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ASSESSING THE INFLUENCE OF BODY MASS INDEX AND TIBIAL PROSTHESIS DESIGN CHARACTERISTICS ON SURVIVORSHIP AND REVISION RATES IN TOTAL KNEE ARTHROPLASTY

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Faculty Disclosure Information

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  - Speakers bureau/paid presentations: DePuy, Stryker, Smith and Nephew, Intellijoint, Sanofi, Zimmer
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INTRODUCTION

TOTAL KNEE ARTHROPLASTY (TKA)

- Body mass index (BMI), prosthesis design, and implant alignment have been shown to directly affect functional outcomes and early revision rates [1-6]
- To date, literature has examined the impact of an individual's BMI, TKA prosthesis designs, and implant positioning on the rate of complications in TKA and the associated survivability [6-11]
- There has been little research on the influence of component sizing with survivorship [3, 4, 12]
- It is unknown whether BMI is correlated with prosthesis sizing and how survivorship may be directly affected by the associated increase in mechanical loads and stress

PURPOSE

- Determine the relationship between increased BMI and tibial prosthesis design characteristics (tibia contact surface area, tibial base plate surface area, and tibia stem length)

METHODS

DATA COLLECTION AND ANALYSIS

- Retrospective review of primary TKA surgeries 01/2000-01/2019
- Surgeries performed by fellowship trained arthroplasty surgeons (n=10)
- Five implant designs:
  1) Johnson and Johnson PFC Sigma
  2) Stryker Triathlon
  3) Smith and Nephew Genesis II
  4) Smith and Nephew Journey II
  5) Smith and Nephew Legion

Tibia Prosthesis	Size	Contact Surface Area (mm^2)	Base Plate Surface Area (mm^2)	Stem Length (mm)
Johnson and Johnson	2	4342.1	2183.5	44.0
PFC Sigma	3	4805.4	2668.3	43.1
	4	5971.3	3224.0	48.6
	5	6486.1	3708.8	48.8
Stryker	2	3914.2	2252.3	26.8
Triathlon	3	4192.9	2491.3	27.3
	4	5089.9	2718.4	32.7
	5	5354.3	3082.3	32.0
	6	5708.5	3382.5	32.1
	7	6510.5	3794.3	36.9
Smith & Nephew	2	4526.7	2222.7	48.8
Genesis II, Journey II, or Legion	3	4954.6	2587.9	47.8
	4	5176.6	2753.3	47.1
	5	5507.1	3135.2	46.7
	6	5715.4	3219.5	48.4
	7	6131.0	3600.7	48.6
	8	6473.8	4082.8	47.7

Table 1. Measured tibia component contact surface area, base plate surface area, and stem length by prosthesis design for the implants.

- Endpoints: 1) revision arthroplasty or 2) surviving implant 01/2020
- Reasons for revision: trauma, loosening, instability, arthrofibrosis, infection
- A chart review of death summaries and obituaries was completed
- Patient demographics and TKA patient-specific information were retrieved from the database
- Smith and Nephew TKA implants were grouped for study analysis, as the tibial base plate size is the same

STATISTICS

- Independent t-tests → compare differences in BMI and age between those with major complications and those without
- Independent t-tests → determine differences in demographics and TKA patient-specific information between implant types
- Kaplan-Meier survival analysis → implant survivability
- A Cox multivariate regression → determine if tibia implant dimensions were related to revision surgery
- Statistical analysis was conducted using GraphPad Prism 9 and R and significance was accepted at p≤0.05

PROJECT SUMMARY

- Patient factors (age, sex, and BMI) appear to drive survivability outcomes after primary TKA more than the implant factors of the size and/or tibia stem choice

RESULTS, CONCLUSION, AND DISCUSSION

RESULTS

- A retrospective review of n=8548 primary TKA surgeries was completed

	Johnson & Johnson (PFC Sigma)	Stryker (Triathlon)	Smith & Nephew (Genesis II, Journey II, and Legion)	Difference between groups (p-value)
Number included	1389	1978	5181	
Gender (% female)	49	60	61	<0.01
Age (years)	68.3 (9.7)	67.7 (9.8)	67.8 (10.1)	0.19
BMI (kg/m^2)	33.1 (6.8)	33.4 (7.4)	33.2 (7.2)	0.40
Most Common Selected Implant (size)	3	3	3	
Survival time (years)	9.23 (4.02)	4.81 (2.76)	9.22 (5.10)	<0.01
Number of revisions (%)	3.31	2.73	2.59	
Revision for infection (%)	1.37	1.11	0.98	

Table 2. Patient demographics and TKA patient-specific information retrieved from the institutional arthroplasty database.

