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Original Article

Functional outcomes of total knee arthroplasty in patients with Parkinson's disease: A case control study

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ABSTRACT

Background: Parkinson's disease is a neurodegenerative condition causing coordination loss in musculoskeletal system. Many studies suggest that total knee arthroplasty in patients with Parkinson's disease has unfavorable treatment results and high complication rates. Our hypothesis was that total knee arthroplasty might be an effective procedure in patients with Parkinson's disease.

Methods: Parkinson's disease patients who underwent total knee arthroplasty between 2006 and 2018 were retrospectively evaluated. Patients who had Parkinson's disease diagnosis before surgery and who had a minimum follow-up duration of 12 months were included. Secondary knee osteoarthritis patients were excluded. A matched control group was randomly formed. Outcome measures were evaluated by preoperative and postoperative Knee Society Score and joint range of motion values. Comparison was made by means of increase in Knee Society Score and range of motion values. Study group patients were reviewed according to Columbia Classification System to determine disease severity. Stages I-II were accepted as "low-grade" and III-IV-V as "high-grade" disease. Another comparison was made between "low-grade" and "high-grade" patients. Patient who showed disease progression after surgery were also compared to patients without progression.

Results: There were 13 patients in both groups. In study group, mean preoperative and postoperative Knee Society Score values were 45.4 (±16.8) and 85.6 (±7.60); range of motion values were 93.9° (±17.0°) and 99.5° (±9.37°) respectively with a mean follow-up of 64.5 (±44.7) months. In control group, mean preoperative and postoperative Knee Society Score values were 38.8 (±11.5) and 86.1 (±10.0); range of motion values were 100.4° (±14.6°) and 109.2° (±10.2°) respectively with a mean follow-up of 51.8 (±13.6) months. No significant difference was observed between 2 groups ($p > 0.05$). Mean preoperative KSS and ROM values were significantly lower in high-grade patients (30.0 (±17.0) and 78.8° (±11.8°) respectively) compared to low-grade patients (52.2 (±11.9) and 100.6° (±14.7°) respectively) ($p < 0.05$). However, mean increase in KSS and ROM values were significantly higher for high-grade patients ($p < 0.05$). Mean increase in Knee Society Score and range of motion was 32.4 (±10.9) and 1.00° (±9.46°) respectively in patients with progression, 45.4 (±16.8) and 8.63° (±8.00°) in patients without progression ($p > 0.05$).

Conclusion: Total knee arthroplasty is a successful treatment of knee osteoarthritis in Parkionson's disease patients with similar outcomes compared to general population despite disease severity and progression.

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1. Introduction

Parkinson's disease (PD) is the second most common progressive neurodegenerative disease following Alzheimer's disease [1,2]. It is a disease that affects the dopaminergic neurons in the substantia nigra and causes rigidity, bradykinesia and postural

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instability following loss of coordination on the musculoskeletal system [2,3]. It creates a burden on the musculoskeletal system, in addition to the osteodegeneration which may accompany. In the treatment of knee osteoarthritis (KOA), which is the most common form of osteodegeneration, a high success rate is reported with total knee arthroplasty (TKA) surgery. However, results are controversial in patients with PD [4–6].

There are limited number of studies with low level of evidence evaluating whether patients with PD can benefit from this treatment modality. In the first published series, high complication rates have been reported for which stiffness, flexion contractures and postural instability were the likely culprits [4,5,7]. However; in recent series, satisfactory results of TKA have been reported in patients with PD [6,8,9]. Clinical outcomes of TKA surgery in this specific patient group is still controversial. In addition to this, current knowledge about the effect of the disease severity and progression on surgical outcomes lacks evident data. Our hypothesis was that PD patients might have similar functional outcomes after TKA surgery compared to general population. The aim of this study was to compare the mid-term functional results of cruciate retaining (CR) TKA in patients with PD to patients without PD diagnosis and to evaluate the effect of disease severity and progression on clinical outcomes.

2. Materials-methods

Institutional review board approval was obtained before the formation of the study. The records of patients who had PD and who were treated with TKA in our clinic between January 2006 and March 2018 were evaluated retrospectively. The criteria for inclusion were PD diagnosed by a neurologist before surgery, treatment with TKA due to primary KOA and being followed for a minimum of 12 months. Patients who had secondary KOA and patients who were diagnosed with PD after TKA surgery were excluded. Included patients formed the study group and an age matched control group was randomly computer generated with patients without PD diagnosis and who underwent TKA surgery from the same database (3920 patients) and the same time period using a 1:1 match ratio (Table 1). All patients underwent unilateral TKA surgery with a medial parapatellar approach with a cemented total CR knee prosthesis [Genesis II (Smith & Nephew; Memphis, Tenn) without patellar surface replacement and all surgeries were performed by same surgeon. Drains were removed on the 1st day postoperatively and same rehabilitation program was performed to all patients including quadriceps strengthening, walking and range of motion exercises.

