Chulalongkorn Medical Journal

Volume 38
Issue 8 *August 1994*

Article 5

8-1-1994

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Pibul Itiravivong

Yongsak Wangroongsub

Prakit Tienboon

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Posterior stabilized condylar arthroplasty : A critical review of range of motion.

Pibul Itiravivong*
Yongsak Wangroongsub* Prakit Tienboon *

Itiravivong P, Wangroongsub Y, Tienboon P. Posterior stabilized condylar arthroplasty: A critical review of range of motion. Chula Med J 1994 Aug; 38(8): 471-478

A series of 138 Thai patients diagnosed with osteoarthritis and rheumatoid arthritis who had undergone a total of 150 posterior stabilized condylar knee prostheses was reviewed during the period of 1981 to 1989. Over 90 % of the cases showed good anatomical results and functional performance. This figure is comparable to that reported in series of different types of total knee replacement. However, because the average degree of knee flexion gained in this series was only 103.4° (Range 60°-110°), no patient was capable of kneeling, squatting (including the use of old-fashioned toilets) and meditating in a sitting position, all of which positions were part of their daily activities. Because this insufficient range of knee flexion posed a significant problem for Asian patients, new designs of squatting knee prosthesis are called for.

Key words: *Total knee arthroplasty, Range of motion.*

Reprint request: Itiravivong P, Department of Orthopaedic Surgery, Faculty of Medicine, Chulalongkorn University, Bangkok 10330, Thailand.
Received for publication. September 12, 1994.

*Department of Orthopedics and Rehabilitation Medicine, Faculty of Medicine, Chulalongkorn University.

พิบูลย์ อิทธิระวิวงศ์, ยงศักดิ์ หวังรุ่งทรัพย์, ประกิต เทียนบุญ. การผ่าตัดเปลี่ยนข้อเข่าเทียมชนิดโพสทีเรีย สเตบิไลเซด คอนไดลาร์ : การศึกษาพิสัยการเหยียดและงอของข้อเข่าหลังผ่าตัด. จุฬาลงกรณ์เวชสาร 2537 สิงหาคม; 38(8): 471-478

ผู้ป่วย จำนวน 138 ราย ได้รับการรักษาโดยการผ่าตัดเปลี่ยนข้อเทียมชนิด Posterior Stabilized Condylar Knee เนื่องจากโรคข้อเข่าเสื่อม และโรครูมาตอยด์ จำนวนทั้งสิ้น 150 ข้อ ระหว่างปี ค.ศ.1981 ถึง 1989 ผลการรักษาพบว่ามากกว่า 90% ของ ข้อเข่าหลังการผ่าตัดรักษาสามารถเหยียดงอข้อเข่าและใช้งานได้โดยปราศจากความเจ็บปวดซึ่งผลการรักษานี้ใกล้เคียงกับรายงานผลการผ่าตัดเปลี่ยนข้อเข่าโดยวิธีการอื่นๆ อย่างไรก็ตามผู้ป่วยเหล่านี้สามารถเหยียดและงอข้อเข่าได้ระหว่าง 60° ถึง 110° (เฉลี่ย 103.4°) เนื่องจาก ข้อจำกัดของข้อเข่าเทียมที่ใช้นั้นออกแบบให้งอได้มากที่สุดเพียง 110 ° เท่านั้น ทำให้ผู้ป่วยส่วนมากซึ่งเป็นพุทธศาสนิกชนไม่สามารถประกอบกิจกรรมทางศาสนา เช่น การคุกเข่าไหว้พระ, การนั่งสวดมนต์ หรือการนั่งยอง ๆ เพื่อการขับถ่ายแบบเดิม คณะผู้รายงานหวังว่าจะมีการออกแบบข้อเข่าเทียม ซึ่งเลียนแบบการเคลื่อนไหวของข้อเข่าตามธรรมชาติ เพื่อว่าผู้ป่วยสามารถเหยียดงอข้อเข่าได้มากกว่าที่มีใช้อยู่ในปัจจุบัน

Caucasian and Asian people perform an unequal range of movement of their knees in their daily living, owing to differences in their customa, cultures, and traditional life-styles. While Caucasians need about 106° knee flexion[1,2] for tying shoes and lifting objects, Asians (Japanese, Koreans and Thais) need to flex their knees up to 140° for squatting (including for the use of old-fashioned toilets) and sitting on the floor for meditation. Whether the outcome of surgery, in term of the range of motion Asians can perform following total knee replacement is wholly satisfactory or not remains to be seen. This is a prospective study of a series of 138 Thai patients, who underwent Insall-Burstein posterior stabilized condylar knee arthroplasties during the period of 1981 to 1989. The aim of the study is to determine the degree of anatomical and functional evalation of the patients following surgery, especially in terms of the range of movement of their knees and that movement relates to their daily activities.

