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Dr. Shravan Kumar Peddamadyam Anjaneyulu
Assistant Professor, Department of Orthopedics, Nizam's Institute of Medical Sciences, Hyderabad, Telangana State, India

Dr. Bodla Arvind Kumar
Assistant Professor, Department of Orthopedics, Nizam's Institute of Medical Sciences, Hyderabad, Telangana State, India

Dr. C Nagesh
Additional Professor, Department of Orthopedics, Nizam's Institute of Medical Sciences, Hyderabad, Telangana State, India

Dr. P Chandrashekar
Professor & HOD, Department of Orthopedics, Nizam's Institute of Medical Sciences, Hyderabad, Telangana State, India

Dr. VBN Prasad Rao
Ex-Professor & HOD, Department of Orthopedics, Nizam's Institute of Medical Sciences, Hyderabad, Telangana State, India

Corresponding Author:
Dr. Bodla Arvind Kumar
Assistant Professor, Department of Orthopedics, Nizam's Institute of Medical Sciences, Hyderabad, Telangana State, India

Short term results of low contact stress total knee arthroplasty: original article

Dr. Shravan Kumar Peddamadyam Anjaneyulu, Dr. Bodla Arvind Kumar, Dr. C Nagesh, Dr. P Chandrashekar and Dr. VBN Prasad Rao

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Abstract
Introduction: Conventional fixed-bearing knee prostheses have been proved to be clinically successful in elderly individuals with low activity levels. Polyethylene wear and loosening remain important problems with current fixed-bearing knee prostheses. In mobile-bearing knee prosthesis rotation of polyethylene insert is allowed and the contact area of the articular surface can be greatly increased and there can be a consequent reduction in contact stresses, and decreased polyethylene wear and there is decreased constraint forces at the bone and tibial prosthesis interface leading to decreased loosening. The objective of this study were to assess the clinical outcome of the procedure, to assess the complication rate of bearing dislocation associated with mobile bearing prosthesis, to compare our results with those of other similar studies and to compare the results of the study with those of fixed bearing prosthesis done earlier in our institute.
Materials and Methods: This prospective study involved 30 total knee arthroplasties which were performed on 20 patients using Low Contact Stress (LCS) prosthesis. The patients were assessed pre-operatively and pos-operatively clinically and radiologicallyat each visit and also using the Knee Society Rating System. The Depuy (Johnson & Johnson) LCS total knee arthroplasty was used in this study.
Results: Total of 30 total knee arthroplasties were performed using low contact stress prosthesis in 20 patients. The mean post-operative knee society knee and function scores in the present study were 89.2 (range, 73-97) and 87 (range, 75-100), at mean follow-up period of 16 months. Our study has shown excellent results in 26 knees and good results in 4 knees.
Conclusion: LCS prosthesis TKR showed excellent clinical outcome with excellent improvement in the pain relief scores, this study was comparable with other studies and those of studies on total knee replacement with fixed bearing prosthesis performed earlier in the same institute.

Keywords: Total knee arthroplasty, osteoarthritis, low contact stress, knee score, femur, tibia

Introduction
Knee is a complex joint and its degeneration in age related post-traumatic and rheumatoid like arthropathies may give rise to severe disability. Total knee arthroplasty (TKA) has become a standard operative procedure to relieve pain and restore function in these patients. The most common clinical diagnosis associated with total knee arthroplasty is primary osteoarthritis (OA), but other potential underlying diagnoses include inflammatory arthritis, Rheumatoid Arthritis (RA), fractures of the knee (post-traumatic OA and/or deformity), dysplasia, and malignancy involving the knee joints [1, 2, 3]. Modern Total knee replacement prosthesis and the operation have evolved over many decades. Many early total knee designs were accompanied by poor clinical results or early prosthetic failure and instability. Fully constrained knee arthroplasties and hinged prostheses, which were designed to enhance joint stability, were fraught with unacceptably high long term failure rates. Surface replacements urshed the era of modern prostheses and provided an impetus to the continuous efforts in development of new designs, fixation techniques and refinements of surgical procedure. Gunston polycenteric prosthesis was the first cemented surface arthroplasty of knee joint. But the greatest influence on the direction of both prosthetic design and surgical technique has been the pioneering work of Freeman and colleagues in 1973. Despite these improvements, greater demands have been placed on these implants as a result of improved design kinematics and extension of indications for TKA to include younger more active patients.

