Title	Total knee arthroplasty in Japanese patients aged 80 years or older(本文)
Author(s)	小平, 俊介
Citation	
Issue Date	2019-09-30
URL	http://ir.fmu.ac.jp/dspace/handle/123456789/1052
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DOI	
Text Version	ETD

Original Research

Total knee arthroplasty in Japanese patients aged 80 years or older

Shunsuke Kodaira [1,2], Tadashi Kikuchi [1], Michiyuki Hakozaki [2], Shinichi Konno [2]

[1]Department of Orthopaedic Surgery, Bange Kosei General Hospital, Fukushima, Japan

[2]Department of Orthopaedic Surgery, Fukushima Medical University School of Medicine, Fukushima, Japan

Running head: Safety and efficacy of TKA in Japanese old adults

1 Hikarigaoka, Fukushima-shi, Fukushima 960-1295, Japan

Tel: +81-24-547-1276

Fax: +81-24-548-5505

Email: kodaira@fmu.ac.jp

ABSTRACT

Objective: The population of Japan is aging rapidly, and since the aging of patients who undergo total knee arthroplasty (TKA) is also expected, it is necessary to determine the efficacy and safety of TKA among old adult patients.

Methods: This study retrospectively analyzed the cases of the patients who underwent a primary TKA for osteoarthritis at Bange Kosei General Hospital between January 2009 and June 2014 and were postoperatively followed-up for ≥1 year. Among the 2,945 knees of the 1,968 patients, 1,003 knees of 679 patients aged ≥80 years at the time of surgery were designated as the older group, and we compared their cases with those of the younger group of 1,044 knees of 673 patients aged <75 years.

Results: The rate of improvement of the Japanese Orthopaedic Association (JOA) score were not significantly different between the older and younger groups. Postoperative range of motion were significantly improved in both groups. The number of postoperative days of hospital stay in the older group was 2 days longer than that of the younger group. Concerning postoperative complications, confusion, delayed wound healing, and acute heart failure were significantly more frequent in the older group. The frequencies of pneumonia, cerebral infarction, peroneal nerve palsy and bedsore did not differ significantly. Loosening of implants was observed: older group, n=0 joints; younger group, n=5 joints. The number of prosthetic joint infections: older group, n=5; younger group, n=2 (nonsignificant).

Conclusion: The rate of improvement in the JOA score did not differ significantly between the groups. TKA is an effective and safe treatment for osteoarthritis even in old adult patients when the surgical indication is based on careful preoperative screening and attention to specific postoperative complications.

Key words: Osteoarthritis, Knee, Total knee arthroplasty, Japanese, Old adults, complications, JOA score

Introduction

Total knee arthroplasty (TKA) is widely indicated for advanced osteoarthritis or rheumatoid arthritis of the knee. Numerous clinical studies have reported the efficacy and safety of TKA for old adult patients.[1–5] The safety of TKA has been improved based on the recent advances in anesthesia, perioperative health care, and surgical techniques, especially for older patients.[6,7] On the other hand, the relevance between effectiveness and patients' age have not become clear, and the background of patients who benefit by receiving TKA is still unknown.[8] A re-evaluation of the effectiveness and safety of TKA for old adult patients is thus needed. We conducted the present study to clarify the effectiveness and safety of TKA in Japanese patients aged ≥80 years with the largest-

ever number of patients.

Patients and Methods

Study design and ethics statement

This study was a non-invasive retrospective observational study. The opt-out method of obtaining informed consent was adopted. The patients were anonymized to protect their personal information. This study was approved by the ethical review committee of Bange Kosei General Hospital (BANRIN 17-001), and the study was performed in accordance with approved guidelines and regulations.

Patients

We retrospectively analyzed the cases of the consecutive patients (all Japanese) who underwent a primary TKA for osteoarthritis at Bange Kosei General Hospital between January 2009 and June 2014 and were postoperatively followed-up for ≥1 year. Among the 2,945 knees of these 1,968 patients (Fig. 1), we designated the 1,003 knees of the 679 patients aged ≥80 years at the time of surgery as the 'older group,' and we compared their cases with those of the 'younger group' of the 1,044 knees of the 673 patients aged <75 years. The intermediate-age group (75≤ years <80) of 898 knees of 616 patients, the most frequent generation of TKA, were excluded from this study for the purpose of highlighting the differences of clinical outcome between the younger and older group by

excluding the transitional generation. The distribution of the TKA patients is shown in Figure 1; the older-group patients were 80–94 years old, and the younger-group patients were 47–75 years old. The breakdown of follow-up period in both groups is shown in Figure 2.

