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Published in:
Annals of the Royal College of Surgeons of England

DOI:
10.1308/rcsann.2017.0086

Publication date:
2017

Document Version
Publisher's PDF, also known as Version of record

Royal College of Surgeons
ADVANCING SURGICAL CARE

ORIGINAL RESEARCH

Ann R Coll Surg Engl 2017; **00:** 1–5
doi 10.1308/rcsann.2017.0086

Cruciate Retaining compared with Posterior Stabilised Nexgen total knee arthroplasty: results at 10 years in a matched cohort

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ABSTRACT

BACKGROUND Debate has persisted for many years about whether to sacrifice or replace the posterior cruciate ligament when performing total knee arthroplasty. A paucity of long-term follow-up studies comparing outcomes between cruciate-retaining and posterior-stabilised knees exist. We aimed to compare results at ten-year follow-up.

METHODS A matched paired study comparing a cohort of 107 Zimmer Nexgen® Cruciate Retaining (CR) patients with a cohort of 107 Nexgen Posterior-Stabilised (PS) knees matched for age, sex, body mass index and preoperative American Knee Society score was undertaken. All patients underwent independent clinical assessment and knee society scoring preoperatively and at 1, 3, 5, 7 and 10 years postoperatively.

RESULTS Fifty-three patients (49.5%) in the CR group and 44 patients (41.1%) in the PS group were alive at 10-year follow-up. There were no significant differences between the CR and PS groups with regards to functional assessment ($P = 0.95$), overall range of movement ($P = 0.46$) or patient satisfaction ($P = 1.0$) at 10 years. However, there was a significantly better score improvement in range of movement in PS knees compared with CR knees ($P = 0.027$). There were six revisions (5.6%) in the PS group and 1 (0.93%) in the CR group ($P = 0.12$). Both CR and PS knees showed excellent survivorship with no significant difference at 10 years ($P = 0.068$).

CONCLUSIONS There were no significant differences in functional score, overall range of motion or patient satisfaction between the Nexgen cruciate retaining and posterior stabilised total knee arthroplasty at 10-year follow-up. However, PS knees had a greater score improvement in range of motion compared with CR knees.

KEYWORDS

Total knee arthroplasty – Cruciate retaining – Posterior stabilised – Long-term outcomes

Accepted 17 April 2017

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Introduction

Total knee arthroplasty (TKA) is the 'gold standard' treatment for end-stage osteoarthritis of the knee. The aims of surgery are to alleviate pain and to improve function.[1] Research has shown TKA to be an extremely cost-effective intervention,[2] with a mean cost per quality-adjusted life year (QALY) of £5,623.00.[3] Results are generally excellent, with survival rates greater than 90% at 10 years' and 70% at 20 years' follow-up.[4–6] However, despite significant advances in surgical technique and implant design, patient satisfaction levels remain around 80–90% after primary TKA.[7–9] With increasing emphasis being placed on patient-related outcome measures (PROMs), it is important to understand the issues affecting patient satisfaction in TKA. Knee joint kinematics are considered to be important contributing factors. Preservation or functional reformation of the posterior cruciate ligament is one of the key factors in restoration of knee kinematics.[10] Controversy has persisted for over 40 years as to whether to preserve or substitute the posterior cruciate ligament in TKA.[11] Proponents of cruciate retaining (CR) designs often cite preservation of bone stock, normal knee kinematics, increased proprioception and a physiological femoral rollback mechanism as the main advantages.[12–15] However, advocates of posterior stabilised (PS) TKA argue that sacrificing the posterior cruciate ligament allows for easier correction of severe deformity and facilitates the use of a more congruent articular surface, minimising polyethylene wear and allowing more reliable femoral rollback by the cam–post articulation.[16–18] They also argue that surgery is less technically demanding and more easily reproducible, and that there is an increased postoperative range of motion.[16–18] Most previous clinical studies comparing CR and PS TKA have reported only 1–5-year follow-up results, with no significant difference in clinical outcomes.[12,19–23]

Trials evaluating bilateral paired CR and PS TKA have not proven any significant difference in terms of clinical outcome or patient satisfaction but again these only had short- to medium-term follow-up.[24–26] Several studies have reported significantly better range of movement in favour of PS knees.[22,25–27] We aimed to investigate the outcomes of CR and PS TKA in a single region at 10-year follow-up.