Current total knee prosthesis (TKP) can be subdivided into two groups based on different fundamental design principles: 1) Fixed-bearing designs, where the polyethylene tibial insert locked with tibial tray and 2) Mobile-bearing designs, which facilitate movement of the insert relative to the tray. Primary objectives of TKA/TKR are pain relief, provides movement with stability and to correct the deformity. Indications of TKR include Rheumatoid arthritis, Osteoarthritis, Post traumatic Osteoarthritis, Failure of previous High tibial osteotomy or Unicondylar arthroplasty, Patellofemoral Osteoarthritis, Severe pain from chondrocalcinosis or pseudo gout is a rare indication in the absence of cartilage space loss.

Aim of the Study

This prospective study of analysis of short term results of Total Knee Arthroplasty with Low Contact Stress prosthesis has been undertaken with the objectives-1) To assess clinical outcome of the procedure, 2) To assess the complication rate of bearing dislocation associated with mobile bearing prosthesis, 3) To compare our results with those of other similar studies, 4) To compare the results of the study with those of fixed bearing prosthesis done earlier in our institute.

Materials and Methods

A consecutive series of 30 total knee arthroplasties were performed on 20 patients between January 2009 and June 2010, at Nizam's Institute of Medical Sciences (NIMS), Hyderabad using LCS prosthesis. A prospective study of these cases was undertaken. The patients were assessed clinically and radiologically using the Knee Society Rating System.

Inclusion criteria

1. Primary cemented cruciate-retaining knee arthroplasty using LCS prosthesis
2. Minimum follow up of 1 year at the time of evaluation.

Protocol of Management: All patients presenting with symptoms of degenerative arthritis were thoroughly evaluated. Based on clinical examination, laboratory investigations and radiological data, the etiology was established as primary osteoarthritis or secondary OA (most commonly secondary to Rheumatoid arthritis). All patients who were able to carry out most of their day-to-day activities without much pain were treated conservatively, with physiotherapy program and advice regarding modification of life-styles and occasional usage of analgesics.

The subset of people who were unable to carry out even household activities due to pain was evaluated in detail as to establish their current functional status. All patients with diagnosis of primary osteoarthritis were initially treated with rest, analgesic medication and physiotherapy under supervision to decrease the pain. They were encouraged to perform quadriceps exercises and other physiotherapeutic measures. Functional status was reassessed using Knee Society Score. Surgical management was advised to those patients who did not improve with supervised conservative therapy and such patients were admitted.

Pre-operatively, all the patients were evaluated for any concomitant medical illnesses. Routine investigations like complete blood picture, ESR, Blood glucose levels, Renal and Liver parameters, coagulations profile (PT, APTT), chest X-ray and ECG were taken. Urine and throat swab were taken for culture and sensitivity. In the eventuality of the cultures yielding a positive result, treatment with appropriate antibiotics was started and the surgery performed only after the cultures are proved to be negative. Pre-operative roentgenograms for the assessment of patients included the standing AP view in 14 x 17 film and the lateral radiographs. One dose of IV antibiotics (cefuroxime 750 mg and amikacin 250 mg) was given three hours before surgery and at the time of induction of anaesthesia. Surgical procedure was carried out under regional (combined spinal epidural) or general anaesthesia.

LCS Prosthesis: The Depuy (Johnson & Johnson) LCS total knee arthroplasty is a well established prosthesis with the theoretical advantages of are increased contact area and low contact stress between femoral component and rotating insert, modularity to improve intra operative adaptability, low constraint forces at bone implant interface of tibial component decreasing the chances of loosening, a deep and extended trochlear groove which increases contact area at patella femoral joint. The femoral component is made of Cobalt-Chromium alloy, tibial base plate is also made of Cobalt-Chromium alloy with a highly polished superior surface which is the rotating platform, and it has a central depression in which the polyethylene rotating insert is lodged. The LCS prosthesis is available for both cemented and cement fewer fixations. In our institute we have used cemented cruciate retaining low contact stress prosthesis.