Postoperative evaluation of the patients was performed 2nd week and 1st, 2nd, 4th, 6th, 12th months postoperatively and each following year. The outcome measures were evaluated by Knee Society Score (KSS) and range of motion (ROM) values of the joints obtained in preoperative examination and in the last clinical follow-up (Tables 2 and 3). Comparison between two groups was made by means of increase in KSS and ROM values of two groups after surgery. Postoperative follow-up data including complications were obtained using the hospital registry system.

PD status of the study group patients were evaluated according to the Columbia Classification System (Table 4) which rated the functional limitation of PD. Preoperative and postoperative stages were noted; disease severity and progression were reviewed according to this data. While patients with a Columbia stage I-II were graded as “low-grade”, patients with a Columbia stage III-IV-V were accepted as “high-grade” patients regarding the preoperative Columbia stages. A comparison was made between these patients (Table 5). Patients who showed an increase of at least one stage after surgery were considered as disease progression and these patients were noted. Another comparison was also made between

Table 1
Comparison of demographic data and preoperative clinical evaluation data of study group and control group.

Demographic Data	Study Group	Control Group	P-value
Mean age (years)	75.6 (±8.13)	71.4 (±9.07)	0.23
Gender	4 M/9 F	6 M/7 F	0.42
Mean follow up (months)	64.5 (±44.7)	51.8 (±13.6)	0.34
Mean preoperative KSS	45.4 (±16.8)	38.8 (±11.5)	0.25
Mean preoperative range of motion	93.9° (±17.0°)	100.4° (±14.6°)	0.30
Mean preoperative flexion contracture	8.85° (±7.12°)	7.31° (±4.84°)	0.53

KSS: Knee Society Score.

Table 2
Functional scores, joint range of motion values and Columbia stages of patients with Parkinson's disease.

Patient number	Age (years)	Sex	Side	Pre-op KSS	Post-op KSS	Pre-op ROM (degrees)	Post-op ROM (degrees)	Pre-op flexion contracture (degrees)	Pre-op Columbia stage	Post-op Columbia stage
1[a]	63	F	R	57	92	85	93	10	2	3
2[a]	78	F	R	67	96	125	110	15	2	3
3	73	F	L	52	57	85	95	5	2	2
4[b]	77	M	R	17	77	70	87	20	3	3
5	73	M	L	55	90	90	103	5	2	2
6	64	F	R	23	85	95	93	0	2	2
7[a,b]	81	M	L	24	74	95	100	10	3	4
8	77	F	L	57	95	115	115	0	2	2
9[a]	80	F	R	52	77	90	97	15	1	3
10[b]	92	F	R	55	90	70	86	0	3	3
11	85	M	R	55	90	110	110	10	2	2
12[a]	72	F	L	52	75	110	110	5	1	2
13[b]	68	F	R	24	85	80	95	20	3	3

KSS: Knee Society Score.
ROM: Range of motion.
[a] Patients whose disease progressed.
[b] Patients who have high grade Parkinson's disease (Columbia stage III, IV and V) before surgery.

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Table 3
Functional scores and joint range of motion values of control group patients.

Patient number	Age (years)	Sex	Side	Preoperative KSS	Postoperative KSS	Preoperative ROM (degrees)	Postoperative ROM (degrees)	Preoperative flexion contracture (degrees)
1	62	M	R	37	95	90	120	10
2	80	M	R	24	63	120	90	5
3	63	M	R	32	87	110	115	15
4	84	F	L	33	90	100	110	10
5	65	F	R	41	85	125	125	0
6	63	M	L	54	92	110	110	10
7	77	F	L	37	87	110	110	10
8	78	F	R	26	74	70	95	10
9	64	F	R	67	96	90	110	10
10	65	M	L	32	95	90	115	0
11	63	F	L	42	74	95	95	0
12	79	F	R	36	93	95	110	10
13	85	M	R	43	88	100	115	5

KSS: Knee Society Score.
ROM: Range of motion.

Table 4
Columbia classification.

Stage	
I	Unilateral involvement with no functional impairment
II	Bilateral or midline involvement without impairment of balance
III	Impaired righting reflexes
IV	Severely disabling disease
V	Confined to bed or wheelchair

patients with and without disease progression in terms of mean increase in joint ROM and KSS values (Table 6).

