Achieving High Flexion After Primary TKA

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Achieving Deep Flexion After Primary Total Knee Arthroplasty

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Abstract: Total knee arthroplasty patients often have difficulty performing activities involving flexion beyond 130°. The NexGen LPS Flex (Zimmer Inc, Warsaw, Ind) mobile bearing implant accommodates up to 155° of flexion. Two hundred eighteen total knee arthroplasties were performed using this implant on 125 patients over a 2-year period with a minimum of 5 years follow-up. All data were collected prospectively. Forty-four percent of preoperative cases had full flexion (ie, 140° active flexion and ability to kneel with thigh/calf contact for 1 minute). Five-year data showed an average flexion of 140° ± 11.5° and flexion greater than 140° in 103 knees (68%). There were no differences in patellofemoral pain levels, complications, or Knee Society scores despite our patients having, on average, an increase in flexion and function.
Keywords: total knee arthroplasty, knee flexion, rotating platform, mobile bearing, posterior stabilized, deep flexion.

A survey of more than 200 cases in the United States found that patients who underwent primary total knee arthroplasty (TKA) were physically unable to perform certain activities involving deep knee flexion [1]. Although it was reported that these patients did generally have a good Knee Society score, and were satisfied with the overall surgical results, there was dissatisfaction with the restrictions associated with range of motion, primarily achieving deep flexion. Activities involving deep knee flexion considered by the patients to be vital included squatting (82%), kneeling (79%), gardening (50%), sexual performance (77%), and dancing (51%). Postoperative expectations and abilities are different for a variety of patients, and achieving these postoperative goals is multifactorial and contribute greatly to the overall clinical outcome and patient satisfaction after primary TKA [2].

In Asian and Middle Eastern cultures, normal activities of daily living (ADL) heavily depend on the ability to fully flex the knee with most activities related to religious practice and kneeling in deep flexion. As a result, many of these patients decline TKA after realizing that there is a possibility they will not be able to resume their full daily and religious lifestyles after surgery [3].

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Most primary TKA systems available in the market today are designed to achieve a maximum flexion angle of 130°. Unfortunately, these prostheses are not designed to have the capacity for the normal daily and religious ADL of the Asian and Middle Eastern populations. Therefore, the purpose of this study was to prospectively evaluate the minimum 5-year clinical and radiographic outcome of the NexGen LPS Flex TKA system (Zimmer Inc, Warsaw, Ind), a TKA system designed to achieve high flexion to 155°, used in an exclusively Asian and Middle Eastern population. As a control, these cases were compared with the global NexGen TKA series from the Zimmer Feedback database that was used as a benchmark in terms of patient outcome and complication rate.

Materials and Methods

Between December 1999 and June 2002, 218 TKAs were performed on a combined 125 Asian and Middle Eastern patients (54 male, 71 female); all were diagnosed with advanced osteoarthritis of the knee and had failed conservative treatment. The average patient age was 64 ± 9.05 years, (range, 27-96 years) and the average patient body mass index (BMI) was 31.9 ± 6.6 (range, 17.2-55.1). The distribution of patient BMI is detailed in Table 1. The average patient height was 1.55 ± 9.69 m (range, 1.34-1.87 m) and the average weight was 71.4 ± 14.4 kg (range, 42.5-110 kg). Ninety-three patients (186 knees) underwent simultaneous bilateral TKA procedures, whereas 32 patients had unilateral TKA procedures. Femoral component size C was used in 53 cases (24%), size D in 87 cases (40%), size E in 70 cases (32%), and size F in 8 cases (4%). The NexGen LPS Flex mobile

Table 1. Body Mass Index Distribution of Patients

BMI Category		
<25	58	27%
≥5 and <30	75	34%
≥30 and <35	45	21%
≥35	40	18%
Total	218	

bearing knee (Zimmer Inc, Warsaw, Ind) was the implant of choice for all patients. Preoperatively, all patients had AP weight bearing x-rays and maximum lateral flexion x-rays. Knee Society scores, patient satisfaction, and adverse events were also recorded as required by the study protocol.