Post operatively, the patients' knees were kept in a splint in extension for 24 hours. Static quadriceps exercises were initiated. Suction drains were removed on second or third post operative day. Gradually active knee range of motion (ROM) exercises started. Patients were allowed 50% partial weight bearing as tolerated, with a walker or two crutches for support during ambulation. Physiotherapy sessions emphasized range of motion, straight-leg raising, and quadriceps exercises. Routine post operative prophylactic therapy against Deep Venous Thrombosis was given. Post operatively patients are called for follow–up after one month, 3 months, 6 months and yearly thereafter. At each visit, clinical and radiological examination is done to assess Knee Society Scores (KSS). Statistical analysis and comparisons were performed using Chi square test with significance taken for $P<0.05$.

Results

Total of 30 total knee arthroplasties were performed using low contact stress prosthesis in 20 patients during the year of 2009 and 2010.The mean age of the patients at the time of surgery was 55 years (range 52-68). 10 patients were in the age group of 51-60 and 10 in the age group of 61-70.There were 12 women and 8 men. All cases were of primary osteoarthritis. Two patients had united fracture shaft of femur with interlocking nail in-situ with osteoarthritis of right knee. Ten patients had bilateral total knee replacement done. Ten had unilateral knee replaced. In unilateral cases 8 were right and 2 were left. Total of 18 right and 12 left knees were replaced using LCS prosthesis. The average duration of symptoms was 5.7 years (range from 4-8 years). Four patients were diabetic and 2 were hypertensive; one had diabetes and hypertension. Details of the patients who underwent TKR are tabulated in Table 1.

Table 1: Details of the patients

	Number of Patients
Total number of TKR (Procedures)	30
Number of patients	20
Male Patients	08
Female Patients	12
Right Side	18
Left Side	12
Mean time of follow up	16 Months

Patients were stratified into 3 categories according to Halley and Charnley. Sixteen patients (16) in category A (unilateral or bilateral TKR), Four patients (4) in category B (Two knee symptomatic but not replaced), and none were in category C (multiple arthritis or medical infirmity). At follow-up patients were evaluated clinically by an independent observer using the American knee society score (Table 2).

Table 2: American Knee Society Score

Patient Category	Number of Patients	Percentage
A	16	80 %
B	4	20 %
C	0	00 %

In this study, the average pre-operative knee score was 22.7 points (range 13-40). The average postoperative knee score was 89.2 points (range 73-97) (Chart 1).

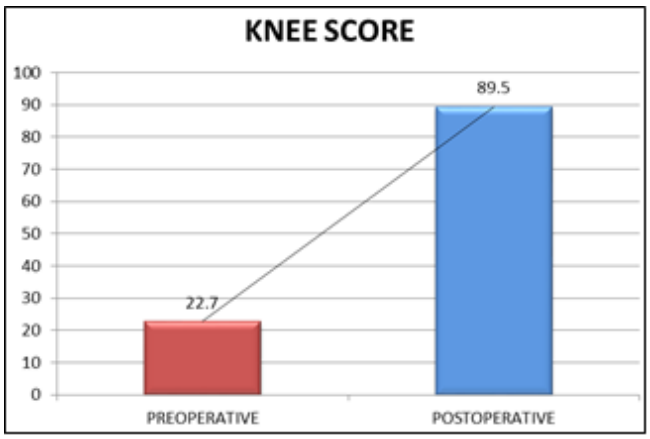

Chart 1: Knee Score of the cases

The average pre-operative functional score was 21 points (range 0-30). The average post-operative function score was 87 points (range 75-100) (Chart 2).