Surgical procedure and postoperative treatment

All the operations were performed under spinal anesthesia, and an air tourniquet was not used. The TKA prosthesis used in this series was the Scorpio NRG, posterior stabilized (PS), or cruciate retaining (CR) type (Stryker, Mahwah, NJ, USA), and patellar replacement was performed in all cases. All the operations were performed or supervised

by an experienced surgeon (T.K.).

Continuous cooling was performed until postoperative day (POD) 2, and physical therapies consisting of walking exercise and range of motion (ROM) exercise were started from POD 3 under management by physical therapists. Continuous passive motion was not performed. Discharge from the hospital was allowed when the patient was able to walk steadily and unassisted. Postoperative physical therapy was performed only during the hospital stay; ambulatory or in-home physical therapies after discharge were not performed. Within one month before the surgery, plain radiographs of the affected limbs were taken, and KL grade and FTA were measured. Just after the surgery, plain radiographs of operated knee were taken in the operating room. After discharging

hospital, plain radiographs of operated knee were taken at the time of outpatient visit, thereafter taken at least every half year.

Evaluation items

The six items we determined in each group and used for the between-group comparison were as follows: (1) the patient's Japanese Orthopaedic Association (JOA) score,[9] (2) the pre- and postoperative ROM of the knee, (3) the number of postoperative days of hospital stay, (4) postoperative complications, (5) loosening of implants, and (6) prosthetic joint infection (PJI).

The JOA score is composed of 4 categories; I, pain on walking; II, pain on

ascending or descending stairs; III, range of motion; IV, joint effusion (Table 1). The rate of improvement in the patient's total JOA score [(postoperative JOA score – preoperative JOA score)/preoperative JOA score ×100] was calculated, whereas the rate of improvement in each category were not calculated because “zero-point” was existed in some cases.

The postoperative JOA score and postoperative ROM were calculated based on the patient's maximum score. When a TKA was performed bilaterally in the same period of hospital stay, the operations were performed one-by-one, and the number of postoperative days of hospital stay was calculated from the second operation. As postoperative complications, confusion and peroneal nerve palsy for the duration of

acute phase, pneumonia, cerebral infarction, acute heart failure and bedsore in the period of hospital stay, and delayed wound healing throughout the follow-up period were evaluated. Wound healing was defined as delayed when re-suturing of a surgical wound was required.

Statistical analysis

We used the Mann-Whitney U-test for the comparisons of body weight (BW), body mass index (BMI), radiological grading (Kellgren-Lawrence [KL] grade[10]), femorotibial angle (FTA), JOA score, ROM, and follow-up period. We used Pearson's chi-square test to examine correlations between two dichotomous variables of gender, the number of patients who received TKA bilaterally, the type of TKA implant, the presence of a past medical history (i.e., diabetes mellitus, ischemic heart disease, and high blood pressure),

and the occurrences of postoperative complications, loosening of implants, and PJI. In all examinations, a p-value <0.05 was considered significant. The data analyses were performed using Statcel 3 software (OMS Publishing, Saitama, Japan).

Results

Patients

The patients' characteristics are summarized in Table 2. The percentage of female patients, BW, BMI, KL grade, FTA, the number of patients who received TKA bilaterally, the type of TKA implant (PS vs. CR type), and past medical histories of diabetes mellitus or ischemic heart disease differed significantly between the older and younger groups, but the rate of high blood pressure did not. KL grade and FTA, which reflect the severity

of OA of the knee, were similar between the two groups with a median but were statistically significant difference.

The rate of improvement of the JOA score

The total preoperative JOA scores of the older and younger groups were 48.1±0.3 and 51.0±0.3 points, respectively. The total postoperative JOA scores of the older and younger groups were 82.8±0.4 and 87.4±0.3 points, respectively (Fig. 3). The improvement rates were 77.8±1.5% in the older group and 76.9±1.4% in the younger group; there was no significant between-group difference, and the postoperative improvement of knee function was equal in the two groups.