The design of the NexGen LPS Flex mobile bearing implant incorporates deep flexion (up to 155°) required in our patient population. The designers have addressed the mechanical design issues that may arise in the process of safe deep flexion [4]. The posterior condyle of the femoral component was made thicker and more rounded to allow the tibia to roll back further in deep flexion, as shown in Fig. 1. The spine and cam mechanism was redesigned to allow lower contact so the femoral implant does not disengage in deep flexion (Fig. 2). To prevent excessive wear on the polyethylene inlay, the femoral component was redesigned to allow more contact area with deep flexion (Fig. 3). The patellar groove was deepened to prevent pressure on the patellar tendon and to allow better tracking for the patella.

All surgeries were performed by the same surgeon using the subvastus approach with quads releases carried out in cases where preoperative flexion was less than 100°. The approach proceeded through a medial parapatellar incision while maintaining the attachment of the vastus medialis on the patella and leaving it intact. Dissections were carried out on the vastus medialis until it was laterally mobilized. Quads releases where performed on those patients who had limited movement where the quads muscle was dissected free from the anterior surface of the femur; the release was done manually and bluntly as far proximally as needed until a flexion of 130° was obtained. This allowed more quads excursion and enabled the surgeon to sublux the patella laterally. No attempt was made to evert and dislocate the patella. Varus deformity is very common in our patients' population. In most cases the deformity was severe requiring extensive medial collateral release. The bone cuts were performed as per recommendation of the manufacturer. Flexion and extension gaps were balanced using block spacers. All components were cemented in full extension. Hemovac drains were used in all patients and were kept in for 24 hours. After wound closure, the passive range of motion was documented and digital images were taken to determine whether full flexion was attained.

During the first 6 hours postoperatively, the knee was kept in 90° of flexion using wedge pillows to decrease blood loss. Over the first 3 postoperative days, epidural pain management was used via an epidural catheter and a continuous infusion of 0.1% ropivacaine (Naropin; APP Pharmaceuticals LLC, Schaumburg, IL) and 2 mg/mL fentanyl at a rate of 5 to 15 mL/h, titrated to obtain good pain relief with full dorsiflexion. All patients were provided with telemonitoring during the use of the epidural. Femoral nerve blocks via a catheter were used in unilateral knee arthroplasty and in cases where patients refused epidural analgesic. The catheter was inserted adjacent to the femoral nerves, and continuous infusion was given for the first 3 days.

Physiotherapy was started on postoperative day 1 after the removal of the drain and applying a reduced dressing. Physiotherapy consisted of aggressive passive and active knee flexion. No continuous passive motion (CPM) machines were used in any case. In the first 3 days postoperatively, emphasis was placed on obtaining movement rather than standing the patients and ambulation. Deep vein thrombosis prophylaxis included daily Comudin (Bristol-Myers Squib Company, Princeton, NJ) based on international normalized ratio level, and patients were discharged from the hospital on this and PO analgesic. Patients had to return to the physiotherapy department for rehabilitation at least

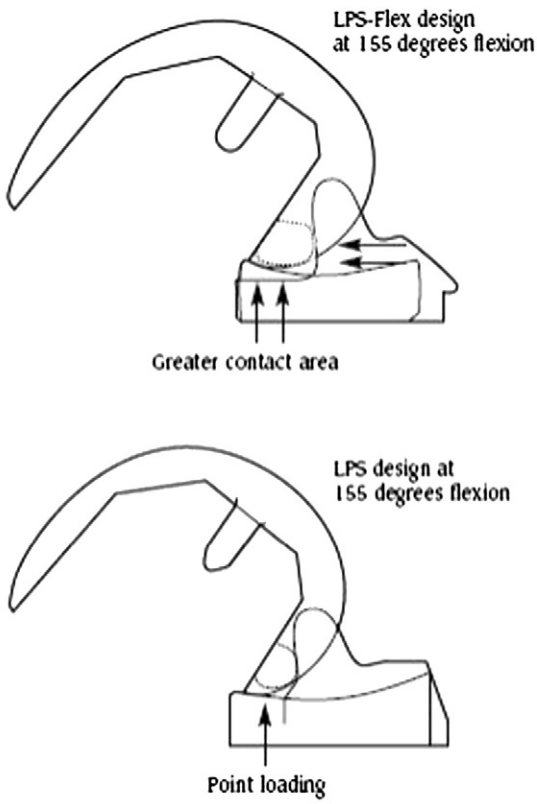

Fig. 1. The double arrows indicate the increased contact area in the flex design at 155°.

