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Prosthetic alignment after total knee replacement is not associated with dissatisfaction or change in Oxford Knee Score
A multivariable regression analysis

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ABSTRACT

Background: Approximately 18% of the patients are dissatisfied with the result of total knee replacement. However, the relation between dissatisfaction and prosthetic alignment has not been investigated before.
Methods: We retrospectively analysed prospectively gathered data of all patients who had a primary TKR, preoperative and one-year postoperative Oxford Knee Scores (OKS) and postoperative computed tomography (CT). The CT protocol measures hip–knee–ankle (HKA) angle, and coronal, sagittal and axial component alignment. Satisfaction was defined using a five-item Likert scale. We dichotomised dissatisfaction by combining '(very) dissatisfied' and 'neutral/not sure'. Associations with dissatisfaction and change in OKS were calculated using multivariable logistic and linear regression models.
Results: 230 TKRs were implanted in 105 men and 106 women. At one year, 12% were (very) dissatisfied and 10% neutral. Coronal alignment of the femoral component was 0.5 degrees more accurate in patients who were satisfied at one year. The other alignment measurements were not different between satisfied and dissatisfied patients. All radiographic measurements had a *P*-value > 0.10 on univariate analyses. At one year, dissatisfaction was associated with the three-months OKS. Change in OKS was associated with three-months OKS, preoperative physical SF-12, preoperative pain and cruciate retaining design.
Discussion: Neither mechanical axis, nor component alignment, is associated with dissatisfaction at one year following TKR. Patients get the best outcome when pain reduction and function improvement are optimal during the first three months and when the indication to embark on surgery is based on physical limitations rather than on a high pain score.
Level of evidence: 2

1. Introduction

Primary outcome goals after total knee replacement (TKR) are good long-term prosthesis survival and high patient satisfaction. Unfortunately, 18% of the patients are not satisfied at one year after surgery [1,2]. Routine use of patient-reported outcome measures (PROMs), such as the Oxford Knee Score (OKS) has become an essential tool to measure and monitor pain and function [3]. Large studies using PROMs have shown that satisfaction following TKR is multifactorial [4–6]. However, the relation between radiological outcome and satisfaction is poorly understood. Component alignment has never been analysed in as a regression model with dissatisfaction as dependent variable.

In the present study we created multivariable regression models to identify variables that are associated with 1) dissatisfaction and 2) change in Oxford Knee Score after total knee replacement. We hypothesised that mechanical axis and implant component alignment are not predictive of patient dissatisfaction or change in OKS using Genesis 2, Legion (Smith and Nephew, Memphis, Tennessee, USA) and ACS (Implantcast GmbH, Buxtehude, Germany) knee replacement systems.

2. Materials and methods

The Ethics Committee of Hollywood Private Hospital in Perth, Western Australia, granted approval to audit surgical procedures that were

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Table 1
Preoperative questionnaires.

Characteristic	N	Median (IQR)	Range
Pain-NRS (0 min–10 max)	163	6.0 (3.0)	0 to 10
Oxford Knee Score (0 worst–48 best)	230	22.0 (10.0)	6 to 45
SF12-physical component	228	30.7 (10.3)	20 to 60
SF12-mental component	228	50.5 (20.8)	19 to 71

(IQR = interquartile range, SF12 = short form 12, NRS = numerical rating score).

performed at Hollywood Private Hospital, Perth and St. John of God Geraldton Hospital between April 2009 and February 2014.

2.1. Patient selection and available variables

For this retrospective analysis a group of consecutive patients with primary TKRs were selected from a prospective database of two experienced orthopaedic surgeons (RJKK, DPF). Independent physiotherapists collected clinical data and questionnaires for the database. All selected patients had a postoperative computed tomography (CT) according to the Perth CT protocol [7] within six weeks post-surgery, and had completed preoperative and one-year postoperative patient-reported outcome scores (PROMs). Extracted patient characteristics were age, gender, American Society of Anaesthesiologists (ASA) score, and body mass index (BMI). Four surgical items were available for analysis: surgical approach (medial or lateral parapatellar), type of prosthesis (Genesis 2 and Legion, Smith and Nephew, Memphis, Tennessee, USA; ACS, Implantcast GmbH, Buxtehude, Germany), whether patients had a cruciate retaining or a posterior stabilised implant and if the patella was resurfaced.

Three-planar prosthetic alignment was evaluated using the Perth CT protocol [7]. Reconstructed images were used for seven measurements. Deviations from intended hip–knee–ankle (HKA) angle and femoral and tibial alignment in coronal, sagittal and axial planes were measured in degrees. Intended tibial posterior slope was three degrees for Genesis 2 and Legion, and five degrees for ACS. Varus, extension, anterior slope and internal rotation were scored as negative value; valgus, flexion, posterior slope and external rotation as positive value. Deviation of more then three degrees from intended alignment was regarded as outlier. The femorotibial mismatch angle is expressed as a positive value only. Analogous to a previous study by Sikorski [8], a cumulative deviation score was calculated by adding the absolute coronal, sagittal and axial deviations. Independent radiologists, who were familiar with the Perth protocol, did the CT measurements. Intra-observer intraclass correlation coefficient (ICC) for rotational measurements is shown to be moderate–good. Inter-observer ICC for femoral rotation is shown to be poor [9,10].

