

## Original Research Article

# A study of clinical and functional outcome of primary total knee arthroplasty using posterior cruciate substitute design

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### ABSTRACT

**Background:** To study the clinical and functional outcome in a consecutive series of Total Knee Arthroplasty using Posterior cruciate substituting (PS) design using the Knee Society Score(KSS). The objectives of the study was 1) To assess the improvement in pain relief post-operatively, stability, mobility of the joint and to assess the correction of deformities. 2) To compare the knee clinical score (KCS) pre-operatively and post-operatively. 3) To compare the knee functional score (KFS) pre-operatively and post-operatively. 4) To assess the radiological outcome of total knee arthroplasty. 5) To study the association between the KCS and the KFS.

**Methods:** The study was conducted on patients who have undergone Primary total knee replacement, in Department of Orthopaedics, KIMS hospital from June 2014 to February 2017. The patient was assessed clinically, functionally using the Knee Society Score and a radiographic evaluation was done. These evaluations were performed at 6weeks, 12 weeks, 24 weeks and 1year follow up visits.

**Results:** At 1 year follow up of 60 knees, the average pre-op knee clinical score and functional score of 24.7 and 41.2 improved to an average post-op score of 89.9 and 87.8 respectively. Knee clinical and functional score grade of excellent to good was seen in 96.7% (58 knees of 60). Significant association was seen between KCS and KFS. 5 patients had delayed wound healing and one patient had deep infection. Alignment of prosthesis was found satisfactory in all patients. Flexion deformity, valgus and varus correction achieved in all the patients.

**Conclusions:** Total knee arthroplasty using posterior cruciate substituting designs resulted in excellent relief of pain, range of motion, restoration of function, low prevalence of patellofemoral complications and continues to function well during the follow-up period. Improvement in clinical score correlated significantly with improvement in functional score. Knee society scoring system effective in evaluating clinical, functional and radiological outcomes.

**Keywords:** Clinical and functional outcome, Knee society score, Total knee replacement, Posterior substitute design

### INTRODUCTION

The common causes of arthritis of the knee include osteoarthritis (OA), rheumatoid arthritis (RA), juvenile rheumatoid arthritis, post traumatic arthritis or secondary osteoarthritis and other types of inflammatory arthritis. The prevalence of arthritis including osteoarthritis (OA) and rheumatoid arthritis (RA) continues to increase with age. In most arthritic knees, some degree of instability,

deformity, contracture or a combination of these elements, can be found.<sup>1-3</sup>

Total knee replacement is a safe and successful operation for the treatment of advanced knee joint degeneration.<sup>4</sup> Total knee arthroplasty is becoming increasingly popular worldwide due to improvements in technology and durability of implants and has become a standard and dependable method of treating severe knee

arthritis.<sup>5,6</sup> Cemented fixation is used due to its reliable long-term results. It has represented the gold standard for TKR due to its proven long-term results and excellent survival rates.<sup>4</sup>

The primary goal of total knee arthroplasties is the achievement of stable tibiofemoral and patellofemoral joints, which relies on accurately aligning these joint components and balancing the soft tissues. In order to achieve these criteria, it is important to utilize appropriate surgical techniques and well-designed implants.<sup>7</sup>

The posterior-stabilized condylar knee prosthesis is one of the condylar prostheses developed at the hospital for special surgery.<sup>8</sup> It was as a modification of the total condylar knee prosthesis which has been called the “gold standard” for total knee arthroplasty longevity.<sup>9</sup> In 1978, it was first implanted at the hospital for special surgery and recent studies proved its durability, since then it has undergone many design changes.<sup>2</sup> It is a “posterior cruciate ligament-substituting” prosthesis, which has a tibial and femoral component articulation, that allows for femoral rollback during knee flexion. This mechanism make it both clinically and mechanically better.<sup>7</sup>

The variety of knee rating systems used in the past made it difficult to compare the merits of prostheses. The Knee Society proposed a rating system, simple but more exacting and more objective. The Knee Society Score combines a relatively objective Knee Score that is based on the clinical parameters and a Functional Score based on how the patient perceives that the knee functions with specific activities. The dual rating system eliminates the problem of declining knee scores associated with patient infirmity.<sup>10</sup>

The knee society roentgenographic evaluation system was developed for uniform reporting of roentgenographic results of total knee arthroplasty. So, comparisons could be made not only between different institutions but also between different implants. The important aspects of successful arthroplasty are featured in the system, such as component position, leg and knee alignment, and the prosthesis-bone interface or fixation. The system has a numerical score for the prosthetic interface that assesses the quality of fixation.<sup>11</sup>

This is a consecutive study of sixty patients; the clinical, functional and radiological outcome of total knee arthroplasty using posterior substituting design.