Patients and methods

We reviewed results at 10 years for all patients who underwent a TKA with the Zimmer (Warsaw, Indiana, USA) Nexgen® CR fixed bearing knee for primary osteoarthritis between March 1996 and April 2001. We compared the results with a matched paired cohort of patients who had a TKA with a Zimmer Nexgen Legacy® PS fixed bearing knee for osteoarthritis within the same time period. Individual matched pairing of each patient based on their preoperative data was undertaken to ensure that patients with similar preoperative age, sex, body mass index (BMI) and preoperative clinical scores were included. Surgery was performed under the care of various consultant orthopaedic surgeons at one of three hospitals within the region. Prosthesis type was chosen based on surgeon preference. Patients were identified from our regional arthroplasty database, in which data are prospectively collected by independent clinical audit specialist nurses. Ethical approval to access the database was obtained before the study commenced. All patients who had undergone TKA with prosthesis other than the Zimmer Nexgen and any primary diagnosis other than osteoarthritis were excluded from the study.

Clinical and demographic data were compared between the CR and PS TKA groups. Data recorded included age, gender, BMI, complications, implant survival, pre- and postoperative American Knee Society score (AKSS) and satisfaction. The AKSS (objective) and AKSS (function) components were recorded individually for both groups and used for comparison. In addition, we calculated score improvement for clinical outcome and range of movement (post- minus preoperative) as we consider that these factors offer a better measure of the effect of TKA. All patients were followed-up at 1 year and then at 3, 5, 7 and 10 years by an independent clinical audit specialist physiotherapist. Active range of movement was assessed using a goniometer with the patient in the supine position. Revision for any cause was considered an endpoint.

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) version 22.0 for Windows (IBM Corporation, Armonk, New York). Fisher's exact test was used to compare categorical data. The Student's t-test was used for normally distributed continuous data. Paired T and independent T tests were used to compare the knee scores both within and between the groups. Improvement in knee range of movement between the groups, together with pain scores, were analysed with the paired T test. The independent T test was performed to statistically analyse pain score improvement between the two groups. The independent T test was also performed to compare mean AKSS score improvement in both groups. 10-year survivorship with 95% confidence interval was calculated using Kaplan–Meier survival analysis. To test differences in the Kaplan–Meier survival between the two groups, the log rank test and Wilcoxon test were used. A *P*-value of 0.05 or less was considered statistically significant.

Results

A total of 214 knees were included: 107 knees with the CR prosthesis and 107 knees with the PS prosthesis. There were no significant differences in patient demographics between the two groups. The mean age of the CR group was 70.6 years (range 40–86 years) and of the PS group was 70.8 years (range 46–85). Mean BMI was the same in both groups (CR group 28.6, range 19.2–40.3; PS group 28.6, range 19.7–57.7; $P = 0.96$). There were 56 men and 51 women in both groups.

Three patients (1.4%) were lost to follow-up, all from the PS group. There were 53 deaths in the CR group and 54 deaths in the PS group. There were no known problems with implants in these patients prior to death or loss to follow-up. Currently, 53 knees (49.5%) in the CR group and 44 knees (41.1%) in the PS group remain in regular follow-up.

Preoperative AKSS, range of movement and pain scores for all patients included in the study are shown in Table 1, with baseline details for the patients with continuing follow-up presented in Table 2, with postoperative scores presented in Table 3.

For patients included in the 10-year follow-up, the preoperative AKSS (function) scores were 56.1 points for the CR knees and 55.5 points for the PS knees ($P = 0.94$). At 10-year follow-up, the AKSS (function) score was 53.6 for the CR knees and 58.0 for the PS knees ($P = 0.46$). The AKSS (objective) averaged 88.5 points for CR knees and 88.7 points for PS knees ($P = 0.95$), indicating good long-term function for both types of knees.

Patients with a PS TKA had superior range of movement compared with those with a CR TKA at 1-year follow-up ($P = 0.027$). Range of movement was no longer significantly better by the third year of follow-up ($P = 0.06$) and there was no significant difference in total range of movement between CR and PS groups at 10-year follow-up ($P = 0.42$).

Table 1 Preoperative clinical scores and range of movement for all patients

Clinical score	Patient groups				*P*-value
	CR (*n* = 107)		PS (*n* = 107)		
	n	SD	*n*	SD	
AKSS:					
Objective	29.6	± 15.3	30.2	± 15	0.906
Function	51	± 17.3	53	± 16.4	0.266
Range of movement	92.3	± 20.6	88.3	± 21.3	0.132

AKSS, American Knee Society score; CR, Cruciate retaining; PS, posterior stabilised; SD, standard deviation

Table 2 Preoperative clinical scores and range of movement for patients who were alive and followed-up for 10 years

Clinical score	Patient groups				*P*-value
	CR (*n* = 107)		PS (*n* = 107)		
	n	SD	*n*	SD	
AKSS:					
Objective	31.23	± 16.76	30.5	± 15.7	0.094
Function	56.06	± 17.47	55.46	± 15.09	0.938
Range of movement	94.92	± 17.09	88.14	± 21.93	0.586

AKSS, American Knee Society score; CR, Cruciate retaining; PS, posterior stabilised; SD, standard deviation

Table 3 Postoperative clinical scores and range of movement for patients who were alive at 10-year follow-up

