



A Retrospective Study Of Functional Outcome At 2 Year Follow-Up Of Patients Operated With Seven Different Implant Designs Of Total Knee Arthroplasty

Mohammed Maaz Afzal¹, Kishore karumuri², Vbn Prasad³, Chiranjeevi⁴, AV Gurava Reddy⁵
¹Fellow In Arthroplasty, ²Registrar, ³Consultant surgeon, ⁴Consultant surgeon, ⁵Chief Consultant Surgeon
Department of Orthopedics, Sunshine hospitals, secunderabad, Telangana, India

***Corresponding Author:**

Mohammed Maaz Afzal

Fellow In Arthroplasty, Department of Orthopedics, Sunshine hospitals, secunderabad, Telangana, India

Type of Publication: Original Research Paper

Conflicts of Interest: Nil

Abstract

Background: To evaluate the functional outcome in patients with Osteoarthritis after primary Total knee Arthroplasty using seven different designs of posterior-stabilized implants.

Patients And Methods; A retrospective study of 1038 patients who underwent Primary Total knee Arthroplasty in 2018 and 2019 at a single institute using one of the seven most common brands of implant. These included NaturalKnee2 (Zimmer) in 160 patients, DePuy/Johnson & Johnson Sigma (DePuy Synthes, Raynham, Massachusetts) in 155, Beuchelpappas /Rotating platform in 152, Smith & Nephew Genesis II (Smith & Nephew, London, United Kingdom) in 124, and Scorpio NRG (Stryker) in 154 patient, Link in 143 patients, Maxx Meril in 147 patients. Patients were evaluated Post operatively with Oxford knee score and the post-operative scores were compared between groups.

Results; Outcomes were available for 1012 patients (98%) at two years postoperatively. In multiple regression analysis, which separately compared each implant group with the aggregate of all others, there were no clinically significant differences in the oxford score at two-year follow-up between any of the groups. More than 80% of patients in each group were satisfied at this time in all domains.

Conclusion; Total knee Arthroplasty provides improvement in function and satisfaction regardless of the type of implant. We could not demonstrate superiority of one design above others across these groups of implants, and any price premium for one above the other systems may not be justified.

Keywords: Oxford knee score, Total knee arthroplasty, Implant designs, Posterior stabilized implants

Introduction

Comparison of patient -reported outcomes based on implant brand in total knee arthroplasty on value, defined as the quality of outcome divided by the cost of the intervention, all aspects of the equation are being scrutinized. While implants vary significantly in price, in the Total knee arthroplasty literature, there is little information about which implant provides the best outcomes with fewest complications. While Total knee arthroplasty is considered to be a highly cost-effective operation, approximately 20% of patients remain dissatisfied with the outcome.

Previous authors have compared the functional outcomes and survivorship of different brands of implant and have cited differences based on design. Hamilton et al¹ studied two different designs from one manufacturer in a randomized controlled trial and found a significant difference in patient-reported outcomes and timed functional performance tasks with the newer design significantly outperforming the older one. Similarly, Victor et al² compared survivorship of the Smith & Nephew Genesis I versus Genesis II (both Smith & Nephew, London, United Kingdom) and found improved survivorship with the newer generation. Nunley et al³ compared

newer cruciate-retaining designs to a design that was ten years older and found that the older design outperformed the newer design in terms of satisfaction and functional outcome in young patients. Kahlenberg *et al* ⁴. Compared the patient reported functional and satisfaction outcomes in patients who underwent total knee arthroplasty with 5 different brands. However, to our knowledge, no previous authors have evaluated both, clinically and patient-reported functional outcomes in more than five different brands currently in use for primary total knee arthroplasty. As the cost of the implants comprises one of the highest costs for all aspects of total knee arthroplasty and thus accounts for a sizable portion of national healthcare costs, the performance and cost of different implants is of interest to patients, surgeons, and policymakers.

Outcomes of total knee arthroplasty depend on surgeon, patient, and implant factors. The impact that specific implants might have on patient-reported outcomes is unknown. The primary purpose of this study was to evaluate the differences in the patient-reported functional outcomes and satisfaction after primary total knee arthroplasty using seven different brands of implants. The hypothesis was that there would be no difference in functional outcome that could be attributed to the implant used in primary total knee arthroplasty.

Patients and Methods

Using our institute's arthroplasty registry, we identified 1034 patients with a diagnosis of osteoarthritis who underwent Total knee arthroplasty, in years 2018 and 2019, using one of the seven most common brands of implant used at our institution. The study was approved by our institutional ethical committee and clinical review panel. The patients were identified in our registry based on the implant design and type of polyethylene insert. Patients were only included if the components and insert were from the same company and system, and if they consented to enroll in our arthroplasty registry. Patients were excluded if they were undergoing revision surgery, or had extra-articular deformity or with any constraint greater than standard posterior-stabilized. High-flexion knee designs were excluded.