## **METHODS**

### **Source of data**

The study was conducted on patients who have undergone primary total knee replacement during June 2014 to February 2017, in Department of Orthopaedics, Kempegowda institute of medical sciences and research centre, Bengaluru.

### **Sampling procedure**

It is a prospective study with purposive sampling and sample size of 60 knees.

### **Inclusion criteria**

Inclusion criteria were patients with primary osteoarthritis, patients with secondary osteoarthritis, patients with osteoarthritis of bilateral knee.

### **Exclusion criteria**

Exclusion criteria were patients with septic arthritis of knee joint, patient who has deformity and disability of ipsilateral hip and ankle joint.

### **Preoperative evaluation**

Inpatients meeting the inclusion and exclusion criteria are selected for the study after obtaining written and informed consent.

### **Clinical assessment**

Detailed history of all patients was taken. All patients were assessed clinically and functionally using the knee society score. The knee deformities were examined for any fixed varus or valgus deformities or presence of any fixed flexion contracture. The preoperative medical evaluation of all patients was done.

### **Radiographic assessment**

Standard guidelines were utilized to get knee radiographs – standing anteroposterior view, a lateral view and a skyline view of the patella.

### **Operative procedure**

All patients were taken up for surgery after prophylactic antibiotics (3rd generation cephalosporins given 30 minutes before surgery) under combined spinal epidural anaesthesia. Patient in supine position with knee flexed to 90 degree. Tourniquet was applied at the thigh region. Operated with anterior midline incision, median parapatellar retinacular approach and soft tissue balancing was done. Components cemented using posterior cruciate substituting design without patellar resurfacing. Wound closed in layers with or without suction drain application. After completion of surgery the patient's knee was immobilised in a Jones compressive bandage and a knee immobilizer, immediately post operatively.

### **Postoperative period**

The patients were started on IV antibiotics and DVT prophylaxis.

Patient were advised to continue static quadriceps exercises, knee flexion and extension exercises, To walk full weight bearing within the limits of pain with the knee immobilizer in place. Postoperative day 12, suture removal was done.

**Follow up**

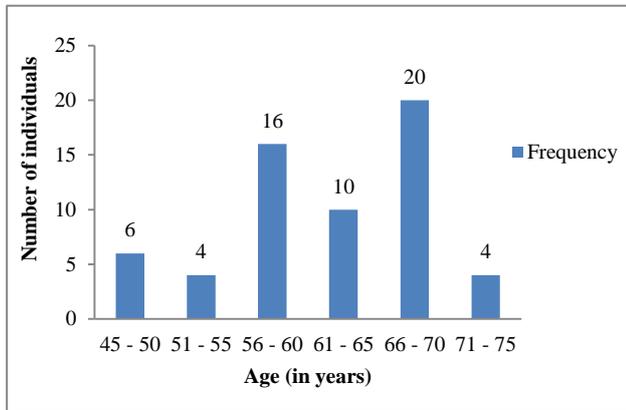
Was done at 6 weeks, 12 weeks, 24 weeks and 12 months post operatively. The patients were assessed clinically & functionally using the knee society score. Postoperative radiographic evaluation was done.

**Statistical methods**

This is a hospital based Prospective, observational study. Data collected was tabulated in Microsoft excel and analyzed using SPSS 16.0. Microsoft word was used to generate graphs/chart and tables. The student t-test for paired comparisons was used to compare means of pre op knee society score and post op knee society score and the P value was determined. The Fischer exact value was calculated to evaluate the association between clinical knee score and functional knee score along with its corresponding P value for significance.

**RESULTS**

**Age distribution**



**Figure 1: Age distribution of study participants, N=60.**

The majority of the patients were from the age group of 66-70 years which accounts for 33.3% of patients in our study. The youngest patient was 46 years of age and the oldest patient was 73 years. The mean age was 62.23 years

**Gender distribution**

There was a female predominance in our study accounting for 63.33% of the patients.