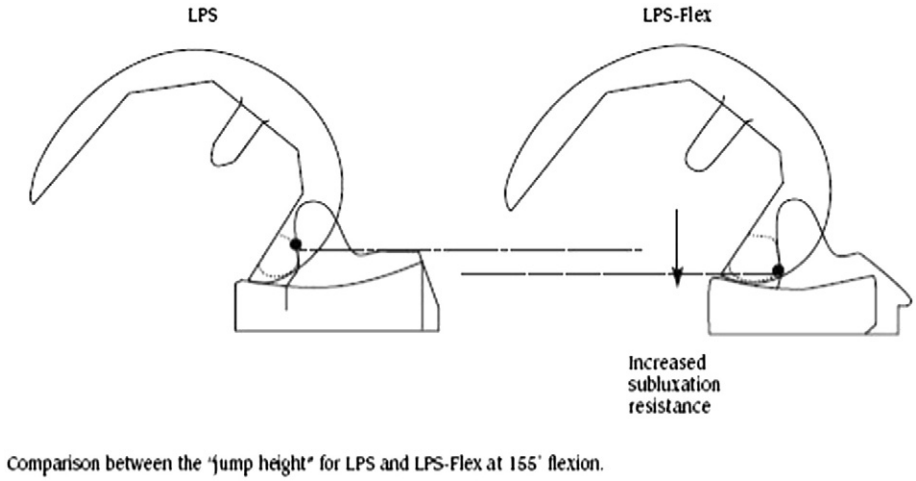

Fig. 2. Contact area in the cam/spine mechanism is lower in the flex design as compared with the regular implant, as indicated by the arrow.

once a week for 6 weeks. There was no home health care available for the patients.

Anteroposterior and lateral maximum flexion x-rays were obtained at 3 months, 3 years, and 5 years postoperative intervals. The x-rays were reviewed by the surgeon in search for signs of component loosening or instability such as patella subluxation or knee instability and to monitor the state of the articulating surface. Knee Society scores were documented at 3 months, 3 years, and 5 years postoperatively. Patients were considered to have full flexion if they had the ability to actively bend the knee to at least 140° and kneel on the ground with their calf in contact with their thigh for at least 1 minute. Statistical analysis was performed using SPSS version 14 (Statistical Package of the Social Sciences, Chicago, IL).

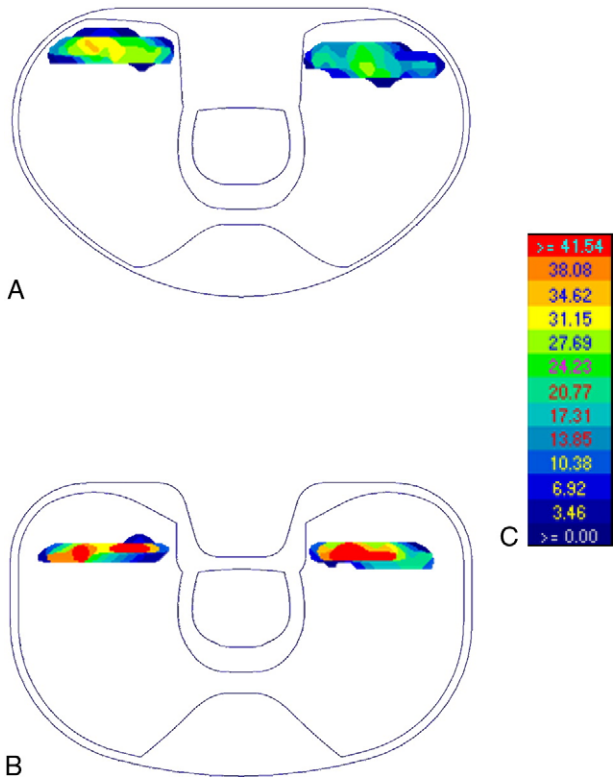

Fig. 3. Pressure with deep flexion of 155° in the flex design (A) and the standard design (B). The color bar (C) shows the relative pressure increment in deep flexion.