All the patients in this study were contributed by a single surgeon and study was done at a single institute. The implants were inserted using the same

technique and standard instrumentation with intra-medullary referencing for the femur and extra-medullary alignment of the tibia. No patient recruited to this study underwent resurfacing of the patellofemoral joint. All components were cemented.

The implants included NaturalKnee2(Zimmer) in 159 patients (183 joints), DePuy/Johson & Johnson Sigma (DePuySynthes,Raynham,Massachusetts) in 155(218 joints), Beuchelpappas/Rotating platform in 153(171 joints), Smith & Nephew Genesis II (Smith & Nephew, London, United Kingdom) in 124(163 joints), and Scorpio NRG(Stryker) in 154 patients(197joints),Link in 143 patients(166 joints),Maxx in 147 patients(167 joints).

Baseline demographics of all these patients which included Age, sex, Height, Weight and the side of surgery (Right /Left /Bilateral) were collected.

Patients were evaluated 2 years Postoperatively using Oxford Knee score and post operative Oxford scores were compared between groups.

Results

Using our institutional registry, we identified 1038 patients who underwent TKA in 2018 and 2019 at a single institute using one of the seven most common brands of implant. Out of these patients, at 2-year follow-up, 1 patient died due to cardiac reasons, 2 of them got hemiplegia and 24 patients lost follow-up. So, outcome was available for 1011 patients.

Tools for assessment was Oxford knee score. Data was analyzed using Analysis of variance (ANOVA) and multiple comparisons were made between the 7 different groups. p- value was considered significant if < 0.05 .

On comparison of Oxford scores between the 7 groups, all were performing equally good, there was no difference in performance between these groups. (p value-0.145)

Discussion

In this retrospective cohort of more than 1000 primary TKAs using seven different designs of implants, we found no clinically significant differences among the 7 groups as all the patients who underwent TKA with any of these implants were performing similarly with regard to oxford score.

Similarly, previous reports have not demonstrated clinically important differences attributable to the brand of implant. Baker et al examined the effect of brand on functional outcomes using the Oxford Knee Score (OKS) in the British National Joint Registry. They noted significantly larger improvements in both scores with Zimmer NexGen implants compared with all other implants, including DePuy PFC (DePuy Synthes), Smith & Nephew Genesis II (Smith & Nephew), Biomet AGC (Zimmer Biomet), and Stryker Triathlon (Stryker, Kalamazoo, Michigan).

Hamilton et al¹ studied two different designs from one manufacturer in a randomized controlled trial and found a significant difference in patient-reported outcomes and timed functional performance tasks with the newer design significantly outperforming the older one. Similarly, Victor et al² compared survivorship of the Smith & Nephew Genesis I versus Genesis II (both Smith & Nephew, London, United Kingdom) and found improved survivorship with the newer generation. Nunley³ et al compared newer cruciate-retaining designs to a design that was ten years older and found that the older design outperformed the newer design in terms of satisfaction and functional outcome in young patients. Kahlenberg et al⁴ compared the patient reported functional and satisfaction outcomes in patients who underwent total knee arthroplasty with 5 different brands.

Furthermore, surgeons consider functional outcome to be one of the most important factors when choosing an implant, and in a competitive implant market, even minor differences may be enough to sway choices in the use of implants. Baker et al found that patients who started with the lowest Oxford Knee Score had a higher change in postoperative scores

Despite the competitive market for knee arthroplasty implants, their prices have increased dramatically in recent decades and account for the single largest expenditure in the cost of an arthroplasty. We found no clinically meaningful differences in patient-reported outcomes between the seven most commonly used knee arthroplasty implants used at our institution.

However, when considering the hundreds of thousands of patients undergoing this procedure annually, the differences in costs without clinically

significant differences in outcomes may be of interest to patients, surgeons, policymakers.

The study has a few limitations. Although the seven groups were similar, there were significant differences in baseline demographics between them, including slight differences in age, comorbidities, and sex and also the severity of deformity.

Strengths of the study are that all the patients were contributed by a single surgeon and study was done at a single institute. Patients were examined apart from their reported functional outcomes. 7 different groups of implant designs were evaluated which were more than the number of groups used by previous authors.

Conclusion: Total Knee Arthroplasty provides improvement in function and satisfaction regardless of the type of implant. Future research should focus on identifying specific elements of design that may contribute to an improved outcome. Our results demonstrate that across these groups of implants, we could not demonstrate a significant superiority of one above the others and any price for one system above others may not be justified.