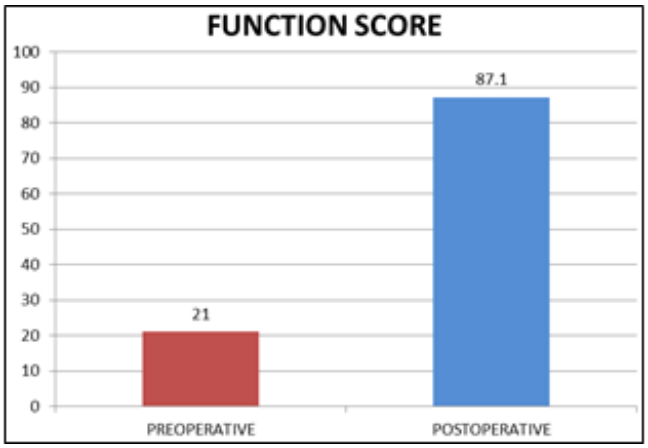

Chart 2: Function Score of the patients

When Range of Motion (ROM), the average pre-operative range of motion (ROM) was 73 degrees. The average post-operative ROM was 94.6 degrees. When post operative instabilities and deformities were assessed, None of the knees had varus deformity, Only one patient had flexion contractures of > 10 degrees, None of the knee had more than 5 mm antero-posterior instability.

At recent follow-up relief of pain was excellent. Sixteen patients had no pain and 4 patients had mild pain. All patients could walk farther than 10 blocks; one patient was using a cane for ambulation postoperatively.

Table 3: Various parameters before and after the surgery

Parameters	Mean Pre-Operative	Mean Post-Operative	P value
Flexion	85 degrees	115 degrees	0.033
Fixed Flexion Deformity (FFD)	15 degrees	0 degrees	0.001
Knee Score	31	84	0.60
Functional Score	28	87	0.60

Mean knee society scores were assessed and the details of the scores are expressed in Chart 3. Changes or improvement in the range of motion (ROM) is expressed in Chart 4.

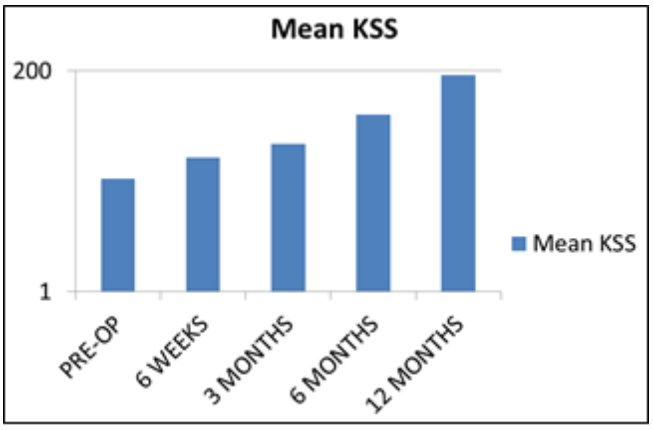

Chart 3: Mean KSS in the patients

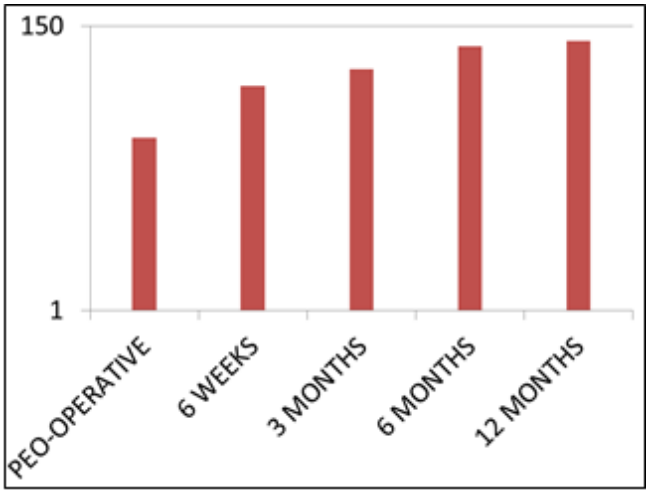

Chart 4: Change in ROM with Post-Operative weeks

Radiographic Results

Alignment

The mean femoral component alignment (α) from the anteroposterior view was 97.2°) and the mean tibial component alignment (β) from the anteroposterior view was 88.7°. The average post op anatomical alignment

(Tibiofemoral angle) was 5.9° valgus. Tibial angle σ on lateral view was 87°. The average femoral flexion angle (γ) was 4.1°.