Materials and Methods

Form 1981 to 1989, there were 138 patients in this series,of whom 120 were female; 129 patients were diagnosed as having severe osteo arthritis and 9 patients sero-positive rheumatoid arthritis. All patients were disabled and most of them considerably overweight. The average age of the patients was 59 years, the range being from 38 to 74 years. The indications for total knee arthroplasty were painful, deformed, unstable and activity-restricted knees. The operation was performed strictly according to the technique of Insall and associates.[3-5] Of a total 150 knee replacements, in 12 patients bilateral procedures were performed in one sitting. All patients were evaluated pre and post-operatively using a modified standard rating system.[3,6,7] Criteria for assessment included anatomical results and functional performance. Anatomical results were evaluated in terms of correction of deformity and arc of motion and functional performance in terms of pain relief, walking ability, climbing stairs, use of walking aid. A score of 90 to 100 points is considered to be excellent; 80 to 89 points, good; 70 to 79 points, fair and less than 69 points, poor. The follow up period was from two to eight years. Pre-operatively, 126 knees were in varus and 24 in valgus alignment (Table 1).

Table 1. Summary of anatomical evaluation of 150 knees before and after operation.

	Pre-operative No. of knees	Post-operative No. of knees.
1. Angular deformity (Mechanical axis)		
1.1 Varus deformity	126	36
0-5 degrees	-	36
6-10 degrees	6	-
11-15 degrees	75	-
>15 degrees	45	-
1.2 Valgus deformity	24	114
0-5 degrees	9	108
6-10 degrees	9	6
>10 degrees	6	-
Total	150	150
2. Toal arc of motion		
0-60 degrees	27	6
60-75 degrees	27	6
75-90 degrees	55	24
90-110 degrees	6	114
>110 degrees	35	-
Total	150	150
3. Average flexion	77.6°	103.4°

Results

Roentgenographic measurements, on the final follow-up postopratively, revealed that 72 % (108 of 150) of the prosthetic knees had an alignment of between 0° and 5° of valgus angulation, 4% had (6 of 150) 10° valgus and 24% (36 of 150) mild varus angulation (Table 1). Concerning the relationship between the tibial implant and the longitudinal axis of the tibia, 120 knees were in the neutral position and in the remaining 30 knees the tibial prostheses were tilted slightly either anteriorly or posteriorly. Eighty percent of the of the knees showed radiolucency at the tibia and bone cement interface. On passive varus and valgus tests of the extended prosthetic knees to determine degrees of joint laxity, 10% of knees showed more than 5° of laxity, 65% less than 5° and 25% showed no laxity. Better arc of motion was detected in most of the prosthetic knees, 90% of the knees demonstrated full extension and 76 % (114 of 150) between 90° and 110° flexion. There were six knees which had less than 60° flexion. Post-operative functional data are listed in Table 2. Overall there was a marked relief of pain, increased walking ability, less usage of walking aids and analgesics. However, all patients, were unable to perform kneeling, squatting (including the use of old-fashioned toilets) post-operatively, even though some of them had managed to do so with pain and difficulty pre-operatively. By employing the assessment criteria[3,6,7] 105 knees fell into excellent, 30 into good, 9 into fair and 6 into poor categatories.

Table 2. Summary of functional performace pre and post operation of 138 patients (150 knees).

	PRE-OPERATIVE	POST-OPERATIVE
PAIN (KNEES)		
Severe on walking	135	-
At rest	15	6
WALKING (PATIENTS)		
5-10 block	30	105
1-5 block	60	30
Household walker	45	3
Non-walker	3	-
STAIR-CLIMBING (PATIENTS)		
One step at a time	126	132
Unable to ascend stair	12	6
WALKING AID (PATIENTS)		
No aid	102	123
One cane	33	15
Non-ambulatory	3	-
SQUATTING, KNEELING, OLD STYLED TOILETTING (PATIENTS)		
Capable	28	-
Uncapable	110	138

Complication

There were four cases of subfascial infection. Twenty four knees showed superficial wound infection. Four cases of dislocation of patellar prostheses were detected in three markedly obese patients.

Discussion

As previously mentioned, 80 % of the knees showed radiolucency at the bone cement interface of the tibial stem. Insall et al[8] and Laskin[9] reported this phenomenon in only 21 % and 65 %, of their cases respectively, who showed good clinical results

on long-term follow-up. The same clinical correlation was also recognized in this series. Not a single patient in our series was able to perform daily kneeling, squatting (including the use of old-fashioned toilets) and sitting for meditation after operation. This is understandable because in doing so the knees must flex up to 140° and the average flexion obtained in this series was 103.4° (Table 1). The designs of posterior stabilized condylar prostheses allow a maximum range of 110° flexion. When comparing the results of this series to other series, employing several different types of knee prostheses[5,8,10,-18] as shown in tables, 3,4,5,6 all popular designs of knee prostheses currently in use, produce very similar results,the average range of movement being between 90° and 115°. This range of movement is sufficient for Caucasians but not Asians.