Results

The mean hospital stay was (13.1) days. Sixty-six (30%) of the 218 knees due for a 5-year follow-up had missed their follow-up appointments because of death (n = 7, 3.2%), refusal to attend the clinic (n = 5, 2.3%), or loss of contact (n = 54, 24.7%). However, all 218 knees did receive a 3-year clinical and radiographic assessment and their status was satisfactory.

One hundred seventy-six (81%) knees had a fixed flexion deformity of 10° or less (average, 2.5° ± 2.7°) preoperatively, which was not evident at the postoperative assessments. None of the patients had extensor lag preoperatively or postoperatively. All but 12 patients who exhibited full flexion preoperatively had full range of motion postoperatively. Conversely, all but 3 patients who exhibited full range of motion preoperatively had full flexion postoperatively. The average preoperative range of motion was 125° ± 17.8° (range, 75°-155°) and improved to 138° ± 16.3° (range, 115°-160°) at 3 months and was 140° ± 11.5° (range, 115°-160°) at the 5-year follow-up. The average preoperative Knee Society score (maximum 100 points) was 16 ± 13.5 (range, 0-55) and improved to an average of 83 ± 8.6 (range, 55-100) at 3 months postoperatively and an average of 88 ± 9.1 (range, 57-99) at 5 years postoperatively. The clinical outcomes and range of motion categories are detailed in Tables 2 and 3, respectively.

Patellar resurfacing with a polyethylene component was used in 201 (92.2%) knees. Patellar tracking was checked by flexing the knee and extending it, before

Table 2. Clinical Results: ROM, Knee Society Score, and Patellofemoral Pain

	Preoperative	3 mo	3 y	5 y
n (knees)	218	218	218	152
n (%) with deep flexion (≥140°)	96 (44%)	144 (66%)	153 (70%)	103 (68%)
Maximum flexion, mean ± SD (min-max)	125 ± 17.8 (75-155)	138 ± 16.3 (115-160)	142 ± 10.6 (115–160)	140 ± 11.5 (115-160)
% Patellofemoral pain	79	1	1	0
Knee Society score, mean ± SD (min-max)	16 ± 13.5 (0-55)	83 ± 8.6 (55-100)	88 ± 7.3 (59-95)	88 ± 9.1 (57-99)

ROM indicates range of motion.

closure, without any external support for the patella (no thumb technique). Medial collateral ligament release was performed in 200 knees (91.7%). Posterior capsule releases were performed in 67 knees (30.7%). Lateral retinacular release was necessary in 6 cases (2.7%). There were 7 cases (3.2%) in which a quad release was necessary because the preoperative range of motion was less than 100°.

Complication rates were similar regardless of whether patients could flex fully or not and showed no difference from the other NexGen TKA cases in the Zimmer Feedback database. Complications are detailed in (Table 4) for both groups of patients. There were no specific complications that could be attributed to deep flexion. There were also no patellar complications such as dislocation in the series. There was one revision 4 and a half years postoperatively for aseptic loosening.

Discussion

We report successful results of the use of the NexGen LPS Flex TKA system in achieving postoperative deep flexion in an Asian and Middle Eastern population with expectations of increased flexion ability for social and religious considerations. In general, deep flexion did not lead to an increased complication rate. Our series displayed a higher average degree of postoperative flexion than comparable mobile bearing knee designs reported in the literature (Table 5).

Moreover, there was no incident of gross component failure due to deep flexion and no incident of increased knee laxity complications in our population. In our series, only one revision took place 4 and a half years postoperatively for aseptic loosening.