None of the knees operated had evidence of radiographic loosening which required revision. Among all other radiographs, 2 knees had radio lucent lines of 1 mm thick present around zones 1 in tibial components and around zone 1 in femoral components. No radiolucency was progressive and was more than 2 mm or extended beyond 2 zones.

Fig 1: Clinical Image showing varus deformity at the knee joints and Post-operative Image showing correction.

Fig 2: Radiographs showing pre-operative varus deformity and post-operative correction of deformity

Fig 3: Intra-operative Image showing Incision, Exposure, Tibial cut and Femoral Anterior-posterior cutting block.

Fig 4: Intra-operative Image showing Implant and closure of the incisions.

Discussion

Total knee arthroplasty can provide excellent pain relief and restoration of function for patients with degenerative arthritis. The success of the procedure is based on prosthesis survival, in addition to pain relief and restoration of function. This study found excellent short-term results with cemented total knee arthroplasty using low contact stress prosthesis (LCS).

The mean age of the patient at the time of surgery was 55 years. This was slightly less than that of other studies done by John J. Callaghan *et al.* and Adrian J. Bauze *et al.* with mean age of 70 and 66 years respectively [4, 5]. There is female preponderance in the study as seen in almost all other studies.

All 30 knees included in the study had primary osteoarthritis. The mean post-operative knee society knee score and function score in the present study were 89.2 (range, 73-97) and 87 (range, 75-100), at mean follow-up period of 16 months**.** Vogt JC *et al.* reported knee score of 78 (range, 20-100) and function score of 66 (range, 0-100) at mean follow-up period of 11.4 years [6]. Valerio Sansone *et al.* reported mean post-operative knee score of 82 (range, 59-100) and function score of 74 (range, 40-100) for a total of 156 at a mean follow-up of 6.3 years [7]. F.F. Buechel and M.J pappas in their study on 123 cases in 97 patients at mean follow-up of 3.7 years reported good to excellent in 86%, fair results 3.3% and poor results in 8.1% [8]. Considering the classification of result, in present study the knee and function score were within in the range of excellent (80-100 points).

In our study, we found complete relief of pain in 24 knees and there was mild pain in 6 knees, and none of the patients had moderate or severe pain postoperatively. John J. Callaghan *et al.* in their study on 66 knees available for follow-up at 9-12 yrs reported complete pain relief in 45 knees, mild pain in 15, moderate pain in 5 and severe pain in 1 knee [4]. PS Miani *et al.* in their study reported that in 98 knees available for follow-up at mean interval of 38 months 90 knees had either absent or mild pain [9].

In our series no knee had significant postoperative antero-posterior or medio-lateral instability. One patient had flexion contracture of 10^0. None had varus deformity or excess valgus deformity. PS Miani *et al.* in their study reported that 2 patients had flexion contractures of 5^0 and none of the knees had significant antero-posterior or medio-lateral instability [9]. Valerio Sansone *et al.* in their study on 110 knees reported that complete extension was observed in most patients, but 8 knees (7.3%) had a postoperative flexion deformity [7]. The postoperative limb alignment (with respect to the mechanical axis of the limb) was neutral in 74 cases (68%), varus in 34 cases (31%), and valgus in 2cases (1%).

In our study range of motion improved from mean pre operative 73^0 to mean post-operative 94.6^0. In the study by Valerio Sansone *et al.*, the average preoperative flexion was 98° (range, 45°–135°); the average postoperative flexion was 108° (range, 0°–135°) [7]. Vogt JC *et al.* reported mean mobility of 105.8^0 in 39 patients available for mean follow-up at 11.4 years [6].

In all the 30 knees we have used cement to fix the prosthesis. In our series outcome of cemented total knee arthroplasty using LCS prosthesis has give excellent results. Nahum rosen berg and Ian Henderson reported surviourship of 97.1% at 5 year follow up in their study on 35 knees operated using LCS cementless cruciate retaining TKA [10].