In the comparison of descriptive statistical methods (mean, standard deviation) and quantitative data; student's t-test and paired sample t tests were used. The results were examined with a confidence interval of 95% ($p = 0.05$). "MedCalc® statistical software was used for data analysis and archiving. (Version 17.9.7, MedCalc® Software bvba, Ostend, Belgium).

3. Results

Study group was formed with 13 (8 R/5 L) knees of 13 (4 M/9 F) patients with a mean age of 75.6 (±8.13) years and a mean follow-up duration of 64.5 (±44.7) months. There were 13 (8 R/5 L) knees of 13 (6 M/7 F) patients in the control group. Mean age was 71.4 (±9.70) years and mean follow-up duration was 51.8 (±13.6) months (Table 1). In patients with PD, the mean preoperative KSS was 45.4 (±16.8) and the mean postoperative KSS was 85.6 (±7.60). The mean preoperative ROM was 93.9° (±17.0°) and the mean postoperative ROM was 99.5° (±9.37°). In the control group, the mean preoperative and postoperative KSS were 38.8 (±11.5) and 86.1 (±10.0) respectively. The mean preoperative ROM value was 100.4° (±14.6°) and the mean postoperative ROM value was 109.2° (±10.2°) (Fig. 1). Mean increase in KSS after TKA was 40.2 (±13.5) in patients with PD and 47.3 (±10.6) in the control group ($p > 0.05$). The mean increase in joint ROM was 5.69° (±9.06°) in patients with PD and 8.85° (±15.8°) in the control group ($p = 0.53$) (Fig. 2). There was no statistically significant difference in terms of mean KSS and ROM increase between 2 groups.

Deep vein thrombosis, periprosthetic infection and wound site problems were not observed in the follow-up of the patients. Regarding preoperative Columbia stages, there were 9 low-grade and 4 high-grade patients. Mean preoperative KSS and ROM values were significantly higher in low-grade patients (52.2 (±11.9) and 100.6° (±14.7°) respectively) compared to high-grade patients (30.0 (±17.0) and (78.8° (±11.8°) respectively) ($p < 0.05$). However, high-grade patients showed a significantly higher improvement both for KSS and ROM values ($p < 0.05$). Mean postoperative KSS values were 87.4 (±7.37) for low-grade patients and 81.5 (±7.33) for high grade patients ($p > 0.05$). Mean postoperative ROM values were 102.9° (±8.59°) and 92.0° (±6.68°) respectively for low and high-grade patients ($p < 0.05$) (Table 5).

Evaluation of disease progression revealed that while 8 patients remained stable; in 5 patients, PD progressed during follow-up according to Columbia classification. In patients whose disease progressed, mean increase in KSS values was 32.4 (±10.9) and mean increase in joint ROM values was 1.00° (±9.46°). In patients without progression, mean increase in KSS values was 45.1 (±13.2) and mean increase in joint ROM values was 8.63° (±8.00°). There was no significant difference between patients with and without disease progression in terms of mean KSS and joint ROM increase ($p > 0.05$) (Table 6).

Table 5
Comparison of functional scores and joint range of motion values of patients with low-grade PD versus high-grade PD.

	Patients with low-grade[a] PD	Patients with high-grade[b] PD	p value
Mean age (years)	73.9 (±7.15)	79.5 (±9.95)	0.14
Sex	2 M/7 F	2 M/2 F	
Mean preoperative KSS value	52.2 (±11.9)	30.0 (±17.0)	0.02
Mean postoperative KSS value	87.4 (±7.37)	81.5 (±7.33)	0.21
Mean increase in KSS	35.2 (±11.3)	51.5 (±12.1)	0.04
Mean preoperative ROM value (degrees)	100.6 (±14.7)	78.8 (±11.8)	0.02
Mean postoperative ROM value (degrees)	102.9 (±8.59)	92.0 (±6.68)	0.04
Mean increase in ROM (degrees)	2.33 (±8.38)	13.3 (±5.56)	0.04

PD: Parkinson's disease.
KSS: Knee Society Score.
ROM: Range of motion.
[a] Low-grade disease (Columbia stage I and II).
[b] High-grade disease (Columbia stage III, IV and V).

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Table 6
Comparison of functional scores and joint range of motion values of patients whose disease progressed and whose disease remained stable in study group.