**Table 1: Gender distribution of the patients who underwent knee arthroplasty, N=60.**

Gender	Frequency	Percentage
Male	22	36.7
Female	38	63.3
Total	60	100

**Indication for surgery**

There was a predominance of osteoarthritis as an indication for surgery in our study, accounting for 86.7% of the patient.

**Table 2: Indication for surgery among the patients who underwent knee arthroplasty, N=60.**

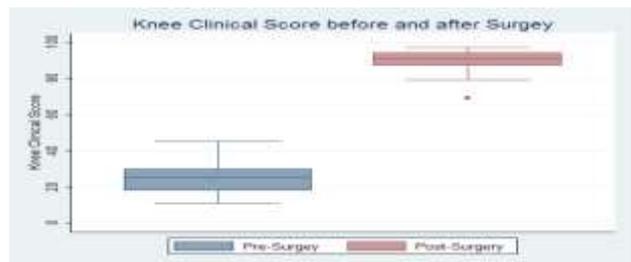
Indication	Frequency	Percentage
Osteoarthritis	52	86.7
Rheumatic Arthritis	8	13.3
Total	60	100

**Knee clinical score**

The average pre-op knee clinical score was 24.7 in this study, which improved to an average post-op score of 89.9

**Table 3: Knee clinical score pre and post-surgery among patients underwent arthroplasty, N=60.**

Status,( N)	Mean (SD)	Median (IQR)	Range
Pre-op (60)	24.7 (8.5)	25 (18-30)	11 - 45
Post-op (60)	89.9 (6.2)	90 (87-94)	69 – 97

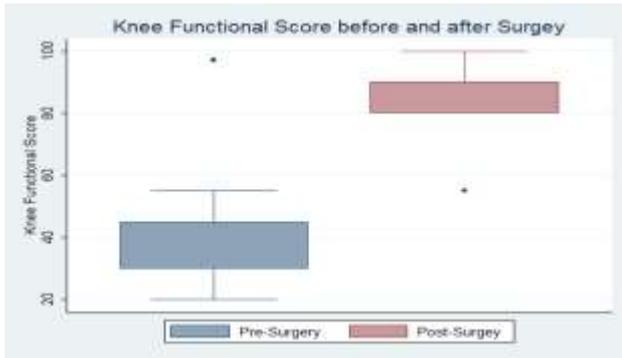


**Figure 2: Box plot depicting knee clinical score pre and post-surgery among patients underwent Arthroplasty, N=60.**

**Knee functional score**

**Table 4: Knee functional score pre and post-surgery among patients underwent arthroplasty, N=60.**

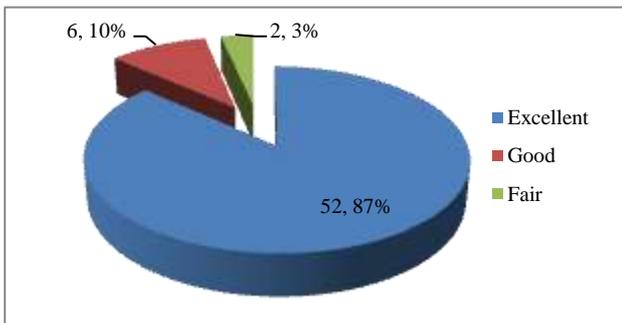
Status,( N)	Mean (SD)	Median (IQR)	Range
Pre-op (60)	41.2 (14.2)	45 (30-45)	20 – 97
Post-op (60)	87.8 (8.7)	90 (80-90)	55 – 100



**Figure 3: Box plot depicting knee functional score pre and post-surgery among patients underwent Arthroplasty, N=60.**

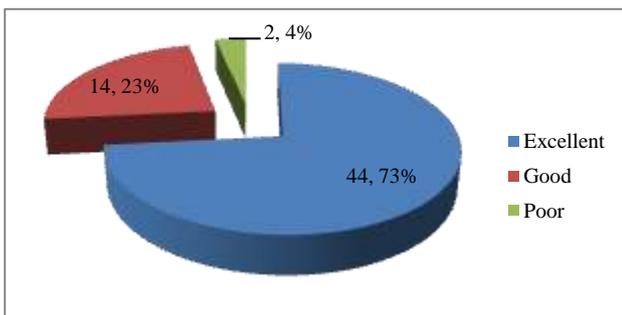
The average pre-op knee clinical score was 41.2 in this study, which improved to an average post-op score of 87.8.

