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Original Article

Complete bilateral knee arthroplasty in staged or simultaneous surgeries in patients with osteoarthritis

Keyvan Ghadimi[1], Mehdi Motififard[2], Reza Mohammadi[2], Aryan Rafiee Zadeh[1]

[1]School of Medicine, Isfahan University of Medical Sciences, Isfahan, Iran; [2]Department of Orthopedic, Isfahan University of Medical Sciences, Isfahan, Iran

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Abstract: Background: Considering the increasing importance of the new method of arthroplasty in the treatment of knee osteoarthritis and the possibility of its two-stage and one-stage process, as well as considering that each method has its own merits, this study examines these disadvantages and comparisons. Methods: In this cross-sectional study, 119 patients undergoing bilateral knee arthroplasty surgery were enrolled in the study, in the first group with the simultaneous process (60) and the second group who were willing two stages (from a period of three months or more) 59 patients, Then the treatment outcomes were compared in both groups. Results: The mean duration of hospitalization in the simultaneous group was significantly lower than that in the staged group ($P < 0.05$). The average surgery cost in the staged method was significantly higher than that of the same group ($P < 0.05$). The mean knee motion range and patients' satisfaction in the two groups did not significantly differ. In the short term, patients' satisfaction was higher in the stage method. Conclusion: The simultaneous approach to hospitalization time and costs was better than the staged method, but in the long-term, there was a significant difference in other aspects.

Keywords: Arthroplasty, osteoarthritis, knee, surgery

Introduction

Diseases of the musculoskeletal system are widespread and affect millions of people worldwide, most of whom are the in elderly or following traumatic events [1, 2]. These diseases impose significant costs on society economically and health. Knee osteoarthritis is one of the most important diseases of the musculoskeletal system, the main feature of which is degenerative changes in the knee joint [3, 4]. The knee's osteoarthritis symptoms include joint pain, joint dryness, instability, deformity, and decreased range of motion [5]. Pain is the most prominent symptom of osteoarthritis of the knee [6].

Symptomatic osteoarthritis of the knee affects about 10 percent of adults over the age of 55, a quarter are severely disabled. It is also estimated that worldwide, about 40% of people over 70 have knee osteoarthritis [7]. The prevalence of osteoarthritis of the knee increases with age due to physiological, structural changes in the knee joint and of course, the role of rising forces and pressure on the knee joint as an accelerating factor in the development of osteoarthritis of the knee [8, 9].

Usually, when weighing, the forces passing through the knee joint are not evenly distributed between the medial and lateral compartments of the knee. On the other hand, the pressure on the medial compartments is about 2.5 times more than the lateral compartment of the knee [10]. This inequality in the distribution of forces may explain the greater involvement of osteoarthritis in the medial knee compartment than in the lateral knee compartment [11, 12].

Medications that are effective in treating osteoarthritis could be classified into two general categories: relieving symptoms and helping to rebuild joint structure [13, 14]. Surgical treatments, including arthroplasty, are recommended when medical treatments cannot control the patient's pain [15, 16]. Arthroplasty is one of the best treatments for degenerative joint diseases, becoming more and more critical [17].

It is reported that about 650,000 arthroplasty surgeries are performed in the United States each year, which in addition to restoring knee function, relieves pain in the majority of patients [18]. Simultaneous bilateral knee arthroplasty is a very effective method in end-stage osteoarthritis of the knee. If performed, it reduces the cost and length of hospital stay in patients compared to stage arthroplasty. Still, despite these benefits, it has been reported that Simultaneous bilateral arthroplasty has in some cases increased the risk of mortality and morbidity [19].

Therefore, due to the increasing importance of the new arthroplasty method in treating osteoarthritis of the knee and because it is not clear which simultaneous or stage treatment is more appropriate, and because there are various reports in this regard, we discuss the advantages and disadvantages of two methods. In the simultaneous method, bilateral arthroplasty can be performed during a day or a hospitalization at intervals of 2 or 3 days. A stepwise approach was performed at 2 or 3 months intervals in the study.

Methods and material

Study design

This is a cross-sectional study performed in 2018-2019 in Kashani and Saadi hospitals affiliated to Isfahan University of Medical Science. The current study was conducted on 119 patients with bilateral knee osteoarthritis. The study protocol was approved by the Research Committee of Isfahan University of Medical Sciences and the Ethics committee has confirmed it (Ethics code: IR.MUI.REC.1396.3.112).