Table 3. Unconstrained (retainded PCL).

AUTHORS	GUNSTON'S	CLOUTIER'S
NO. ARTHROPLASTY	89	107
YEARS OF FOLLOW-UP	2-7.5	2-11
RESULTS		
(EXCELLENT + GOOD)	81 %	90 %
AVERAGE ROM	89.9°	103.5°
	(= PRE-OP.)	(45°-135°)

Table 4. Mild constrained (retained PCL).

AUTHORS	TOWNLEY'S	EDWALD'S	RITTER'S
NO. ARTHROPLASTY	532	124	95
YEARS OF FOLLOW-UP	2-11	2-4	5
RESULTS			
(EXCELLENT + GOOD)	89 %	90 %	97 %
AVERAGE ROM	90° (91 %)	106°	101°
	110°-120° (21 %)	(94°-120°)	
	> 120° (12 %)		

Table 5. Semiconstrained (excised PCL).

AUTHORS	INSALL'S	AGLIETTI'S	SCHURMAN
NO. ARTHROPLASTY	100	30	71
YEARS OF FOLLOW-UP	5-9	5	2
RESULTS			
(EXCELLENT + GOOD)	91 %	80 %	MOSTLY SATISFACTORY
AVERAGE ROM	98°	97°	106.8°
	(75°-125°)	(80°-130°)	(75°-130°)

Table 6. Moderately constrained (PCL substitute)

AUTHORS	INSALL'S	SCOTT'S	HANSSEN'S	ITIRAVIVONG'S
NO.ARTHROPLASTY	119	119	79	150
YEARS OF FOLLOW-UP	2-4	2-8	2-6	2-8
RESULTS				
(EXCELLENT + GOOD)	97 %	98 %	92 %	90 %
AVERAGE ROM	115°	107°	103°	103.4°

How could this problem of inadequete flexion be solved for Asians? Are they facing a dead-end ? Or are they satisfied with the present situation in which knee replacement produces excellent results and average range of movement of 110 in over 90 % of patients. Is it true, as Insall[8] has said, that very little future improvement can be expected in knee prosthesis by trickering with the prosthesis itself?

It is difficult to accept that, if Insall's position is free, Asians will have to be content with knee flexion that is inadequate for their needs. Many surgeons share the same opinion concerning factors[12,16,22,23,24] influencing the amount of flexion after total knee arthroplasty. These factors include prosthetic design, tightness of fit and post-operative physical therapy regimens. Many surgeons have the experience that knees with excellent pre-op motion tend to lose motion after surgery, whereas those with poor pre-op motion tend to improve.[16] This might indicate that there are some restricting factors, such as prosthetic design, insertion technique or post-op therapy. Indeed, if the factors restricting range of motion are the patients' willingness and the prosthetic designs, then patients who need to have full flexion of the knees to perform their daily activities must have the will-power to practice strict physical therapy after surgery. Concerning prosthetic design, the difference in flexion between the normal squatting knee and the currently available prosthetic knee is clearly observed: 140° flexion in the normal knee and 110° in the artificial knee. Surface joint motion with natural intrinsic structures has synchronized gliding and rotational movement[1,2]; however, the artificial knee performs like a hinge at excessively extreme flexion by distraction of the components. The stability of the loading knee depends on natural condylar conformity with propioception, but the joint surface of the prosthetic knee is incongruent with no propioception.[25]

In our opinion, for the prosthetic knee to be capable of enabling the patient to squat, it should have the following design features[23,26]: optimal surfaces approaching the normal geometry of femoral and tibial condyles for maximum flexion; the ability to retain normal intrinsic structures for stability, synchronized joint motion and proprioception. They should have perhaps, better biomaterials[27,28]: instead of having a polyethylene tibial component, it would be ideal if the material could be like a young modulus,similar to that of articular cartilage, for more natural conformity on the loading knee. We would like to issue a plea to those experts who are believed capable of creating a so-called 'squatting knee prosthesis' : "please help those unfortunate patients who need extreme flexion in their old age so that their quality of life could be a lot better than it is now".

Summary

In 138 patient, 150 posterior stabilized condylar knee arthroplasties were performed. Over 90 % of the patients had good clinical results comparable to other reported series of total knee replacements. Concerning range of movement, the average flexion was only 103.4°; therefore, no patient was able to perform functions such as kneeling, squatting (including that for using old-fashioned toilets) and sitting for meditation. Knee prostheses as they are designed presently do not allow such activities. A call for the design of new "squatting-knee" prosthesis was made soas to benefit whose needs currently are not being met.

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