References

1. Hamilton DF, Burnett R, Patton JT, et al. Implant design influences patient outcome after total knee arthroplasty: a prospective double-blind randomised controlled trial. *Bone Joint J* 2015;97-B:64–70.
2. Victor J, Ghijssels S, Tajdar F, et al. Total knee arthroplasty at 15–17 years: does implant design affect outcome? *Int Orthop* 2014; 38:235–241.
3. Nunley RM, Nam D, Berend KR, et al. New total knee arthroplasty designs: do young patients notice? *Clin Orthop Relat Res* 2015; 473:101–108
4. Cynthia A Kahlenberg et al. Patient satisfaction After Total Knee Arthroplasty *HSS J* 2018 JUL.
5. Bourne RB, Chesworth BM, Davis AM, Mahomed NN, Charron KDJ. Patient satisfaction after total knee arthroplasty: who is satisfied and who is not? *Clin Orthop Relat Res* 2010; 468:57–63.
6. Hamilton DF, Lane JV, Gaston P, et al. What determines patient satisfaction with surgery? A prospective cohort study of 4709 patients

following total joint replacement. *BMJ Open* 2013;3: e002525.

7. Judge A, Arden NK, Kiran A, et al. Interpretation of patient-reported outcomes for hip and knee replacement surgery: identification of thresholds associated with satisfaction with surgery. *J Bone Joint Surg [Br]* 2012;94-B:412–418.
8. Garvin KL, Wright TM. Strategies to improve total knee arthroplasty: a multidisciplinary research conference. *J Am Acad Orthop Surg* 2017;25(Suppl 1): S1–S3.
9. Gøthesen O, Espehaug B, Havelin L, et al. Survival rates and causes of revision in cemented primary total knee replacement: a report from the Norwegian Arthroplasty Register 1994–2009. *Bone Joint J* 2013;95-B:636–642.
10. Healy WL, Iorio R. Implant selection and cost for total joint arthroplasty: conflict between surgeons and hospitals. *Clin Orthop Relat Res* 2007; 457:57–63
11. Mendenhall S. 2017 Hip and Knee Implant Review. *OrthopNetw News* 2017; 28:1–24
12. Wright G, Chitnavis J. Focus on: which design of TKR – does it matter? *J Bone Joint Surg [Br]* 2011;93-B:1–3
13. Pritchett JW. Patients prefer a bicruciate-retaining or the medial pivot total knee prosthesis. *J Arthroplasty* 2011; 26:224–228.
14. Pritchett JW. Patient preferences in knee prostheses. *J Bone Joint Surg [Br]* 2004;86-B:979–982.
15. Pradhan, NR, Gambhir, A, Porter, ML. Survivorship analysis of 3234 primary knee arthroplasties implanted over a 26-year period: a study of eight different implant designs. *Knee* 2006; 13:7–11.
16. Roos EM, Roos HP, Lohmander LS, Ekdahl C, Beynon BD. Knee Injury and Osteoarthritis Outcome Score (KOOS)--development of a self-administered outcome measure. *J Orthop Sports Phys Ther* 1998; 28:88–96.
17. Saleh KJ, Mulhall KJ, Bershady B, et al. Development and validation of a lower-extremity activity scale. Use for patients treated with revision total knee arthroplasty. *J Bone Joint Surg [Am]* 2005;87-A:1985–1994.
18. Ware J Jr, Kosinski M, Keller SD. A 12-Item Short-Form Health Survey: construction of scales and preliminary tests of reliability and validity. *Med Care* 1996; 34:220–233.
19. Charlson ME, Pompei P, Ales KL, Mackenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis* 1987; 40:373–383.
20. Dripps RD. New classification of physical status. *Anesthesiol* 1963; 24:111.
21. Roos EM, Toksvig-Larsen S. Knee injury and Osteoarthritis Outcome Score (KOOS) - validation and comparison to the WOMAC in total knee replacement. *Health Qual Life Outcomes* 2003; 1:17.
22. Carr AJ, Robertsson O, Graves S, et al. Knee replacement. *Lancet* 2012; 379:1331–1340.