Clinical score	Patient groups				*P*-value
	CR (*n* = 107)		PS (*n* = 107)		
	n	SD	*n*	SD	
AKSS:					
Objective	88.5	± 13	88.7	± 13.9	0.95
Function	53.6	± 26.6	58	± 31	0.46
Range of movement	100.7	± 17.2	103.6	± 18.8	0.42
Pain score	45	± 9.4	46.8	± 8.6	0.35

AKSS, American Knee Society score; CR, Cruciate retaining; PS, posterior stabilised; SD, standard deviation

Table 4 Score improvement for clinical outcome and range of movement at 10-years

Clinical score	Patient groups				*P*-value
	CR (*n* = 107)		PS (*n* = 107)		
	n	SD	*n*	SD	
AKSS:					
Objective	57.6	± 20.6	58.2	± 21.6	0.88
Function	–2.9	± 27.1	2.6	± 27.7	0.32
Range of movement	6	± 18.9	15	± 22.8	0.027

AKSS, American Knee Society score; CR, Cruciate retaining; PS, posterior stabilised; SD, standard deviation

Table 5 Postoperative complications

	CR (*n*)	PS (*n*)
Complication:		
Deep-vein thrombosis	6	1
Stiffness requiring MUA	5	5
Deep prosthetic joint infection	1	1
Revisions:		
Infection	1	1
Aseptic loosening	–	2
Tibial component malrotation	–	1
Misalignment	–	1
Severe pain	–	1

However, a trend towards slightly better flexion was observed in PS knees throughout the follow-up period and there was superior score improvement in range of movement for PS knees, with a mean increase of 15 degrees for PS knees compared with 6 degrees for CR knees at 10 years ($P = 0.027$). Score improvement is presented in Table 4.

There was no significant difference in pain scores at 10 years between the CR and PS groups ($P = 0.35$). There was no significant difference in patient satisfaction at 10-year follow-up, with 98.1% of the CR group and 97.7% of the PS group remaining satisfied with their knee ($P = 1$).

Postoperative complications occurred in 19 knees (Table 5). One knee in each group had an early deep prosthetic joint infection confirmed with positive intraoperative microbiology cultures. These were both successfully treated with a debridement, antibiotics and implant retention protocol and both implants continued to function satisfactorily. The five stiff knees in each group underwent manipulation under anaesthesia and had demonstrable improvement in range of movement.

There was one revision (0.93%) in the CR group and six revisions (5.6%) in the PS group ($P = 0.12$). One case of infection in the CR group was revised at 1.92 years after primary surgery. In the PS group, there was one case of infection, which was revised at 1.85 years, two cases of aseptic loosening, which were revised at 5.74 years and 7.85 years, one case of tibial component malrotation, which was revised at 5.88 years, one case of misalignment, which was revised at 1 year and one knee was revised due to severe pain at 2.9 years after the primary surgery.

The Kaplan–Meier survivorship curves of the two groups are shown in Figure 1. Both groups demonstrated excellent survivorship. The CR group showed 99% (95% CI) and PS group showed 94.3% (95% CI) survivorship, with no significant differences between the two groups at 10-year survivorship (log rank test $P = 0.054$, Wilcoxon test $P = 0.068$).

Discussion

Whether to preserve or substitute the posterior cruciate ligament in TKA remains a controversial subject. There have been multiple short-term studies comparing CR and PS knees but there is a paucity of literature comparing long-term

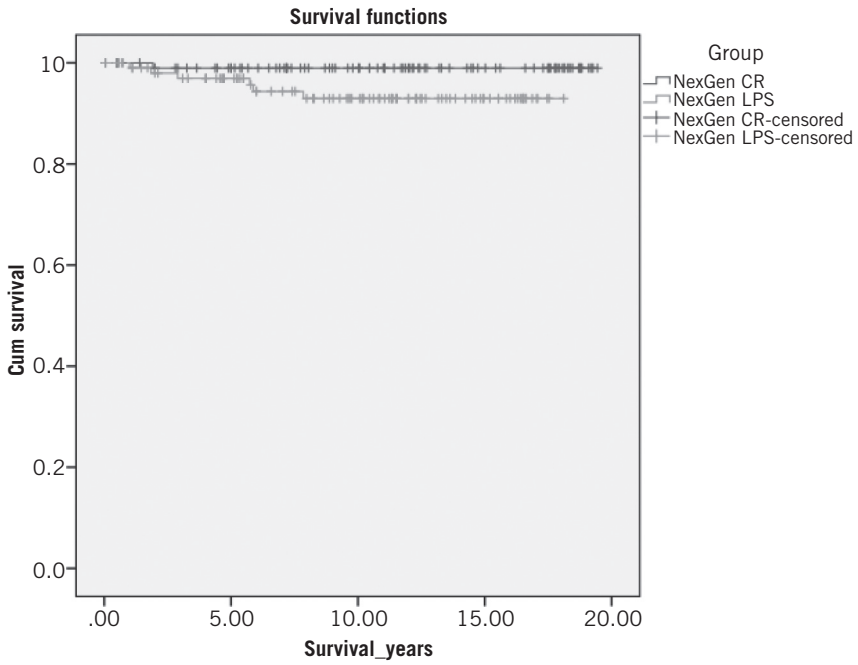

Figure 1 Kaplan–Meier survival curve with revision surgery as the end point (CR, Cruciate retaining; LPS, Legacy posterior stabilised).

