

# Research Paper

## Short-term Outcomes of Semi-constrained Implants in Patients With Complex Primary Total Knee Arthroplasty



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## ABSTRACT

**Background:** Semi-constrained implants are developed to reduce the detrimental impact of constrained implants in patients with complex primary total knee arthroplasty (TKA). However, the outcomes of TKA using semi-constrained implants are mainly unknown.

**Objectives:** This study aims to report the short-term outcomes and complications of primary TKA in patients managed with a semi-constrained implant.

**Methods:** Twenty-three patients (33 knees) who underwent TKA with semi-constrained implants were included in this study. The outcomes of patients were evaluated radiographically and clinically. Clinical evaluation was performed using the knee society score (KSS) and oxford knee score (OKS) at 6 and 12 months. The subjective satisfaction of the patients was also evaluated at 6 and 12 months using yes/no questions. Postoperative complications were inspected through the patient's medical records.

**Results:** The study population included six men and 17 women with a mean age of 70.7±7.6 years. The mean follow-up of the patients was 12.5±4.8 months. The average postoperative tibiofemoral alignment was 0.26±1.1° of valgus (ranging from 3° of valgus to 2° of varus). The mean KSS of the patients were 93.8±8.1 and 94.7±8.3 at 6 and 12 months, respectively. The mean OKS of the patients were 43.6±3.7 and 44.1±3.8 at 6 and 12 months, respectively. All patients were satisfied with the surgery at 6 and 12 months. No postoperative complications were recorded during the follow-up period.

**Conclusion:** The use of a semi-constrained prosthesis is safe and effective as a primary implant in TKA patients having severe deformity or ligamentous laxity.

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## 1. Introduction

**T**otal knee arthroplasty (TKA) is the choice of treatment for end-stage osteoarthritis [1]. Although most patients are satisfied with the results of TKA, almost one in five TKA patients are not satisfied for various reasons, such as unmet expectations or postoperative complications, such as instability and aseptic loosening [2]. Considering the growing number of TKA surgeries caused by the increased rate of obesity and aging in society [3], improving the outcomes of TKA and patients' satisfaction is of critical importance.

Coronal stability is the cornerstone of a successful TKA [4], which is achieved with soft-tissue balancing and using unconstrained implants. However, in complex cases, such as patients with severe knee deformity, a more constrained implant is required to achieve adequate balance and coronal stability. Although constrained prosthesis provides better stability, it is associated with decreased survival and increased rate of complications, such as aseptic loosening [5, 6]. For this reason, a less constrained prosthesis (semi-constrained implant) was developed to reduce the detrimental impact of constrained implants on the patients' outcomes [7]. However, the outcomes of TKA using semi-constrained implants are mainly unknown.

### Objectives

This study was conducted to retrospectively evaluate the short-term outcomes and complications of primary TKA in a cohort of 23 patients with end-stage osteoarthritis who were managed with a semi-constrained implant.

## 2. Methods

This study was approved by the Ethics Committee of Iran University of Medical Sciences under the code IR.IUMS.REC.1400.1217. Between November 2018 and August 2020, medical profiles of the patients who underwent primary TKA with the use of a Stryker Triathlon posterior stabilized TKA (Kalamazoo, MI) with a total stabilized tibial polyethylene insert were reviewed. Patients with follow-up of less than 12 months and those who were lost to the follow-up were excluded from the study. Twenty-three patients (33 knees) were included in the final analysis. The study population included 6 men (26%) and 17 women (74%). The mean age of the patients was  $70.7 \pm 7.6$  years (range 66-74). The mean body mass index (BMI) of the patients was  $35.1 \pm 4.4$  kg/m<sup>2</sup> (range 29.5-39.2). The mean follow-up of the patients

was  $12.5 \pm 2.8$  months (range 12-14). Table 1 presents the characteristics of the patients.

### Procedure

All procedures were performed by a senior knee surgeon. Using a medial parapatellar approach, a gap-balancing technique was implemented to achieve symmetric flexion and extension gaps. Gap balancing was started with the distal femur cut and continued with the proximal tibial cut. Then, the required extension gap was calculated, and medial/lateral released by pie crusting of the medial collateral ligament or lateral collateral ligament to achieve a symmetric extension gap. After that, the flexion gap was set to achieve the same value as the extension gap. A semi-constrained TKA was indicated if the knee was not adequately balanced with these procedures or the collateral ligaments were incompetent. Patellar resurfacing was not performed for any of the patients. All implants were cemented. Postoperatively, a knee brace was used for one week. Wait-bearing was allowed as tolerated.