The JOA scores in category I “pain on walking” were 11.2±0.1 points at preoperation and 25.1±0.2 points at postoperation in the older group, and 13.1±0.1 points at preoperation and 28.5±0.1 points at postoperation in the younger group (Fig. 4). In this category, the JOA scores in the younger group were significantly high both at pre- and postoperation, and postoperative significant improvement was observed in both groups. The JOA scores in category II “pain on ascending or descending stairs” were 4.3±0.1 points at preoperation and 18.8±0.2 points at postoperation in the older group, and 4.7±0.1 points at preoperation and 20.1±0.1 points at postoperation in the younger group (Fig. 5). In this category, the JOA scores in the younger group were significantly high both at pre- and postoperation, and postoperative significant improvement was observed

in both groups.

The JOA scores in category III “range of motion” were 27.6±0.2 points at preoperation and 28.9±0.1 points at postoperation in the older group, and 27.6±0.2 points at preoperation and 28.8±0.1 points at postoperation in the younger group (Fig. 6). In this category, the JOA scores in both groups were not different both at pre- and postoperation, and significantly improved at postoperation.

The JOA scores in category IV “joint effusion” were 4.9±0.2 points at preoperation and 10.0±0 points at postoperation in the older group, and 5.5±0.2 points at preoperation and 10.0±0 points at postoperation in the younger group (Fig. 7). In this category, the JOA score in the younger group was significantly high at preoperation but not different at

postoperation, and significantly improved at postoperation in both groups.

ROM

The ROM values (extension/flexion) were −8.2±0.1°/130.9±0.5° at preoperation and −0.9±0.1°/133.4±0.5° at postoperation in the older group, and −5.6±0.2°/130.7±0.6° at preoperation and −0.3±0.1°/133.3±0.5° at postoperation in the younger group (Fig. 8). Both groups showed significant improvement postoperation. Between the older and younger groups, postoperative ROM of extension in the younger group was significantly superior, but that of flexion was not significantly different.

Postoperative days of hospital stay

The number of postoperative days of hospital stay in the older group (18.8±0.3 days) were significantly but only 2 days longer than that in the younger group (16.8±0.2 days).

Postoperative complications

Confusion, delayed wound healing, and acute heart failure were significantly more common in the older group. Conversely, the frequencies of pneumonia, cerebral infarction, peroneal nerve palsy, and bedsores were not significantly different between the groups (Table 3).

Loosening of implants and PJI

The number of loosened implants was significantly higher in the younger group: 5 joints (0.5%) versus 0 joints in the older group. The number of PJIs did not differ significantly between the groups: 5 joints (0.5%) in the older group and 2 joints (0.2%) in the younger group.

Discussion

In the present series of patients, the JOA scores at both pre- and postoperation were significantly better in the younger group compared to the older group, but the rate of improvement in this score did not differ significantly between the groups. In categories

I “pain on walking” and II “pain on ascending or descending stairs” of the JOA scores, the older group showed remarkable improvement. This result indicated that “relieving the pain on motion”, the main purpose of TKA was achieved. Moreover, from the result of category IV “joint effusion”, TKA reduced joint effusion. Similarly, a significant postoperative improvement of ROM in extension and flexion was also observed in both groups. These results indicate that TKA for osteoarthritis is effective even in very old patients, as it is in younger patients.

In the present study, the period of hospital stay was much longer than previous study in Western country.[11] In Japan, postoperative physical therapy is usually continued until the patients’ ability of walking become steady. Thus, the result of the present study

accurately reflects the current status in Japan. The delayed postoperative rehabilitation schedule in old adult patients is due to their decreased physical strength and cognitive function, and postoperative confusion may prolong the period of hospital stay. However, in the present study, the number of postoperative days of hospital stay in the old adult patients was only 2 days longer than that of the younger group; a longer hospital stay was not required even among these patients ≥80 years old.

Although an improvement of knee function by TKA is expected, the risk of surgical complications is unavoidable,[12] and thus efforts to prevent complications from the preoperative period onward as much as possible are required. We observed that confusion, delayed wound healing, and acute heart failure were significantly frequent in

the older group; in particular, confusion occurred in >10% of the older-group patients. Conversely, the frequencies of pneumonia, cerebral infarction, peroneal nerve palsy, and bedsores were not significantly different between the older and younger groups. Although several precautions against confusion are advocated,[13,14] a standard precaution has not been established in practice. Usually, confusion is a transient condition that occurs based on dementia, and it rarely influences the final prognosis; nevertheless, preoperative detailed information obtained from the patients and their family members about confusion as well as optimal perioperative patient care is required.

