gudena R, et al.** A safe overhang limit for unicompartmental knee arthroplasties based on medial collateral ligament strains. *J Arthoplasty* 2013 ; 28 : 227-33.
8. **Mahoney OM, Kinsey T.** Overhang of the femoral component in total knee arthroplasty: risk factors and clinical consequenses. *J Bone Joint Surg* 2010 ; 92-A : 1115-1121.
9. **Mandalia V. Eyres K, Schranz P, Toms AD.** Evaluation of patients with a painful total knee replacement. *J Bone Joint Surg* 2008 ; 90-B : 265-271.
10. **McArthur J., Makrides P et al.** Tibial component overhang in total knee replacement: Incidence and functional outcomes. *Acta Orthop. Belg*., 2012 ; 78 : 199-202.