outcomes. This study is the first to compare the long-term results of the Nexgen CR and Nexgen PS at 10-year follow-up.

Our results indicate excellent outcomes at 10 years with both types of prosthesis. We have found no significant differences between CR and PS Nexgen TKA patients at 10-year follow-up, in keeping with the majority of other papers comparing CR and PS TKA.[15,18,19,21–24] In contrast, the only other study comparing outcomes of PS and CR TKA at 10 years reported that clinical outcome scores were significantly better in PS compared with CR knees.[28] This study included 143 CR and 271 PS Genesis II® (Smith and Nephew, Memphis, TN) total knee replacements and the authors cited a number of potential reasons for the improved outcome scores in PS compared with CR knees. They considered that continuing degenerative changes in the preserved posterior cruciate ligament, coupled with polyethylene wear as a potential result of reduced knee joint stability could explain the worse outcomes in their CR TKA group. They also considered that the cam–post mechanism, inherent to the PS prosthesis, was more reliable in maintaining functional knee kinematics than the posterior cruciate ligament in a CR prosthesis.[28]

Range of movement is an important aspect of knee function evaluation. Despite the fact that our results showed significant improvement in the postoperative range of movement for both the groups, flexion was significantly better in the PS group at 1-year follow-up. This improved range of motion was no longer significant by the third year of follow-up and there was no significant difference in overall range of motion at 10-year follow-up. However, on analysing score improvement, which takes into account the preoperative range of motion, there was superior improvement in range of movement for PS knees, with a mean increase of 15 degrees for PS knees compared with 6 degrees for CR knees at 10 years ($P = 0.027$). In the only other study comparing results at 10 years, Sando et al. also reported a trend of slightly superior knee flexion in PS knees, although this was not statistically significant ($P = 0.06$).[28]

PS knees allow more physiological knee kinematics and Maruyama *et al.* described nonphysiological posterior cruciate ligament tightness as a cause of limited flexion in CR knees.[25] Increase in the flexion and extension gaps due to resection of the posterior cruciate ligament may also lead to a substantial positive effect on flexion in PS knees. Although PS knees appear to offer improved knee flexion compared with CR designs, this does not seem to influence knee function and patient-reported outcome measures.[29]

We found patient satisfaction to be excellent among both groups. The most common reason for reduced patient satisfaction was stiffness in CR group, whereas it was a mix of both stiffness and continuing pain in the PS group.

There were a greater number of revisions in the PS group (6 knees, 5.6%) compared with the CR group (1 knee, 0.93%), although this was not statistically significant ($P = 0.12$). Similar higher revision rates were reports by Sando *et al.*, with 10-year revision rates of 3.3% in PS knees (9 cases) compared with 1.4% in CR knees (2 cases). Two cases of revision in the PS group were due to surgeon error (misalignment and tibial component malrotation); this is noteworthy, as proponents of PS designs often cite more reproducible surgical technique as an advantage of this

design. Two cases were revised for aseptic loosening in the PS group compared with none in the CR group. The cam–post articulation in PS knees can be an additional source of wear debris, contributing to osteolysis and aseptic loosening.[30]

This study has several limitations. First, our results may be implant specific and are related only to the Zimmer Nexgen total knee arthroplasty system. Second, patients were not randomised and selection bias may have occurred. Significantly, only 52 patients were available in the CR group and 44 patients in the PS group for 10-year follow-up and this may have biased the statistical analysis, although it may be expected given the elderly demographic included in the study. All patients belonged to one geographical region and the results may not be applicable to other populations with significant differences in ethnicity and expectations. Last, the number of knees in both groups was not sufficient to firmly comment on the survivorship.

The current study found no significant differences between the Nexgen CR and Nexgen PS TKA with regards to functional assessment, overall range of movement or patient satisfaction at 10-year follow-up. Although PS knees had significantly better early postoperative knee flexion than CR knees, this was no longer significant by 10-year follow-up. However, when preoperative range of movement was accounted for by calculating the score improvement in range of motion, there was a significantly better improvement in range of motion in PS knees compared with CR knees. The slight superiority in knee flexion score improvement does not appear to impact patient-related outcome measures.

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