Acute heart failure is a severe, life-threatening complication. Belmont et al. reported that the rates of postoperative cardiac complications in a primary TKA and total

hip arthroplasty series was 0.33%, and they noted that age ≥80 years, high blood pressure requiring medication, and past history of cardiac disease were the three most significant predictors.[15] A careful preoperative evaluation of the risk of heart failure is thus mandatory, especially in older patients.

Meehan et al. reported that short-term results (at 1 year) showed a 4.7-times higher risk of aseptic mechanical failure and a 1.8-times higher risk of PJI in younger patients (aged <50 years) compared with patients aged ≥65 years.[16] In the present study, though the postoperative follow-up period was not very long (1–6 years), loosening of the implant was not observed in the older group. We speculate that the older patients are not as active as the younger patients, resulting in decreased mechanical stress on their

implants. Although the difference was not significant, the number of patients who suffered a PJI was larger in our older patients compared to the younger patients. We suspect that reduced immune activity due to aging was the main cause of this result. In this study, we did not use multivariate analysis but univariate analysis. All the subject of this study were Japanese, and characteristics of Japanese patients indicate for TKA are shown in Table 2. The patients who received TKA tended to have heavier weight, higher BMI, and higher morbidity rate of lifestyle-related diseases such as DM at younger age, and vice versa at older age. We considered that comparing these age groups remaining their characteristics has clinical significant. In fact, multivariate analysis had not been used frequently in the previous research of this field. In addition, the task of this study

was to verify that there was no significant difference in TKA outcome between these age groups. Thus, the effect of multivariate analysis was thought to be limited if using the extraneous factors as covariate that were different between the groups.

The limitations of this study are as follows. Because this study was retrospective cohort study that using medical records, possible confounding factors were not controlled, evaluation items were not added, and evaluating the degree of life impairment and the amount of activity were impossible. Moreover, this study was also a retrospective study at a single institution, and all the surgical results were involved by one experienced surgeon. The postoperative follow-up period (minimum 1 year) was not very long, in particular, the follow-up period (Fig. 2) was significantly different between the younger

and older groups. However, since the therapeutic effects of TKA usually reaches the plateau within 12 months, this limitation was thought to be not influence the results concerning the JOA scores or ROM in the present study. The loosening of implants and the risk of PJI should be carefully observed over a longer period. Based on these results of this study, higher functional improvement, and lower complication rate by optimizing the surgical indication for TKA were considered to be the subjects for that should be clarified in the future study.

Conclusion

We evaluated the clinical outcomes of primary TKA for osteoarthritis in Japanese

patients aged ≥80 years and compared them with those of patients aged <75 years. The rate of improvement in the JOA score and the ROM values were not significantly different between the two groups, and the number of postoperative days of hospital stay in the older patients was only 2 days longer than that of the younger patients. Concerning postoperative complications, the frequencies of pneumonia, cerebral infarction, peroneal nerve palsy, and bedsores were not significantly different between the groups, but confusion, delayed wound healing, and acute heart failure were significantly more frequent in the older group. Although no patient in the older group suffered loosening of implants, PJIs tended to be frequent in the older group. Even in these patients aged ≥80 years, our results demonstrate that careful preoperative screening and peri-

/postoperative management will achieve safe and satisfactory outcomes of TKA in patients over 80 years old, similar to the outcomes of younger patients.

Author Contributions:

S Kodaira participated in the operation, carried out the data analysis, interpreted clinical data, and conceived and drafted the manuscript. TK performed or supervised all the operation, supervised the project, participated in the design of study, carried out the data analysis, interpreted clinical data, and conceived and drafted the manuscript. MH and S Konno supervised the project, and reviewed and corrected the manuscript. All authors read and approved the final manuscript.

Disclosure

All authors report no conflicts of interest in this work.

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Figure Legends and Table Captions

Fig. 1. The distribution by age of the patients who underwent a primary TKA for osteoarthritis at Bange Kosei General Hospital between January 2009 and June 2014 and were postoperatively followed-up for ≥1 year.