	Disease with progression	Disease without progression	P values
Mean age (years)	74.8 (±7.46)	76.1 (±8.98)	0.79
Sex	1 M/4 F	3 M/5 F	
Mean follow-up (months)	58.4 (±47.7)	68.3 (±45.6)	0.72
Mean increase in KSS	32.4 (±10.9)	45.1 (±13.2)	0.10
Mean increase in range of motion values (degrees)	1.00 (±9.46)	8.63 (±8.00)	0.14

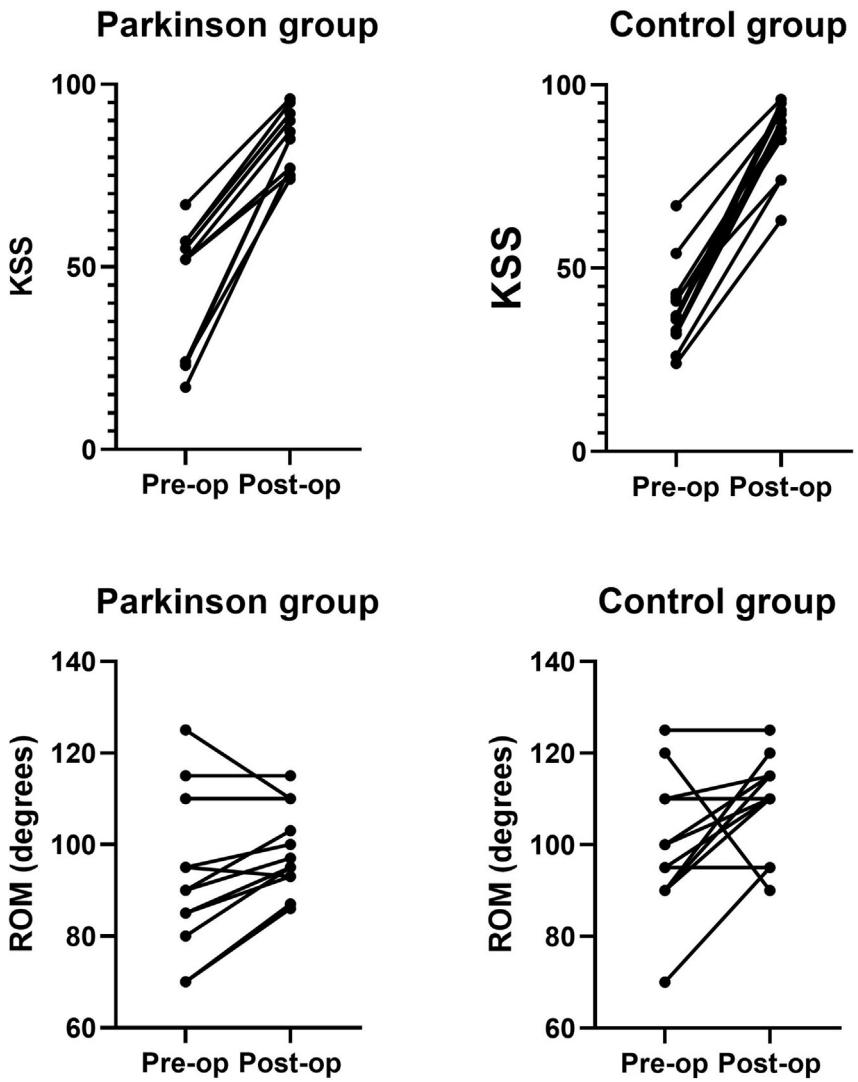


Fig. 1. Preoperative and postoperative Knee Society Score (KSS) and range of motion (ROM) values of two groups.

4. Discussion

Rigidity, progressive flexion contractures, and muscle imbalance seen in PD led to the suspicion of the efficacy of total knee arthroplasty treatment with primary KOA in these patients [8,9]. The first study in the literature is a case series of 3 patients by Oni and MacKenney in the 90's [10]. Two patients had quadriceps tendon rupture, 2 patients had progressive flexion contracture and 1 patient had progression in disease status. Patients who developed complications - although attributed to old age by the authors – died during the follow-up period of six months.

TKA was not reported as a contraindication in patients diagnosed with PD by various authors, but the fact that this patient group had lower treatment success and a higher complication risk was highlighted [5,11]. Duffy et al. reported postoperative confusion in 5 patients, patella fracture in 2 patients, and patellar subluxation in 2 patients in their series of 33 knees and 24 patients [11]. Similar to this study, Vince et al. reported postoperative confusion in 1 patient, patella fracture in 1 patient and flexion contracture in 5 patients [12]. Rondon et al. also highlighted increased need for revision surgery after TKA, mostly due to periprosthetic infection, in patients with PD [13].

