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Cementing technique affects the rate of femoral component loosening after high flexion total knee arthroplasty

Hyuk-Soo Han, Myung Chul Lee *

Department of Orthopedic Surgery, Seoul National University Hospital, 101 Daehak-ro, Jongno-gu, Seoul 03080, Republic of Korea

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ABSTRACT

Background: The purpose of this study was to determine the effects of different cementing techniques on the rate of early femoral loosening of high-flexion total knee arthroplasties (TKAs).
Methods: A total of 734 knees from 486 patients treated with high-flexion design TKA between July 2001 and July 2010 were divided into two groups based on the cementing technique used. For 403 knees (group N), cement was applied onto the distal and anterior cut surfaces of the femur and the posterior flanges of the femoral component without pressurization. For 331 knees (group P), cement was applied onto distal and anterior femoral cut surfaces with digital pressurization and whole cement surfaces of the femoral component. Two groups were subjected to clinical and radiological evaluation with a minimum five year follow-up period. Cox proportional hazards model with revision surgery of the prosthesis or radiological loosening as an endpoint was used to evaluate the effect of the cementing technique and other covariates.
Results: The pressurizing and bi-surface cementing technique resulted in significant reduction in femoral radiological loosening incidence compared to that without pressurization (0.3% vs. 2.5%, $P = 0.015$) and revision rate for aseptic causes (0.9% vs. 3.2%, $P = 0.032$). Cox proportional hazard regression analysis revealed a significant difference in component survival rate between the two groups if femoral radiological loosening was considered as failure (hazard ratio, 4.229, 95% confidence interval (CI): 1.256–14.243, $P = 0.020$).
Conclusion: Pressurizing and bi-surface cementation can reduce the occurrence rate of early loosening around the femoral component in high-flexion TKAs.

1. Introduction

Whether high-flexion total knee arthroplasties (TKAs) have the risk of early femoral loosening remains controversial. High flexion activities in vitro have shown high stress even in high-flexion design TKAs [1–3]. Concerns have been expressed about the possibility of early loosening in high-flexion TKAs in vivo. Several studies have reported progressive radiolucent lines (RLL) or early loosening of high-flexion TKAs [4–7]. However, other high-flexion TKA studies have demonstrated good results without premature failure [8,9]. It has been proposed that early failure of fixation is probably related to errors in the cementing technique [10,11].

* Corresponding author.
E-mail addresses: oshawks7@snu.ac.kr (H.-S. Han), leemc@snu.ac.kr (M.C. Lee).

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Aseptic femoral loosening in TKA can be caused by many factors. Poor preparation of bone surface, inadequate support of the prosthetic posterior condyle, malalignment of components, and cementing technique are technical factors that can adversely affect component fixation and clinical success [10,12–14]. A stable primary fixation is one of the most important factors influencing the longevity of TKA. The bone–cement–prosthesis interface is especially critical in terms of implant survival [15]. High-flexion TKA design may allow the patient to perform more stressful activities with his knee prosthesis [11]. Therefore, more solid bone–implant interface fixation is needed to prevent the risk of aseptic loosening [16]. Nevertheless, very little is known about the stress in the bone–implant interface of high-flexion TKAs.

Consensus on what is the single best technique for cementation in TKA remains unclear. Most studies have been performed on the tibial side in conventional design [17,18]. Proponents of pressurizing cementation state that this technique provides better fixation [12]. On the other hand, advocates of surface cementation state that sufficient implant stability can be achieved by surface cementation with decreased metaphyseal bone loss in case of revision without the potential stress-shielding effect [18–20].

The purpose of this study was to determine the effect of cementing technique on early femoral loosening of high-flexion TKAs. To the best of our knowledge, no clinical study on this issue has been reported. The hypothesis of this clinical study is that the rates of early loosening around the femoral component in high-flexion TKAs are different if the pressurizing and bi-surface cementing technique is used or not. The relationship between early loosening and clinically relevant covariates was investigated to determine the risk factors for these conditions.