Achieving knee flexion beyond 130° requires component design changes and intraoperative considerations in soft tissue management [16]. However, after successful TKA, the patellofemoral contact pressures in a normal knee are not different than those in the replaced knee [17]. Nagura et al [18] reported that compression forces on the patella while squatting are less then those exerted during the descent of stairs. As Ritter [19] recently reported, the improved range of motion achieved in our patient population may be explained in that they had significantly increased range of motion preoperatively despite their ailment; patients thus maintained a better range of motion postoperatively due to their normal ADL. Ahlberg et al [20] has shown that patients in Saudi Arabia have on average 15° of flexion more than subjects in Scandinavia. Similar geographical differences for range of motion were also documented by Hoaglund et al [21] who found a greater range of motion in Chinese populations when compared to whites living in Hong Kong. However, one might be cautious in expecting similar results in western populations using the same knee unless preoperative deep flexion is part of the patient's ADL history.

Although deep flexion was achieved in most of our patients, and full range of motion in all patients, the Knee Society score failed to show any signs of significant

Table 4. Complications in Patients That Did and Did Not Achieve Full Flexion (≥140°)

Adverse Event	≥140° Achieved	≥140° Not Achieved
Dislocation	0	1
Femoral crack	1	0
Foot drop	1	0
Hematemesis	0	2
Hyponatremia	0	2
Lethargy, confusion	2	1
Paralytic ileus	2	0
Patellar tendon rupture	0	1
PE and MI	2	0
Severe contact dermatitis adhesive tape	0	1
Skin necrosis	0	1
Tibial crack	1	0
Urinary retention	3	1
Wound healing, skin necrosis	0	1

PE, pulmonary embolism; MI, myocardial infarction.

Table 3. Clinical Results: Range of Motion Categories

ROM							
Preoperative				5-y Follow-Up			
Category	n	%	Mean, SD, Min-Max	Category	n	%	Mean, SD, Min-Max
<130	62	28	115, 10.2, 90-125	<130	19	12	132, 11.6, 110-150
≥130 and <140	43	20	132, 2.5, 130-135	≥130 and <140	30	20	142, 8.0, 125-155
≥140	113	52	143, 4.9, 140-155	≥140	103	68	145, 6.6, 130-160

Table 5. Flexion of Comparative TKA Designs

TKA Design	Author	ROM (degrees)	Mean Follow-Up
LCS Knee System, DePuy Orthopaedics Inc (Warsaw, IN)	Bhan et al [5]	107	6 y
	Hardford et al [6]	99	130 mo
	Callaghan et al [7]	105	13 y
	Kim et al [8]	132	13.2 y
	Callaghan et al [9]	102	9.7 y
	Beuchel et al [10]	110	173 mo
PFC Sigma RP; DePuy Orthopaedics Inc	Ranawat et al [11]	120	16 mo
	Kim et al [12]	130	5.6 y
	Evans et al [13]	116	2 y
	Gupta et al [14]	116	12 mo
	Ranawat et al [15]	116	8 mo
PFC Sigma RP-F, DePuy Orthopaedics Inc	Gupta et al [14]	125	12 mo
	Ranawat et al [15]	122	6 mo

difference despite the functional advantage of greater flexion to our patient population. Meneghini et al reported that increased deep flexion did not benefit clinical outcome as assessed by the Knee Society scoring system [22]. We agree with Noble et al that the knee score may be inadequate in reflecting the functionality of the patient especially with regard to high-performance designs or cultural ADL differences [1].

In conclusion, our results show deep flexion to be safe and that there is no increased rate of complication that can be attributed to deep flexion. It should be pursued when possible, on selected patients, specifically those who have certain cultural backgrounds that enable them to maintain a good range of motion as preoperatively. We had difficulty in finding universal terms describing deep knee flexion activities and their significance. The knee score has failed to assess any improved functionality of patients who had deep flexion. Further assessment techniques should be developed for the measurement of cultural ADL. In our population, the fact that patients who had better range of motion also had better function and could therefore normally perform their daily activities makes deep flexion a positive trend to pursue in selected patients.