**Postoperative grading of knee clinical score**



**Figure 4: Pie chart depicting grading knee clinical score, N=60.**

**Postoperative grading of knee functional score**



**Figure 5: Grading of knee functional score, N=60.**

**Complication**

In our study 5 patients had delayed wound healing. They were treated with antibiotics, regular dressing and wound healed

One patient had deep infection in post op period at 12<sup>th</sup> day, Patient was treated with surgical debridement, irrigation and polyethylene spacer exchanged.

**Table 5: Complications following knee arthroplasty, N= 60.**

Complication	Frequency	Percentage
No complication	54	90
Delayed wound healing	5	8.3
Infection	1	1.7
Total	60	100

**Comparison of pre-op and post-op knee clinical scores and knee functional score, n=60**

The difference between the mean's of pre-op KCS and post-op KCS score was 65.2. The P value was significant (<0.001) when the pre - op and post - op Knee Clinical Scores were compared.

The improvement in pre-op KCS Score to post-op KCS was statistically significant.

The difference between the mean's of pre-op KFS and post-op KFS score was 46.6. The P value was significant (<0.001) when the pre - op and post - op Knee functional Scores were compared.

The improvement in pre-op KFS Score to post-op KFS was statistically significant.

**Knee clinical score and knee functional score cross tabulation**

Out of the 52 patients who had excellent knee clinical scores, 42 patients (80.7%) had excellent knee functional scores, 10 patients (19.3%) had good knee functional scores.

Out of the 6 patients who had good knee clinical scores, 2 patients (33.3%) had excellent knee functional score, 4 patients (66.7%) had good knee functional scores.

**Table 6: Comparison of pre-op and post-op knee clinical and knee functional score.**

Comparison	Paired difference		t statistics value	df	p value
	Mean	SD			
Pre-KCS vs Post-KCS	65.2	8.4	42.5	29	<0.001
Post-KFS vs Post-KFS	46.6	12.7	20.1	29	<0.001

**Table 7: Association of knee clinical score grading and knee functional score grading, N=60.**

Knee Clinical Score	Knee functional Score			
	Excellent	Good	Fair	Poor
<b>Excellent</b>	42 (80.7)	10 (19.3)	0	0
<b>Good</b>	2(33.3)	4 (66.7)	0	0
<b>Fair</b>	0	0	0	2 (100)
<b>Poor</b>	0	0	0	0

Fischer exact test was done, p value= 0.011.

Fischer exact test indicating significant association between clinical knee score and functional knee score at 12 months follow up of total knee arthroplasty.

**Radiological results**

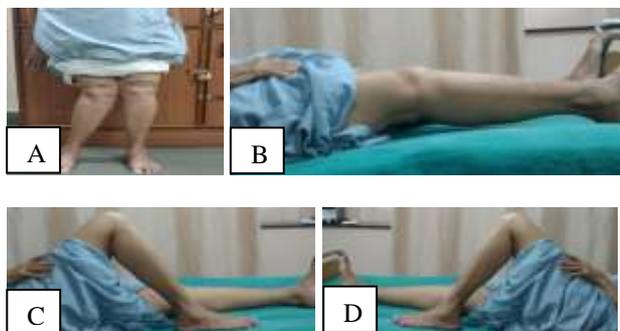
The ideal placement of the tibial component was defined as 90 ± -5 deg to the long axis of the tibial shaft on both the antero-posterior and lateral X-rays. The desired placement of the femoral component was 5 ± - 5 deg of valgus on the antero-posterior X-rays.

Considering the given range of placement of components, In our study all 60 cases, the placement of tibial component in both AP and lateral views was 90 ± -3 degrees and the placement of femoral component in AP view was 5-7 degrees of valgus.

In our 1 year follow up study the component position and knee alignment was well maintained. There was no significant change in radiological outcome assessment in 1 year follow up.

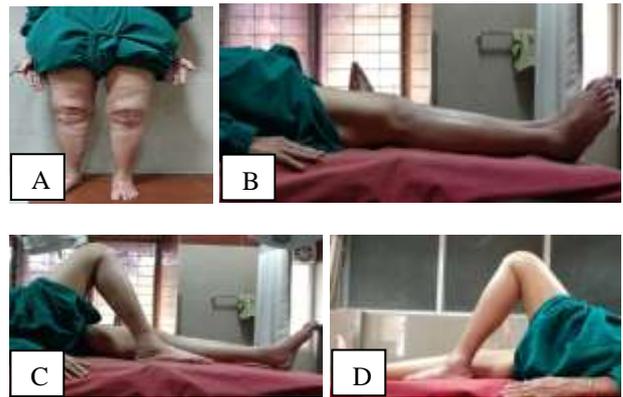
In our study on radiological assessment, there were no significant radiolucent lines noted around the entire circumference of the prosthesis or a change in alignment from previous radiographs in 1 year follow up. Radiological assessment signifies, there was no sign of loose prosthesis/ implant loosening radiologically.