2. Methods

Between July 2001 and July 2010, 842 primary TKAs were performed for 652 Korean osteoarthritis patients using a NexGen Legacy Posterior Stabilized–Flex fixed bearing prosthesis (Zimmer, Warsaw, IN). Of the 652 patients, 10 patients (12 knees) died and 10 patients (13 knees) could not be contacted. Eighty-three knees were excluded from analysis because the duration of follow-up was less than five years or their data were incomplete, leaving 734 knees eligible for this study.

These consecutive patients were divided into two groups based on the cementing technique used to secure the femoral component. From July 2001 to April 2006, the cement was prepared in a hand-mixing bowl following the instructions of the manufacturer and applied onto the distal and anterior cut surface of the femur and spread over the two posterior flanges of the femoral component without pressurization (group N). From May 2006 to July 2010, the cement was placed directly onto all cementing surfaces of the femoral prostheses and digitally impacted into the anterior and distal cut-surface of the distal femur (group P). We then impacted the components into place and carefully removed any cement left at the immediate space between the bone and prosthesis. However, tibia cementation was the same for both groups. Usually two packets of the same kind of cement (Palacos®; Heraeus Medical GmbH, Wehrheim, Germany) were used in all procedures. A pneumatic tourniquet was inflated during cementation and implantation in all cases. Apart from the cementation technique, patients included in our study received a TKA procedure using the same surgical approach and a single surgeon performed all surgeries.

All patients followed the same postoperative rehabilitation protocol, starting continuous passive motion the day after surgery and beginning full weight bearing as tolerated two days after surgery. Passive gentle flexion exercise was performed until patients achieved near 130° of knee flexion.

The demographics and baseline characteristics of the two groups are summarized in Table 1. The median follow-up durations of group N and group P were 8.3 years and 5.8 years, respectively.

All patients were followed prospectively. They were evaluated clinically and radiologically at six weeks, three months, six months, one year, and then yearly thereafter. Clinical assessment was performed using range of motion (ROM), Knee Society knee score (KSKS) and function score (KSFS) [21], Hospital for Special Surgery (HSS) scores [22], and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) [23]. The non-weight-bearing maximal knee flexion angle was measured using a standard goniometer preoperatively and at each follow-up. While measuring the maximal knee flexion angle, patients were asked to bend their knees as much as they could or until they felt slight pain while lying in supine position. Radiological

Table 1
The demographics and preoperative characteristics of the subjects.

	All (n = 734)	Cement technique		*P*
		Conventional (n = 403)	Pressurizing (n = 331)	
Gender, female	696 (94.8%)	392 (97.3%)	304 (91.8%)	<0.001
Age (years)	69.1 ± 6.9	68.2 ± 6.0	70.2 ± 7.7	<0.001
BMI (kg/m^2)	26.9 ± 3.3	27.1 ± 3.0	26.7 ± 3.5	0.077
Knee flexion contracture (°)	14.4 ± 8.9	14.7 ± 9.6	14.1 ± 8.0	0.353
Knee further flexion (°)	124.1 ± 16.1	124.4 ± 14.3	123.6 ± 18.0	0.527
Range of motion (°)	109.2 ± 21.1	109.7 ± 18.7	108.6 ± 23.8	0.470
KSKS	44.1 ± 17.0	39.1 ± 16.8	48.2 ± 16.0	<0.001
KSFS	41.1 ± 19.9	43.0 ± 22.8	39.5 ± 17.0	0.037
HSS	52.2 ± 15.2	43.4 ± 11.5	62.8 ± 11.9	<0.001
WOMAC	51.4 ± 19.4	54.6 ± 16.6	47.6 ± 21.7	<0.001
Follow-up duration (years)	Median = 5.8 (IQR, 3.6–8.1)	Median = 7.3 (IQR, 4.8–9.2)	Median = 4.9 (IQR, 2.3–6.0)	

Values are expressed as mean ± standard deviation. BMI, body mass index; HSS, Hospital for Special Surgery score; IQR, interquartile range; KSFS, Knee Society function score; KSKS, Knee Society knee score; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index.