	Coefficient	Standard Error	p-value	Hazard Ratio	95% CI
Demographic					
Age < 70	0.596	0.150	**<0.01**	1.814	1.352 - 2.434
BMI ≥ 40 (kg/m^2)	0.329	0.159	**0.04**	1.389	1.016 - 1.899
Sex (male)	0.599	0.192	**<0.01**	1.820	1.250 - 2.651
Implant Dimension					
Tibia Contact Surface Area (mm^2)	0.000	0.001	0.91	1.000	0.997 - 1.002
Tibia Base Plate Surface Area (mm^2)	0.000	0.001	0.83	1.000	0.997 - 1.003
Tibial Stem Length (mm)	0.039	0.124	0.76	1.039	0.815 - 1.326
Implant Type					
Johnson and Johnson	0.150	0.318	0.64	1.162	0.623 - 2.167
Stryker	0.905	1.802	0.62	2.472	0.072 - 84.577
Smith and Nephew	(0.000)			(1.000)	

Table 3. Cox multivariate regression model results.

- Cumulative survivability was 98.0% at 5 years and 97.1% at 10 years

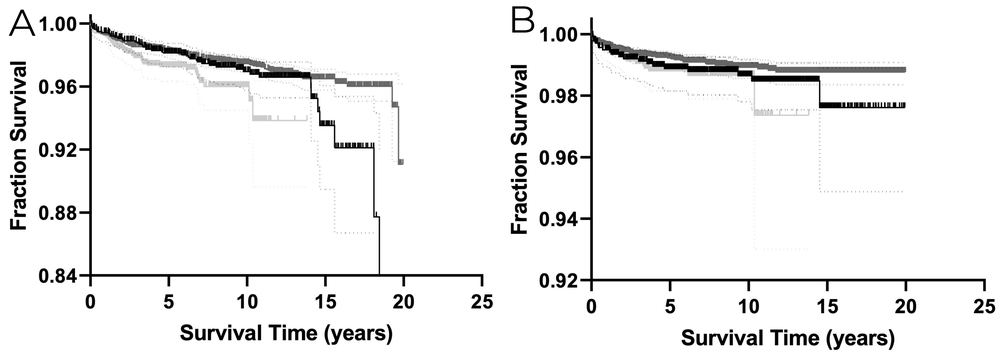

Figure 1. Kaplan Meier cumulative survivability curve for all implant types (A) and all implant types with associated infections (B). Johnson and Johnson (black), Stryker (light grey), and Smith and Nephew (dark grey).

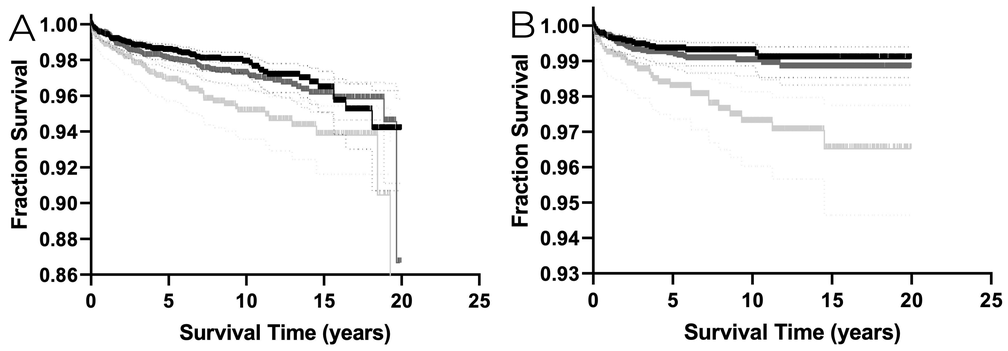

Figure 2. Kaplan Meier cumulative survivability curve for implant types stratified by BMI (A) and stratified by BMI with associated infections (B). BMI < 30 kg/m^2 (black), BMI 30-40 kg/m^2 (dark grey), BMI ≥ to 40kg/m^2 (light grey).

CONCLUSION AND DISCUSSION

- Age <70 years (p<0.01), male sex (p<0.01), and BMI ≥40 kg/m^2 (p=0.04) were significantly related to revision in all implants
- BMI ≥40 kg/m^2 was associated with decreased implant survivability
- Patients with high BMI do not necessarily require larger implants, and surface area and stem length do not seem to affect survivability of the implant

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