Sampling method

Sampling was performed in both hospitals in the same way. The type of surgery was determined based on the surgeon's opinion and according to other factors such as the patient's age, anesthesiologist's opinion and the accompanying disease. Still, there was no specific method to assess whether the patient needed one or two stages of surgery.

Inclusion and exclusion criteria

The inclusion criteria were age more than 18 years, patients diagnosed with primary osteoarthritis of the knee, being a candidate of complete or simultaneous bilateral arthroplasty and signing the written informed consent to participate in this study. Diagnosis of primary osteoarthritis of the knee was made using radiological imaging. In this condition, X-rays provide clear, detailed images of the knee joint and may reveal bone spurs or narrowing of the joint, the classic hallmark for diagnosing osteoarthritis of the knee. A healthy knee joint appears to have a gap between the bones on an X-ray because the cartilage acts as a cushion between the femur and the tibia. Exclusion criteria were the presence of any congenital or developmental disease, lack of insurance, or bone disease and a history of surgery or previous fracture around the knee, the presence of inflammatory disease, rheumatoid arthritis and new joint deformity, patients who did not go to the orthopedic clinic for follow-up treatment, patients who did not want to continue to participate in this project or patients who died (due to complications), patients with a history of cardiovascular disease or having a body mass index (BMI) more than 30 kg/m^2.

Patient grouping and surgical interventions

First, patients with osteoarthritis were examined by an orthopedic physician, and patients who required bilateral knee arthroplasty were divided into two groups simultaneously or in stages, using Random Allocation Software. After obtaining informed consent, if the conditions were met, they were included in the study according to the inclusion criteria and underwent surgery. Patients treated by simultaneous method underwent surgical arthroplasty in both knees with intervals of 2-3 days. On the other hand, patients in the staged group underwent a surgical operation and knee arthroplasty in one knee and had a 2-3 months recovery duration. After that period, they underwent surgical arthroplasty in the other knee.

A single knee orthopedic surgeon performed the surgery.

Measurements

The data collected in this study were included in a checklist. These data were age, sex, BMI, type of operation, type of anesthesia, underlying diseases, length of hospital stay, need for ICU hospitalization, need for blood transfusion,

Table 1. Demographic data of patients in this study

Variable		Simultaneous group	Staged group	*P*-value
Age (years)		62.54 ± 4.07	68.76 ± 4.58	0.23
Gender	Male	15 (25%)	10 (16.9%)	0.28
	Female	45 (75%)	49 (83.1%)	
BMI	Above 30	9 (16.4%)	8 (13.8%)	0.70
	Under 30	46 (83.6%)	50 (86.2%)	
Type of anesthesia	general	2 (3.3%)	4 (6.8%)	0.39
	Spinal	58 (96.7%)	55 (93.2%)	
disease Underlying	Inflammatory	1 (4.3%)	7 (14.9%)	0.24
	Diabetes	3 (13%)	10 (21.3%)	
	Osteoporosis	19 (82.6%)	30 (63.8%)	

pain level, mortality during and after surgery, nervous or vascular injury rate, postoperative infection, need for revision, hospital fee for surgery and hospitalization with insurance, duration of pain recovery (week), Knee score (0 to 10 points), evidence of loosening radiology, need for physiotherapy, duration of recovery of knee swelling, and patient satisfaction.

We used Knee Score by the Oxford Score Knee Outcome Scale (OKS) to assess patient's functions. OKS is a concise measuring instrument that measures the amount of pain and physical activity associated with the knee. This scale was first developed and validated by Dawson to evaluate the outcome of hip and knee replacement. The instrument consists of 12 questions, each of which scores between zero and 10. A score of zero means the worst situation and a score of 10 means no problem [20]. Physical therapy needs, and revision criteria were assessed by two expert orthopedic surgeons and based on clinical conditions of the patients. Radiological evidence of loosening was the appearance of peri-implant radiolucency, implant displacement and peri-implant cement fracture. Patient's satisfaction was measured using a three scored Likert scale. Based on this method, the patients scored their satisfaction levels in low, medium and high.

Statistical analysis

The obtained data were entered into the Statistical Package for Social Sciences (SPSS) (version 24, SPSS Inc., Chicago, IL). Quantitative data were reported as mean ± standard deviation and qualitative data as frequency distribution (percentage). Independent t-test, Chi-square were used to analyze the data. *P*-value < 0.05 was considered as a significance threshold.