### Outcome measures

The outcome of the patients was evaluated radiographically and clinically. In each follow-up visit, standing lateral and anteroposterior radiographs, alignment view radiographs, and Merchant view radiographs were obtained. Postoperative tibiofemoral alignment was evaluated on recent radiographs.

Clinical evaluation of the knee function was performed prospectively using the knee society score (KSS) and Oxford knee score (OKS). The KSS ranged from 0 to 100, with a higher score demonstrating a better function. KSS was also categorized as follows, excellent (score  $\geq 90$ ), good (score 77-90), fair (score 65-77), and poor (score  $< 65$ ) [8].

The OKS ranged between 0 and 48, with higher scores indicating better outcomes. The subjective satisfaction of the patients and their re-choice to undergo the same operation were evaluated with yes/no questions. Clinical evaluations were performed two times, once after six months and the other one after one year.

## 3. Results

### Radiographic outcomes

The mean knee extension was  $8.7 \pm 7.9^\circ$  (range 0–20°) before the surgery and  $3.1 \pm 3^\circ$  (range, 0–10°) after the

**Table 1.** Characteristic features of patients undergoing total knee arthroplasty (TKA) with a semi-constrained implant

Variables		Mean±SD/No. (%)
Age (y)		70.7±7.6
Sex	Male	6(26)
	Female	17(74)
BMI (Kg/m <sup>2</sup> )		35.1±4.4
Laterality	Left	5(21.7)
	Right	8(34.8)
	Bilateral	10(43.5)
Follow-up (month)		12.5±4.8

Abbreviations: BMI: body mass index

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surgery. The mean knee flexion was 100.8±17.2° (range 65–120°) before the surgery and 119.2±14.2° (range, 90–130°) after the operation. According to the preoperative standing radiographs, a varus deformity was present in 29 (87%) knees. The mean varus angle was 14.2±5.1° (range 9-21°). The preoperative valgus deformity was present in 4 knees (13%). The mean valgus angle was 6.1±2.1° (range 5-9°). The average postoperative tibiofemoral alignment was 0.26±1.1° of valgus (ranging from 3° valgus to 2° of varus) (Table 2).

### Clinical outcomes

Six months after the operation, the mean KSS of the patients was 93.8±8.1 (excellent in 19 patients and good in four patients). After 12 months, the mean KSS of the patients was 94.7±8.3 (excellent in 20 patients and good in four patients).

The mean OKS of the patients 6 and 12 months after the operation were 43.6±3.7 and 44.1±3.8, respectively.

At 12 months, all the patients were satisfied with the results of TKA. Twenty patients (87%) stated that they would select the same procedure if they were to go back in time and decide again. The remaining three (13%) patients were uncertain (Table 3).

### Complications

Superficial or deep infection was not seen in any of the patients. No case of aseptic loosening was recorded until the last follow-up. Also, no hardware failure or periprosthetic fracture was recorded as well. In addition, deep vein thrombosis was not detected in any of the patients.

### 4. Discussion

In this study, we evaluated the short-term outcomes and postoperative complications of semi-constrained TKA. After 12 months, the knee function was excellent in 20 patients (87%) and good in 3 patients (13%). None of the patients had varus or valgus deformity, according to the

**Table 2.** Radiographic measures before and after total knee arthroplasty (TKA) with a semi-constrained implant

Variables	Mean±SD/No. (%)	
	Before TKA	After TKA
Knee extension (°)	8.7±7.9	3.1±3
Knee flexion (°)	100.8±17.2	119.2±14.2
Alignment	Varus	29(87)
	Valgus	4(13)
	Normal	0 - 33(100)

Abbreviations: TKA: total knee arthroplasty

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**Table 3.** Clinical outcome measures 6 and 12 months after total knee arthroplasty (TKA) with a semi-constrained implant

Variables	Mean±SD/No. (%)
KSS at 6 months	93.8±8.1
KSS at 12 months	94.7±8.3
OKS at 6 months	43.6±3.7
OKS at 12 months	44.1±3.8
Satisfaction at 6 months	Satisfied: 23(100) Dissatisfied: 0(0)
Satisfaction at 12 months	Satisfied: 23(100) Dissatisfied: 0(0)
If you could go back in time and make the decision again, would you choose to have the joint replacement surgery? (6 months)	Yes: 21(91.3) Uncertain: 2(8.7) No: 0(0)
If you could go back in time and make the decision again, would you choose to have the joint replacement surgery? (12 months)	Yes: 20(87.0) Uncertain: 3(13.0) No: 0(0)

Abbreviations: KSS: Knee Society Score; OKS: Oxford Knee Score

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tibiofemoral alignment view radiographs. Aseptic loosening did not occur in any of the patients. No other postoperative complications, such as periprosthetic fracture, hardware failure, and infection were observed.