References

1. Noble PC, Gordon MJ, Weiss JM, et al. Does total knee replacement restore normal knee function? Clin Orthop Relat Res 2005;431:157.
2. Weiss JM, Noble PC, Conditt MA, et al. What functional activities are important to patients with knee replacements? Clin Orthop Relat Res 2002;404:172.
3. Shankran-Kutty M. Joint replacement surgery in the Arab: special considerations. 12th Arab American Medical Association Meeting; 1995. [Ref Type: Conference Proceeding].
4. Nagura T, Otani T, Suda Y, et al. Is high flexion following total knee arthroplasty safe?: evaluation of knee joint loads in the patients during maximal flexion. J Arthroplasty 2005; 20:647.
5. Bhan S, Malhotra R, Krishna Kiran E, et al. A comparison of fixed bearing and mobile bearing total knee arthroplasty at a minimum follow-up of 4.5 Years. J Bone Joint Surg [Am] 2005;87:2290.
6. Hartford J, Harned M, Kaufer H, et al. Primary meniscal-bearing knee replacements: 8 to 15 year follow-up. Clin Orthop Relat Res 2007;465:227.
7. Callaghan J, O'Rourke M, Iossi M, et al. Cemented rotating-platform total knee replacement: a concise follow-up, at a minimum of fifteen years, of a previous report. J Bone Joint Surg [Am] 2005;87:1995.
8. Kim Y, Yoon S, Kim J. The long term results of simultaneous fixed-bearing and mobile-bearing total knee replacements performed in the same patient. J Bone Joint Surg [Br] 2007; 89:1317.
9. Csallaghan J, Squire M, Goetz D, et al. Cemented rotating-platform total knee replacement: a nine to twelve-year follow-up study. J Bone Joint Surg [Am] 2000;82:705.
10. Beuchel Snr F, Beuchel Jnr F, Pappas M, et al. Twenty-year evaluation of meniscal bearing and rotating platform knee replacements. Clin Orthop Relat Res 2001;338:41.
11. Ranawat A, Rossi R, Loreti I, et al. Comparison of the PFC Sigma fixed-bearing and rotating platform total knee arthroplasty in the same patient: short-term results. J Arthroplasty 2005;19:35.
12. Kim Y, Kim D, Kim J. Simultaneous mobile and fixed bearing total knee replacement in the same patients: a prospective comparison of mid-term outcomes using a similar design of prosthesis. J Bone Joint Surg [Br] 2007; 89:904.
13. Evans M, Parsons E, Scott R, et al. Comparative flexion after rotating platform vs fixed-bearing total knee arthroplasty. J Arthroplasty 2006;21:985.
14. Gupta S, Ranawat A, Shah V, et al. The PFC Sigma RP-F TKA. Designed for improved performance: a matched pair study. Orthopedics 2006;29(suppl 9):49.
15. Ranawat C, Ranawat A, Gupta S, et al. Design specific increase in range of motion with the PFC Sigma RP-F TKR: a matched-pair study. Presented at the Annual Meeting of the Knee Society and the American Association of Hip and Knee Surgeons, Chicago, IL, March; 2006.
16. Dennis DA, Komistek RD, Scuderi GR, et al. Factors affecting flexion after total knee arthroplasty. Clin Orthop Relat Res 2007;464:53.
17. Argenson JN, Komistek RD, Mahfouz M, et al. A high flexion total knee arthroplasty design replicates healthy knee motion. Clin Orthop Relat Res 2004;428:174.
18. Nagura T, Dyrby CO, Alexander EJ, et al. Mechanical loads at the knee joint during deep flexion. J Orthop Res 2002;20: 881.

19. Ritter MA. High-flexion knee designs: more hype than hope? In the affirmative. J Arthroplasty 2006;21(4 Suppl 1): 40.
20. Ahlberg A, Moussa M, Al-Nahdi M. On geographical variations in the normal range of joint motion. Clin Orthop Relat Res 1988;234:229.
21. Hoaglund FT, Yau AC, Wong WL. Osteoarthritis of the hip and other joints in southern Chinese in Hong Kong. J Bone Joint Surg Am 1973;55:545.
22. Meneghini RM, Pierson JL, Bagsby D, et al. Is there a functional benefit to obtaining high flexion after total knee arthroplasty? J Arthroplasty 2007;22(6 Suppl 2):43.