At the time of the nine to twelve-year follow-up on Cemented Rotating-Platform Total Knee Replacement John J. Callaghan *et al.* reported that of the 114 knees in the eighty-two patients for whom the final outcome was known, none required a reoperation and none had a dislocation of the mobile bearing prosthesis [4].

In our series none of the patients required re-operation for any of the postoperative surgical complications. None of the patients had problems of dislocation of bearing which was reported in some of the studies on TKA with LCS prosthesis. One patient had delayed wound healing. No other patient had problems of wound healing or infection. This study results showed excellent clinical outcome comparable with other studies. However, as results are short-term, further follow up studies are required to see the performance over longer duration.

A study was conducted in our institute in 2006 on Total Knee Arthroplasty using fixed bearing prosthesis. The implant used was Press-Fit Condylar (PFC) Sigma prosthesis and the details are tabulated in table 4.

Table 4: Comparison of our study with that of previous study on fixed bearing prosthesis performed in our institute.

	PFC Sigma prosthesis	**LCS prosthesis**
Number of patients	38	20
Number of knees	51	30
Mean follow-up	28 months	16 months
Mean age	60 years	55 years
Pre op knee ROM	77^0	73^0
Post op knee ROM	94^0	94.6^0
Pre op knee score	23.4	22.7
Post op knee score	86.2	89.2
Pre op function score	13.53	21
Post op function score	64.7	87

Comparing short term results of total knee arthroplasty using PFC Sigma (Fixed bearing) prosthesis and that using LCS (Mobile bearing) prosthesis done in our institute, we found that age of population in whom LCS prosthesis was used were slightly younger and more active than those in whom PFC Sigma prosthesis was used. Results of knee score which included pain relief, range of motion, stability, and deformity were almost similar in both the studies. Results of function score in mobile bearing group were much better than those in fixed bearing group. This was mainly because the population included in study of fixed bearing prosthesis was older and less active than those in total knee replacement using mobile bearing LCS prosthesis. Overall the short term results of TKA using LCS (mobile bearing) prosthesis have given excellent results which are comparable with those of short term results of TKA using PFC Sigma (fixed bearing) prosthesis. However long term follow up is necessary to get a better comparison.

KY Chiu *et al.* compared the early results of mobile-bearing knee prosthesis with fixed-bearing knee prosthesis in 16patients who had one-stage, sequential, bilateral replacements [11]. In each patient, Low Contact Stress (LCS, Depuy) rotating-platform prosthesis was inserted in one side, and an Anatomic Modular Knee (AMK, Depuy) posterior-stabilised prosthesis was inserted in the other side. There were significant improvements in the Knee Society knee score and functional score, as well as the Oxford Knee score after both mobile-bearing and fixed-bearing knee replacements ($p < 0.001$). However they could not find any significant difference between the clinical results of the two prostheses. The authors' early experience with the mobile-bearing total knee prosthesis was as favorable as the medium-term experience of the fixed-bearing total knee prosthesis in this prospective, match-pair study.

Huang *et al.* compared biomechanical and clinical aspects in both fixed and mobile-bearing designs [12]. In biomechanical aspect, the mobile-bearing design has proved to provide less tibiofemoral contact stresses under tibio-femoral mal-alignment conditions. It also provides less wear rate in in-vitro simulator test. However, in clinical aspect, the mid-term or long-term survivorship of mobile bearing knees had no

superiority over that of fixed-bearing knees. The theoretical advantages for mobile-bearing design to provide a long-term durability have not been demonstrated by any outcome studies. Finally, the fixed-bearing design with all-polyethylene tibial component was suggested for relatively inactive, elder people. The mobile-bearing design is suggested for younger or higher-demand patients due to the potential for reduced polyethylene wear and more normal kinematics response after joint replacement.

Conclusion

Total knee replacement is a very effective surgery in management of symptomatic arthritic knee with excellent improvement in pain scores is possible in most of the patients with no complications. Post operative knee and functional status Knee Society Score is a very useful tool in assessing the effectiveness of the TKA.

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