**Illustration 1: Case of genu valgum**



**Figure 6: Preoperative images**

A=Valgus deformity, B=Fixed flexion deformity, C=Right knee flexion, D=Left knee flexion.



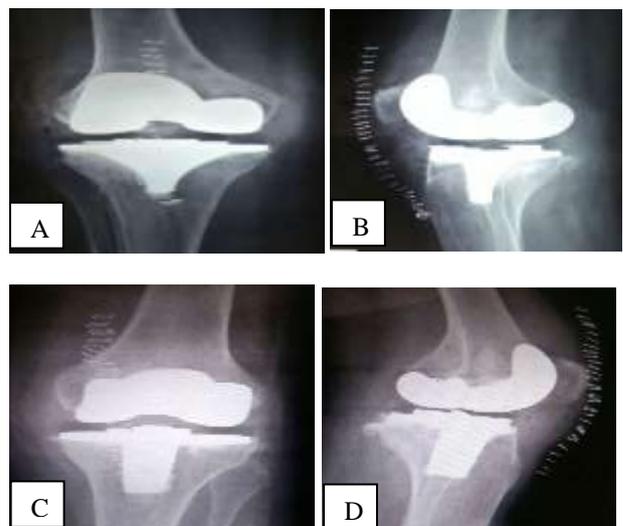
**Figure 7: 12 months postoperative images.**

A=Valgus deformity corrected, B=Fixed flexion deformity corrected, C=Right knee flexion improved, D=Left knee flexion improved.



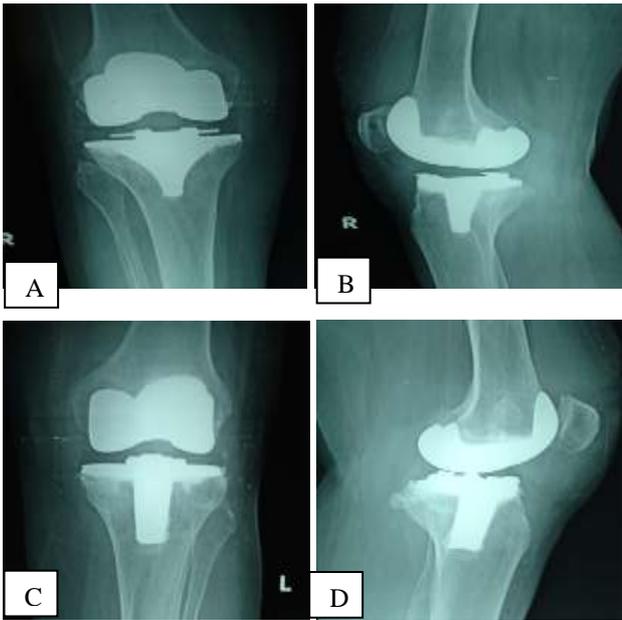
**Figure 8: Preoperative radiographs.**

A, B= Right knee, C, D= Left knee.



**Figure 9: Immediate postoperative radiographs.**

A, B= Right knee, C, D= Left knee.



**Figure 10: 1 year postoperative radiographs.**

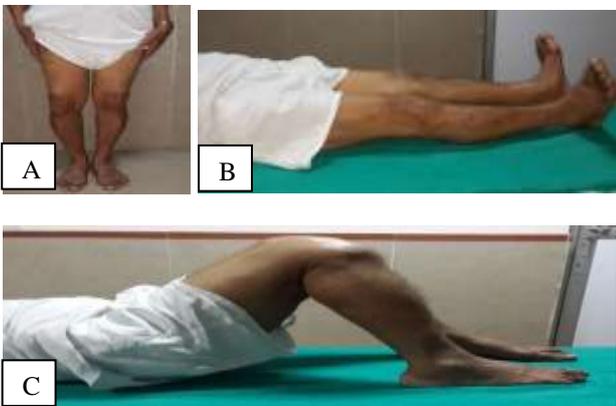
A, B= Right knee, C, D= Left knee.