In 2011, Lachiewicz and Soileau [9] first reported the outcomes of the second-generation constrained condylar prosthesis in primary TKA in 27 knees with a mean follow-up time of 5.4 years. The most common indications for the use of the second-generation constrained condylar prosthesis were severe valgus deformity and incompetent medial collateral ligament. None of the patients required a revision TKA during the follow-up period. Aseptic loosening, prosthetic fracture, tibial fracture, and patella problems were not observed in any of the patients. A minimally displaced patella fracture was observed in two knees, which was not asymptomatic. We considered the same indications for the use of a semi-constrained prosthesis. The mean follow-up of the patients was considerably shorter in our study. Similar to the study of Lachiewicz and Soileau, we observed no serious complications following the implication of a semi-constrained prosthesis.

The results of semi-constrained TKA have been reported in a small number of previous studies. Sabatini et al. [10] reported their experience using semi-constrained prostheses in primary TKA. Twenty-eight patients who underwent second-generation semi-constrained knee arthroplasty were included in their study. All patients were >75 years of age and had a severe deformity. The mean follow-up of the patients was 31.3 months. The mean KSS improved from 30 points before the operation to

92.1 points at the last follow-up. A full-extension knee was achieved in all patients. No radiolucent lines were observed during the radiographic evaluation. No deep infections or periprosthetic fractures were observed in any of the patients. Aseptic loosening was not seen in any of the patients as well. In our study, the mean KSS of patients was 94.7 at 12 months after the operation, which was comparable to the study of Sabatini et al. Similarly, no postoperative complications, such as aseptic loosening and periprosthetic fracture were observed in our cohort.

Martin et al. [7] aimed to investigate whether differences were observed in clinical and or radiographic outcomes for those who required a semi-constrained implant with a TS tibial insert and those who did not (primary TKA design with a posterior stabilized [PS] insert). Seventy-five patients were included in each group. The average follow-up of the study was 25 months. While the TS group had significantly greater preoperative varus, the two groups were similar in terms of postoperative revision, reoperation, and other complications. Aseptic loosening occurred in one patient in the TS group and no patient in the PS group. No aseptic loosening was observed in our series. However, it should be noted that our follow-up was shorter, and the number of patients was less (12.5 months, 23 patients).

Johnson et al. [11] evaluated functional outcomes and implant survival in a series of 23 TKA patients under the age of 60 years managed with semi-constrained prostheses. At a 66-month follow-up, Western Ontario and McMaster University Osteoarthritis Index scores

and KSS were 15.7 and 94.7, respectively. The patient-reported outcomes were not different between one year and the final follow-up. Aseptic loosening was not seen in any of the patients. All patients kept the implants until the last follow-up with a satisfaction rate of 85.7%. Excellent or good results were reported by 92% of the patients. Although the follow-up period of our study was significantly smaller, the patient's functional outcome (KSS), satisfaction rate, and implant survival were similar (94.7%, 100%, and 100%). Likewise, aseptic loosening was not seen in our series.

Also, other authors have reported the outcome of the semi-constrained prosthesis for TKA [12, 13]. The majority of these studies, including ours, report the safety and effectiveness of semi-constrained prostheses in providing adequate coronal stability in patients with complex primary TKA.

## 5. Conclusion

Semi-constrained prosthesis provides a satisfying clinical and radiologic function for patients with complex primary TKA. They are associated with a small risk of postoperative complications, such as aseptic loosening, periprosthetic fracture, and implant failure. Therefore, the use of this prosthesis as a primary implant in patients with severe deformity or ligamentous laxity seems promising.

The present study had limitations. The main limitations of this study were its retrospective patient recruitment, the small number of patients, and the short follow-up period. Therefore, large-scale prospective studies are required to provide further support for the results presented here.

## Ethical Considerations

### Compliance with ethical guidelines

All ethical principles were considered in this article. The participants were informed of the purpose of the research and its implementation stages. They were also assured about the confidentiality of their information and were free to leave the study whenever they wished, and if desired, the research results would be available to them.

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## Authors' contributions

All authors equally contributed to preparing this article.

## Conflict of interest

The authors declared no conflict of interest.

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