Although complication rates are reported to be high in the literature, no complication was seen in the patients included in our study. Increased risk of recurrent falls in PD patients may also be a factor that increases the complication rates of TKA treatment due to possible injuries or prolonged duration of bed rest. Kalilani et al. reported 2.05 (95% CI 1.88–2.24) fold increase in fall risk in patients

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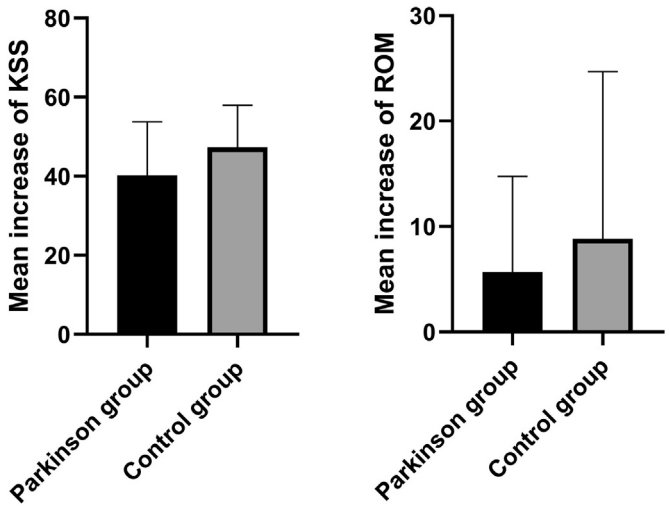


Fig. 2. Mean increase values in Knee Society Score (KSS) and range of motion (ROM) values of two groups.

with PD compared to people of the same age group without Parkinson's disease [14]. Lack of physical activity has been reported to worsen the findings in patients with Parkinson's disease [15]. In our study, it is thought that the absence of complications is due to early mobilization and effective physical therapy protocol.

The findings of this study revealed that TKA surgery in PD patients had similar outcomes compared to general population. Moreover, even though patients with high-grade disease had poorer functional scores and ROM values preoperatively, they had significantly higher improvement compared to patients with low-grade disease. Although postoperative ROM values were lower in patients with high-grade disease, there were no difference between two groups in terms of postoperative KSS values. Additionally, regarding disease progression, no difference was found on final outcomes between patients with and without disease progression. However, these findings may be related to the fact that there was not any patient with very severe disease (Columbia stage V) in our series which may reflect the importance of appropriate evaluation and selection of the patient prior to decision to perform the surgery.

Successful treatment results in other published series following the first reports are noteworthy [6,13]. One of the largest series in the recent literature is by Wong et al. who treated 43 knees of 35 PD patients with TKA. The authors compared the efficacy of TKA in patients with PD with the control group in terms of functional results and complications. They reported no significant difference between the two groups [6]. Even though the authors stated that they included patients regardless of implant design in order to obtain a higher patient number, the fact that no standard surgical technique was applied may be confusing about the results. In patients with flexion contracture, the choice of cruciate retaining (CR) or posterior stabilized (PS) prosthesis designs or lack of standardization of cementation preferences may have affected the results. Although the authors reported similar functional results to those of the control group, the study did not provide any information about the severity or progression of the PD in afflicted patients. In our study, both the study group and control group patients underwent a standard surgical procedure, a cemented CR TKA surgery, and patients with PD were reviewed regarding disease severity and progression. In another study, Rondon et al. compared the results of 123 total joint arthroplasties in PD patients to control group and reported that functional scores were poorer in patients with PD. Although there is not as much functional improvement in patients with Parkinson's disease as the control group, significant functional recovery is nonetheless achieved [13]. Despite the higher patient number, they evaluated both results of knee and hip arthroplasties and the study lacked any information about implant design, operative or postoperative treatment protocol.

The findings of this study suggest that TKA for primary KOA is a successful treatment modality in PD patients with similar functional outcomes compared to general population. In appropriately chosen patients, disease severity and progression does not seem to have a significant impact on outcomes.

Retrospective design of the study is one of its limitations. However, small patient number is the first limitation to discuss for this study. Due to traditional knowledge suggesting high complication rates and poor functional outcomes, TKA is rarely performed in patients with PD. Following a standardized patient selection process, we tried to report the results of all available patients. We performed a 2-sided power analysis for mean increase of KSS value between two groups which gave a result of 0.31 (mu1 = 40.2, mu2 = 47.3, sigma = 12.4, alpha = 0.05, sample size = 13) due to small cohort size. However, this study showed consistent results compared to previous reports with higher patient number [6,13]. We followed a meticulous patient selection protocol which is the reason for small patient number but to our opinion, is also a strength for our study compared to previous reports in the literature. Besides that, evaluation of the influence of disease severity and progression on outcomes brings a new point-of view and makes an exceptional contribution to existing literature. However, future studies with more evident data is essential on this topic.

Conflict of interest

None.

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