**Illustration 2: Case of genu vara**



**Figure 11: Preoperative images.**

A=Varus deformity, B=Fixed flexion deformity, C= Knee flexion range.



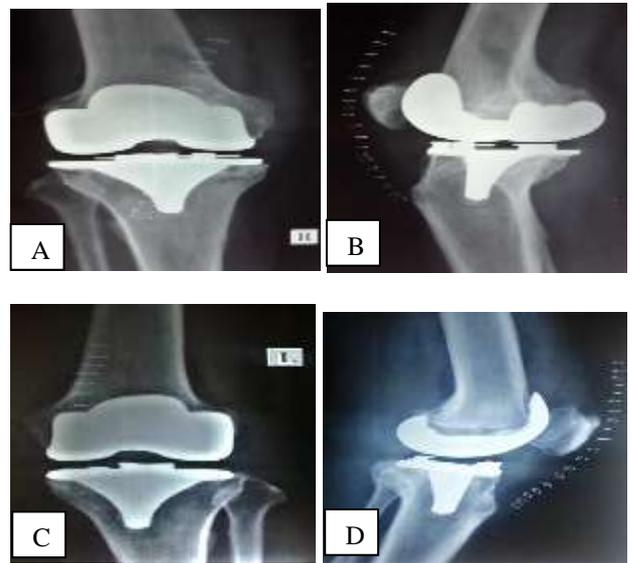
**Figure 12: 12 months postoperative images.**

A=Varus deformity corrected, B=Fixed flexion deformity corrected, C= Knee flexion range improved.



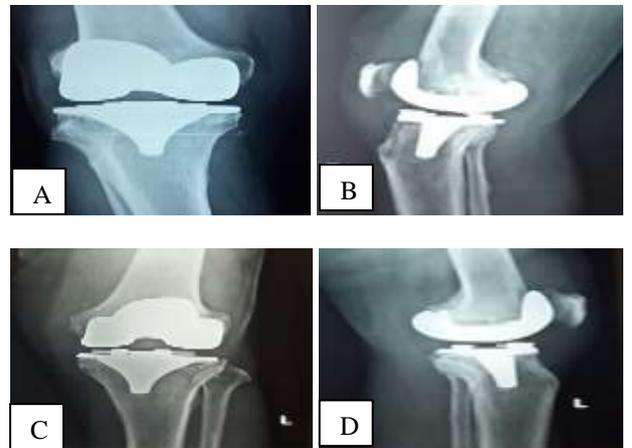
**Figure 13: preoperative radiographs.**

A, B= Right knee, C, D= Left knee.



**Figure 14: Immediate postoperative radiographs.**

A, B= Right knee, C, D= Left knee.



**Figure 15: 1 year postoperative radiographs.**

A, B= Right knee, C, D= Left knee.

## DISCUSSION

Total knee arthroplasty is generally an effective procedure and is associated with substantial functional improvement. Elderly patients who were having difficulty mobilising because of degenerative arthritic found good relief after total knee arthroplasty.

Dowsey et al found that patients with more severe radiographic knee damage at the time of surgery are most likely to have substantial gains in terms of both pain relief and improved function as a result of a total knee arthroplasty.<sup>12</sup>

In our study of 60 knees of patients, who underwent total knee arthroplasty, the majority of the patients were from the age group of 66-70 years (33.3%). The mean age was 62.23 year. There was a female predominance (63.33%). It was comparable to other studies.

**Table 8: Age and sex ratio distribution.**

Study	Mean age	Sex ratio (male:female)
<b>Our study</b>	62.23(45-73)	36.7%, 63.3%
<b>N Hunter et al.</b> <sup>13</sup>	66.7 (34 - 80)	47.6%, 52.4%
<b>Zaki SH et al.</b> <sup>14</sup>	70 (53 - 88)	37.9%, 62.1%
<b>Aglietti et al.</b> <sup>15</sup>	66.5(27-79)	13%, 87%

The diagnosis was osteoarthritis in 52 patients and rheumatoid arthritis in 8 patients. There was a predominance of osteoarthritis as an indication for surgery in our study, accounting for 86.7% of the patient

Ritter et al carried out a study to compare the restoration of flexion and knee function in a large series of cruciate-retaining and cruciate-substituting total knee arthroplasties. They found that, at the prosthesis level, cruciate-substituting models provided greater flexion and cruciate-retaining models provided higher function scores.<sup>16</sup>

In this study, patients who met the inclusion criteria, all the knees were operated using a posterior cruciate substituting design.