A five-item Likert scale was used to categorise overall satisfaction at three months and one year postoperatively. Categories were 'very satisfied', 'satisfied', 'neutral/not sure', 'dissatisfied', and 'very dissatisfied'. Dissatisfaction was dichotomised by combining 'very dissatisfied', 'dissatisfied', and 'neutral/not sure'.

PROMs were completed at three and 12 months, with a clinical window of ±1 month. The Oxford Knee Score is a self-completed patient based outcome score assessing levels of, and changes in pain and knee function. The 12-item responses were summed to give a total of 0 points (worst possible score) to 48 points (best possible score). General health status was assessed SF-12 and expressed as two meta-scores: the Physical Component Summary (PCS) and the Mental Component Summary (MCS). Pain in the joint in the last week was rated using a Numerical Rating Score (0 = no pain; 10 = unbearable pain).

Complications were classified as based on timing of the complication and its treatment. Timing was either during the inpatient stay or outpatient within the first postoperative year. Treatment was categorised as Medical (e.g. thromboembolism, respiratory or urinary tract infections, delirium, cardiac dysrhythmias and antibiotics for suspected superficial surgical site infection) or Surgical (e.g. washouts, closure of wound dehiscence and manipulation under anaesthetic).

Table 2
Surgical characteristics and complications.

Characteristic	Category	N	%
Approach	Medial parapatellar	199	86.5
	Lateral parapatellar	31	13.4
Prosthesis	ACS	82	35.7
	Genesis-2	94	40.9
	Legion	54	23.5
Cruciate	Cruciate retaining	139	60.4
	Posterior stabilised	91	39.6
Patella resurfacing	No	96	41.7
	Yes	131	57.0
	Patellectomy	3	1.3
ASA score	1	14	6.4
	2	139	63.2
	3	67	30.5
Complications	None	135	58.7
	Postoperative	54	23.5
	Outpatient	13	5.7
	Readmission	28	12.2

(ASA = American Society of Anaesthesiologists).

2.2. Statistical analysis

Mean deviations from ideal radiographic alignment in satisfied and dissatisfied patients were compared using one-sided (for absolute values) and two-sided (for negative and positive values) Independent samples T-test. Outliers were analysed using the Chi-squared test. The paired samples T-test was used to analyse the change in OKS within the categories 'very satisfied', 'satisfied' and 'dissatisfied'. The Kruskal–Wallis test was used to compare preoperative and one-year

Table 3
Deviation from intended alignment.

Variable	Dissatisfied (N = 45)	Satisfied (N = 160)	*P*-value
HKA-angle	−1.0 ± 2.9	−1.4 ± 2.6	0.385[a]
Absolute deviation	2.5 ± 1.8	2.4 ± 1.7	0.444[a]
Range	9° varus to 6° valgus	8° varus to 6° valgus	
Outliers	9 (20%)	38 (24%)	0.597[b]
Coronal femur	1.3 ± 1.6	0.8 ± 1.7	0.045[a]
Absolute deviation	1.6 ± 1.3	1.4 ± 1.1	0.190[a]
Range	2° varus to 5° valgus	4° varus to 6° valgus	
Outliers	4 (9%)	9 (6%)	0.427[b]
Coronal tibia	−0.8 ± 1.3	−0.3 ± 1.6	0.054[a]
Absolute deviation	1.2 ± 1.0	1.2 ± 1.0	0.401[a]
Range	4° varus to 1° valgus	5° varus to 3° valgus	
Outliers	1 (2%)	3 (2%)	0.882[b]
Femoral flexion	1.0 ± 2.7	0.9 ± 1.8	0.842[a]
Absolute deviation	1.7 ± 2.3	1.4 ± 1.4	0.172[a]
Range	4° extension to 14° flexion	3° extension to 9° flexion	
Outliers	4 (9%)	13 (8%)	0.870[b]
Tibial slope	0.2 ± 2.8	0.1 ± 2.7	0.960[a]
Absolute deviation	2.2 ± 1.7	2.2 ± 1.6	0.437[a]
Range	1° anterior to 10° posterior	6° anterior to 9° posterior	
Outliers	10 (22%)	32 (20%)	0.744[b]
Femoral rotation	0.1 ± 2.4	−0.3 ± 2.3	0.309[a]
Absolute deviation	1.6 ± 1.8	1.6 ± 1.6	0.417[a]
Range	5° internal to 9 ° external	6° internal to 7° external	
Outliers	6 (13%)	21 (13%)	0.971[b]
Femorotibial mismatch	2.9 ± 2.3	2.6 ± 1.9	0.179[a]
Cumulative deviation	11.2 ± 4.1	10.5 ± 4.3	0.167[a]

(Mean ± standard deviation [degrees], HKA = hip–knee–ankle, outlier = >3 degrees deviation from intended alignment).
[a] Independent Samples T-test.
[b] Chi-squared test.