Results

Study population

In this study, 60 patients underwent simultaneous surgery at intervals of two to three days (15 men and 45 women) and 59 patients underwent staged surgery (10 men and 49 women). There was no significant difference between the two groups in terms of age, sex, BMI, type of anesthesia, underlying disease (P > 0.05) (**Table 1**).

Patient's characteristics

The mean duration of hospitalization in the concurrent group was higher than the same time for the first stage of the staged group and it was lower for the total length of hospitalization in the staged group (P < 0.05). The need for ICU hospitalization in the staged group was significantly higher than the concurrent group (P = 0.004). In addition, there was no significant difference between the two groups based on the need for blood transfusion, complications and incidence of DVT and PTE, the need for analgesia, DVT prophylaxis requirement, postoperative infection, and the need for revision (P > 0.05). Notably, no mortality and nerve damage were seen in patients in both groups. The mean surgery costs in the stepwise method was significantly higher in the concurrent group (P < 0.001). There was no significant difference between the two groups based on the amount of pain in the first and second knee (P > 0.05). These data are shown in **Table 2**.

Patient's clinical data

In addition, there was no significant difference between the two groups based on the duration of pain recovery in the first knee (P = 0.77). There was no significant difference between the two groups based on knee movement in the first knee (P = 0.14), but the mean knee movement in the second knee in the concurrent group was significantly higher than the staged group (P = 0.002). There was no significant difference between the two groups re-

Table 2. Comparison of different data between two groups

Variable		Simultaneous group	Staged group	*P*-value
Hospitalization duration (days)		6.65 ± 1.01	3.62 ± 0.58	0.01
Need for ICU admission		3 (5%)	14 (23.7%)	0.004
Need for blood transfusion	one unit	40 (88.9%)	36 (90%)	0.86
	Two units	5 (11.1%)	4 (10%)	
Complications or incidence of DVT/PTE		1 (1.7%)	4 (6.8%)	0.16
Need for pain killers	Less than 1 week	1 (1.7%)	3 (5.1%)	0.38
	Up to 2 weeks	43 (72.9%)	37 (62.7%)	
	More than 2 weeks	15 (25.4%)	19 (32.2%)	
Need for DVT prophylaxis	weeks two	49 (83.1%)	49 (83.1%)	0.14
	weeks Six	9 (15.3%)	5 (8.5%)	
	Over 6 weeks	1 (1.7%)	5 (8.5%)	
infection Postoperative		0	2 (3.4%)	0.15
Requiring revision		0	2 (3.4%)	0.15
Cost (million Tomans)		13.01 ± 13.46	22.53 ± 22.39	> 0.001

Table 3. Comparison of clinical data of the two groups

Variable			Simultaneous group	Staged group	*P*-value
Pain intensity	First knee		7.46 ± 1.18	7.60 ± 1.18	0.40
	knee Second		7.16 ± 0.95	7.56 ± 1.15	0.08
Knee movement rate	knee First		107.43 ± 7.31	105.33 ± 8.60	0.14
	knee Second		110.66 ± 8.10	105.78 ± 11.83	0.002
Knee score improvements after 6 months	knee First		7.76 ± 0.85	7.94 ± 0.70	0.11
	knee Second		8.10 ± 2.83	7.81 ± 1.04	0.09
Radiological evidence of loosening			knee Second	1 (1.7%)	0.31
sessions Physiotherapy			18.87 ± 6.99	19.17 ± 9.24	0.03
Duration of knee swelling improvement	two weeks		2 (3.4%)	0	> 0.001
	One Month		43 (72.9%)	17 (28.8%)	
	Over a month		14 (23.7%)	42 (71.2%)	
Patient's satisfaction	First knee	medium	11 (18.3%)	24 (40.7%)	0.007
		High	49 (81.7%)	35 (59.3%)	
	Second knee	Low	0	5 (8.5%)	0.002
		medium	8 (13.3%)	19 (32.2%)	
		High	52 (86.7%)	35 (59.3%)	

garding knee swelling. There was no significant difference between the two groups regarding radiological evidence of loosening. There was no significant difference between the two groups regarding of the need for physiotherapy. There was no significant difference between the two groups in terms of patient satisfaction in the long run, in the short term; patient satisfaction was higher in the staged group (**Table 3**).