Tomek et al carried out a study in which a quadriceps-sparing (QS) subvastus technique of total knee arthroplasty was compared with medial parapatellar arthrotomy (MPPA) to determine which surgical technique led to better patient-reported function and less postoperative pain and opioid utilization and concluded that the QS technique yielded no significant early functional advantages or differences in opioid utilization compared with the MPPA technique.<sup>17</sup>

In this study all patients were operated using medial parapatellar approach.

Smith et al in a prospective and randomized control study concluded that no benefit was shown of TKR with patellar resurfacing over that without resurfacing with respect to any of the measured outcomes like knee society clinical rating system, specific evaluation of anterior knee pain, stair-climbing and rising from a seated to a standing position.<sup>18</sup>

In our study, none of the patella's were resurfaced. All patella's were circumferentially denervated. There was no anterior knee pain in any of our subjects.

Laskin et al reported a series of patients with preoperative fixed varus or valgus deformities of 15 degrees or more associated with flexion contractures. Such knees treated with PCL retention had less postoperative flexion, more severe residual flexion contractures, and less correction of the mechanical axis than knees with PCL substitution.<sup>19,20</sup>

**Table 9: Pre-op deformities.**

Pre op deformity	No. of knees	Percentage
<b>Nil</b>	21	35%
<b>Fixed flexion deformity</b>	34	56.6%
<b>Varus deformity</b>	20	33.3%
<b>Valgus deformity</b>	12	20%

In our study flexion deformity, valgus and varus correction was achieved in all the patients

The knee society score was used to assess the outcome of Total knee Arthroplasty. The knee Society Score rating system was a logical outgrowth of the Hospital for Special Surgery (HSS) rating system.<sup>10</sup>

The American knee society has proposed knee society score rating system to be simple but more exacting and more objective. The rating is divided into separate knee and patient function scores. Thus, increasing age or a medical condition will not affect the knee score.

The knee Society Roentgen graphic evaluation and scoring system was developed for uniform reporting of roentgen graphic results of Total Knee Arthroplasty

With the use of posterior cruciate substituting design, at 12 months follow up an average pre-op knee clinical score of 24.7 improved to an average post-op score of 89.9 and an average pre-op knee clinical score of 41.2 improved to an average post-op score of 87.8. Our study results were comparable to other studies.

According to the knee society clinical and functional scoring system of the 60 knees of patients assessed in these study 58 knees of patients (96.7%) had excellent and good results. Results were comparable to other similar studies.

**Table 10: Knee society clinical score.**

Knee society clinical score		
Study	Mean Pre Op Kcs	Mean Post Op Kcs
<b>Our Study</b>	24.7(11-45)	89.9(69-97)
<b>Sancheti KH et al.<sup>21</sup></b>	39.4	87
<b>Zaki SH et al.<sup>14</sup></b>	45 (30-65)	To 84 (45-92)
<b>Rand et al.<sup>5</sup></b>	32	84
<b>Ranawat et al.<sup>6</sup></b>	44	93

**Table 11: Knee society functional score.**

Knee society functional scores		
Study	Mean Pre Op KFS	Mean post op KFS
<b>Our study</b>	41.2(20-97)	87.8 (55-100)
<b>Sancheti KH et al.<sup>21</sup></b>	46.7	86
<b>Zaki SH et al.<sup>14</sup></b>	38 (25-55)	73 (50-95)
<b>Rand et al.<sup>5</sup></b>	49	86
<b>Ranawat et al.<sup>6</sup></b>	40	78

**Table 12: Clinical grading.**

Clinical grading							
Study	No. knees	Average follow-up (years)	Range of Follow up	Excellent (%)	Good (%)	Fair (%)	Poor (%)
<b>Our study</b>	60	1.4	1.2 – 2	86.7	10	3.3	0
<b>Insall et al.<sup>7</sup></b>	118	3	2–4	88	8	1	3
<b>Aglietti et al.<sup>15</sup></b>	85	5	3–8	57	33	5	5
<b>Scott et al.<sup>22,23</sup></b>	119	5	2–8	83	15	0	2
<b>Stern et al.<sup>24</sup></b>	194	10	9–12	61	26	6	7
<b>Ranawat et al.<sup>6</sup></b>	125	4.8	3.8–6.2	83	10	2	5
<b>Colizza et al.<sup>25</sup></b>	101	10.9	10–11.9	74	22	0	4

Total knee arthroplasty using posterior substitute design improved the functional ability of the patient and the ability of the patient to get back to pre-disease state, as reflected by no pain to occasional pain (90%), unlimited walking (85%), normal up and down the stairs (80%),

and walking without supporting aid (100%) and improvement in the post-op knee functional score.