Tables for statistical Analysis

Table 1: One-way Post-Operative oxford by group

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
BP	152	32.0000	7.08604	.57475	30.8644	33.1356	5.00	44.00
DUPEY	155	39.0774	2.35635	.18927	38.7035	39.4513	32.00	47.00
LINK	143	41.2308	4.26696	.35682	40.5254	41.9361	4.00	47.00

MAXX	124	31.2016	5.95099	.53441	30.1438	32.2595	5.00	45.00
STRYKER	154	40.6948	1.79443	.14460	40.4091	40.9805	37.00	45.00
S&N	124	76.9839	394.82230	35.45609	6.8007	147.1670	34.00	4438.00
ZIMMER	160	41.3813	2.46452	.19484	40.9964	41.7661	33.00	47.00
Total	1012	42.6087	138.42917	4.35148	34.0697	51.1477	4.00	4438.00

Null Hypothesis: All the groups same regarding Post Operative OXFORD Score

Alternative Hypothesis: Not all the groups are same regarding Post Operative OXFORD Score

L.O.S: $\alpha = 0.05$

TABLE 2: Anova Post-Oxford

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	182776.261	6	30462.710	1.595	.145
Within Groups	19190648.783	1005	19095.173		
Total	19373425.043	1011			

Test Statistic:

Conclusion: Since the p-value of the Anova test is $0.145 > 0.05$, we can conclude that all the groups are same regarding Post Operative OXFORD Score

TABLE 3: Post-Operative Post Hoc Tests

Multiple Comparisons						
Dependent Variable: POSTOXFORD						
Tukey HSD						
(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
BP	DUPEY	-7.07742	15.77405	.999	-53.6790	39.5242
	LINK	-9.23077	16.09841	.998	-56.7906	38.3291
	MAXX	.79839	16.72183	1.000	-48.6032	50.2000
	STRYKER	-8.69481	15.79939	.998	-55.3712	37.9816

	S&N	-44.98387	16.72183	.102	-94.3855	4.4177
	ZIMMER	-9.38125	15.65155	.997	-55.6209	36.8584
DUPEY	BP	7.07742	15.77405	.999	-39.5242	53.6790
	LINK	-2.15335	16.02271	1.000	-49.4896	45.1829
	MAXX	7.87581	16.64896	.999	-41.3105	57.0622
	STRYKER	-1.61739	15.72225	1.000	-48.0659	44.8312
	S&N	-37.90645	16.64896	.256	-87.0928	11.2799
	ZIMMER	-2.30383	15.57368	1.000	-48.3134	43.7058
LINK	BP	9.23077	16.09841	.998	-38.3291	56.7906
	DUPEY	2.15335	16.02271	1.000	-45.1829	49.4896
	MAXX	10.02916	16.95659	.997	-40.0660	60.1243
	STRYKER	.53596	16.04766	1.000	-46.8739	47.9459
	S&N	-35.75310	16.95659	.348	-85.8483	14.3421
	ZIMMER	-.15048	15.90212	1.000	-47.1304	46.8295
MAXX	BP	-.79839	16.72183	1.000	-50.2000	48.6032
	DUPEY	-7.87581	16.64896	.999	-57.0622	41.3105
	LINK	-10.02916	16.95659	.997	-60.1243	40.0660
	STRYKER	-9.49319	16.67297	.998	-58.7505	39.7641
	S&N	-45.78226	17.54955	.124	-97.6292	6.0647
	ZIMMER	-10.17964	16.53294	.996	-59.0232	38.6639

STRYKER	BP	8.69481	15.79939	.998	-37.9816	55.3712
	DUPEY	1.61739	15.72225	1.000	-44.8312	48.0659
	LINK	-.53596	16.04766	1.000	-47.9459	46.8739
	MAXX	9.49319	16.67297	.998	-39.7641	58.7505
	S&N	-36.28907	16.67297	.309	-85.5463	12.9682
	ZIMMER	-.68644	15.59934	1.000	-46.7719	45.3990
S&N	BP	44.98387	16.72183	.102	-4.4177	94.3855
	DUPEY	37.90645	16.64896	.256	-11.2799	87.0928
	LINK	35.75310	16.95659	.348	-14.3421	85.8483
	MAXX	45.78226	17.54955	.124	-6.0647	97.6292
	STRYKER	36.28907	16.67297	.309	-12.9682	85.5463
	ZIMMER	35.60262	16.53294	.322	-13.2410	84.4462
ZIMMER	BP	9.38125	15.65155	.997	-36.8584	55.6209
	DUPEY	2.30383	15.57368	1.000	-43.7058	48.3134
	LINK	.15048	15.90212	1.000	-46.8295	47.1304
	MAXX	10.17964	16.53294	.996	-38.6639	59.0232
	STRYKER	.68644	15.59934	1.000	-45.3990	46.7719
	S&N	-35.60262	16.53294	.322	-84.4462	13.2410

INFERENCE:

There is no significant difference between the seven groups, that is, all the groups perform similarly with regard to Oxford Knee Score.