Discussion

According to the results of this study, the use of simultaneous method compared to the staged methods has advantages such as lower cost, more extended hospital stay than the total stages. Because in the same method, surgery is performed for the patient once, the patient's treatment costs are reduced. There was no significant difference between the two methods regarding pain recovery time and swelling and patient satisfaction.

In a study by Sheth et al., which compared two simultaneous and stepwise bilateral knee arthroplasty procedures, they concluded that complications and mortality in both methods were relatively rare. Also, the rate of complications such as septic and non-septic revision,

death and side effects in the simultaneous method is slightly higher than the staged method, but in general there was no difference between the two methods in this regard [21]. In our study, no mortality was reported, the need for revision and infection was the same in the stepwise and simultaneous methods.

In the study of Sarzaeem et al., which was performed on 120 patients with a mean age of 68.2 years (with the majority of males), they concluded that there were no significant differences between the two groups of patients in simultaneous and staged bilateral arthroplasty based on demographic information. During 38 months of patient follow-up, DVT occurred in only two patients in the staged group and therefore there was a significant difference between the two methods in this regard. In the end, it was stated that the simultaneous method had better results than the stepwise method and can be considered the preferred method in treating these patients. This is because the rate of hospitalization in the concurrent method was relatively less than the step-by-step method [22]. In our study, as in the above analysis, the amount of DVT and PTE was seen in five patients, but there was no difference between the two methods in this regard, but the duration of hospitalization in the concurrent method was significantly longer than the stepwise method.

A study that examined the costs of the simultaneous and stepwise two-way method concluded that all charges in the concurrent process are less than the step-by-step method, except for prosthesis, which was slightly more expensive in the simultaneous method than the two-stage method but did not affect the choice of the surgical procedure [23]. In our study, the costs in the simultaneous method were significantly lower than in the step method.

In a multicenter study on bilateral arthroplasty, the mean length of hospital stay was 11 days and the mean blood loss was 4.1 L in these patients. The postoperative transfusion rate was seen in 68 patients (55%). In this study, 65% of patients agreed with this method (satisfaction) [24]. On the other hand, in our study, 88.9% received one unit of blood and 11.1% received two units of blood in the simultaneous method, and the satisfaction rate was relatively high.

In a study by Jain et al., patients with bilateral knee arthroplasty were followed for two years. During this time, the mean ROM in patients changed from 95 to 129 degrees, and the mean knee score increased. Most infections were seen in patients in the first six months after surgery. On the other hand, no DVT and PTE, myocardial infarction, arterial fibrillation or other heart problems were seen in patients. Simultaneous bilateral arthroplasty was proposed as a safe method for patients [25]. In our study, no infection was seen in the simultaneous method and also a case of DVT or PTE was seen in this method.

In a study that compared two methods of simultaneous and stepwise bilateral arthroplasty, it was concluded that people in the simultaneous group are relatively younger and with a predominance of the male sex compared to the step group. Also, the rate of concomitant comorbidity was relatively lower in patients in the concurrent group and the rate of blood transfusion was higher in the concurrent group. On the other hand, the duration of hospitalization was shorter and the rate of infection was lower. However, the rate of cardiac complications in this method was higher than the stepwise method [26]. Therefore, according to the results of recent studies and the results of our study, both bilateral and stepwise arthroplasty procedures were associated with specific complications.

But the point is that using the simultaneous method, given the cost, chronic stress of patients at two-step intervals is better than the step-by-step method. But the duration of hospitalization in the step method was less than concurrent. Therefore, according to the experience and opinion of the surgeon and anesthesiologist, simultaneous surgery is usually recommended to patients who do not have cardiovascular problems and are not old. In the end, due to the small sample size in our study and other effective factors in comparing the two methods that have not been studied, such as the duration of the operation to record information, it seems that more studies with higher sample size are needed in this field.

The limitations of this study were restricted study population and conducting this survey in a single city. We believe that multicentric studies on larger populations could better reveal

the beneficial effects of each of the two surgical methods.

Conclusion

The use of the simultaneous approach to hospitalization time and costs was better than the staged method, but in the long-term, there was a significant difference in other aspects. This issue has high clinical importance.

Disclosure of conflict of interest

None.

Address correspondence to: Aryan Rafiee Zadeh, School of Medicine, Isfahan University of Medical Sciences, Hezar Jarib St., Isfahan City, Isfahan, Iran. Tel: +989380686777; E-mail: rafieezadeh.a@gmail.com

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