Total knee arthroplasty using posterior substitute design improved the range of knee flexion of 100-130 degree (90%).

**Table 13: Functional grading.**

Functional grading						
Study	No. knees	Average follow-up (years)	Range of Follow up	Excellent (%)	Good (%)	Fair/Poor (%)
<b>Our study</b>	60	1.4	1.2 – 2	73.3	23.4	3.3
<b>Insall et al.<sup>7</sup></b>	118	3	2–4	88	9	3
<b>Aglietti et al.<sup>15</sup></b>	85	5	3–8	66(OA) 38(RA)	26(OA) 50(RA)	8(OA) 12(RA)
<b>Scott et al.<sup>22,23</sup></b>	119	5	2–8	87	7	6

Infection is one of the most dreaded complications affecting TKA patients.

Deirmengian et al found that immediate component removal should be considered in the presence of acute *Staphylococcus aureus* infection in TKA. Debridement for acute *Streptococcal* or *Staphylococcus epidermidis* species has better success, but likely should be done within 2 to 3 days from the onset of symptoms.<sup>26</sup> Mont et al found that in selected circumstances, irrigation, debridement, and retention of the components can result in low morbidity with high success rates.<sup>27</sup>

In our study we had one case of deep infection accounting for 1.7% of the patients. The patient presented with signs of infection at post-operative day 12, the culture was gram positive streptococcal organism and the patient was treated with debridement, irrigation and polyethylene spacer exchanged. Patient was started on IV antibiotics based on sensitivity of organism. Patient was followed up regularly. After 12 months of follow up patient had no signs of infection and no radiolucent lines were seen on radiographs.

**Table 14: Complications.**

Complication		
Study	Deep infection	Delayed wound healing
<b>Our study</b>	1.7%	8.3%
<b>Aglietti et al.<sup>15</sup></b>	2.8%	9.8%
<b>Zaki SH et al.<sup>14</sup></b>	0.6%	0.6%
<b>N Hunter et al.<sup>13</sup></b>	2.2%	
<b>Hanssen et al.<sup>28</sup></b>	2.5%	
<b>Salvati et al.<sup>29</sup></b>	2.6%	
<b>Wilson et al.<sup>30</sup></b>	1.6%	

In our study, other complications like knee stiffness, extensor lag, vascular injuries, skin necrosis, thromboembolism, fat embolism, joint instability, patellar fractures, and peri prosthetic fractures were absent.

In our study alignment of prosthesis was found satisfactory in all knees of patients and no significant radiolucent lines were seen at 1 year follow up evaluation.

## CONCLUSION

Total knee arthroplasty using posterior cruciate substituting designs resulted in excellent relief of pain, range of motion, restoration of function, low prevalence of patellofemoral complications and continues to function well during the follow-up period. The posterior cruciate ligament substitution during total knee arthroplasty would allow better range of motion and more normal gait. The range of motion greater than 90 degrees is more reliably attained with a posterior substituting design. With the posterior substituting prosthesis all deformities (valgus/varus/fixed flexion deformity) were corrected and accurate mechanical alignment was achieved. The prosthesis more accurately reproduced joint position when the knee was extended from a flexed position. TKA improves the functional ability of the patient as reflected by the improvement in the post-op knee clinical score and knee functional score. The association between the knee clinical score and knee functional score was statistically significant. Short term clinical, functional and radiological outcome following total knee arthroplasty are good. The knee society score is an effective scoring system as it incorporates clinical and functional outcome following total knee arthroplasty. The improvements can be well documented using knee society scoring system in follow up of patients. The knee society radiological evaluation system is an effective system to evaluate early signs of loose prosthesis/ implant loosening radiologically in follow up cases.

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*Conflict of interest: None declared*

*Ethical approval: The study was approved by the institutional ethics committee*

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