Fig. 2. The breakdown of postoperative follow-up period. The follow-up period in the younger group is significantly longer than the older group ($p < 0.05$).

Fig. 3. Pre- and postoperative Japanese Orthopaedic Association score (total score). Data are mean±SE.

Fig. 4. Pre- and postoperative Japanese Orthopaedic Association score (category I, pain on walking). Data are mean±SE.

Fig. 5. Pre- and postoperative Japanese Orthopaedic Association score (category II, pain on ascending or descending stairs). Data are mean±SE.

Fig. 6. Pre- and postoperative Japanese Orthopaedic Association score (category III, range of motion). Data are mean±SE.

Fig. 7. Pre- and postoperative Japanese Orthopaedic Association score (category IV, joint effusion). Data are mean±SE.

Fig. 8. Pre- and postoperative range of motion (ROM) values. Data are mean±SE.

Table 1. The Japanese Orthopaedic Association (JOA) score for osteoarthritic knees[9]

(Authors' translation)

I. Pain on walking (total 30 points)

Walking 1 km or more usually with no pain, but without regard to mild pain, rarely felt, with certain activity	30
Walking 1 km or more regardless of pain	25
Walking 500 m or more, but less than 1 km without regard to pain	20
Walking 100 m or more, but less than 500 m without regard to pain	15
Walking indoors or nearby, but less than 100 m without regard to pain	10
Inability to walk	5

Inability to stand	0

II. Pain on ascending or descending stairs (total 25 points)

No pain	25
Pain with handrails, but no pain with step-by-step ambulation	20
Pain relieved by using handrails	15
Pain with step-by-step ambulation: pain relieved by using handrails	10
Pain even with step-by-step ambulation and handrail use	5
Inability to ascend or descend because of pain	0

III. Range of motion (total 35 points)

Squatting	35
Sideways or cross-legged sitting	30
Flexion or arc of motion of 110° or more	25
Flexion or arc of motion of 75° or more	20
Flexion or arc of motion of 35° or more	10
Flexion or arc of motion less than 35° including ankylosis or severe flexion contracture	0

IV. Joint effusion (total 10 points)

No edema, no swelling	10

Occasional puncture required	5
Frequent puncture required	0

(Total 100 points)

Table 2. Patients' characteristics

Parameter		Older group (1,003 knees)	Younger group (1,044 knees)	p-value
Age, years*		82 (81 to 84)	71 (67 to 73)	<0.05
Gender**	Female	768 (77%)	849 (81%)	<0.05
	Male	235 (23%)	195 (19%)	
BW, kg*		54 (49 to 60)	62 (55 to 68)	<0.05
BMI, kg/m^2*		25.1 (22.8 to 27.3)	27.0 (24.5 to 29.5)	<0.05
Kellegren-Lawrence grade*		4 (3 to 4)	4 (3 to 4)	<0.05

Femorotibial angle, degree*		183 (180 to 188)	183 (179 to 186)	<0.05
Number of patients who received TKA bilaterally		324 (32%)	371 (36%)	<0.05
Type of TKA implant**	PS type	958 (96%)	962 (92%)	<0.05
	CR type	45 (4%)	82 (8%)	
High BP**	Yes	772 (77%)	709 (68%)	0.099
	No	231 (23%)	335 (32%)	
DM**	Yes	146 (15%)	186 (18%)	<0.05
	No	857 (85%)	858 (82%)	

Ischemic heart disease**	Yes	82 (8%)	52 (5%)	<0.05
	No	921 (92%)	992 (95%)	

*Values are median (interquartile range). **Number of knees (%). BMI: body mass index, BP: blood pressure, DM: diabetes mellitus.

Table 3. Postoperative complications

Postoperative complication	Older group (1,003 knees)	Younger group (1,044 knees)	p-value
Confusion	117 (11.7%)	17 (1.6%)	<0.05
Pneumonia	0 (0%)	1 (0.1%)	0.31
Delayed wound healing	11 (1.1%)	2 (0.2%)	<0.05
Cerebral infarction	5 (0.5%)	1 (0.1%)	0.09
Acute heart failure	5 (0.5%)	0 (0%)	<0.05
Peroneal nerve palsy	1 (0.1%)	1 (0.1%)	0.98
Bedsore	6 (0.6%)	5 (0.5%)	0.71

Number of knees (%).

Figure 1

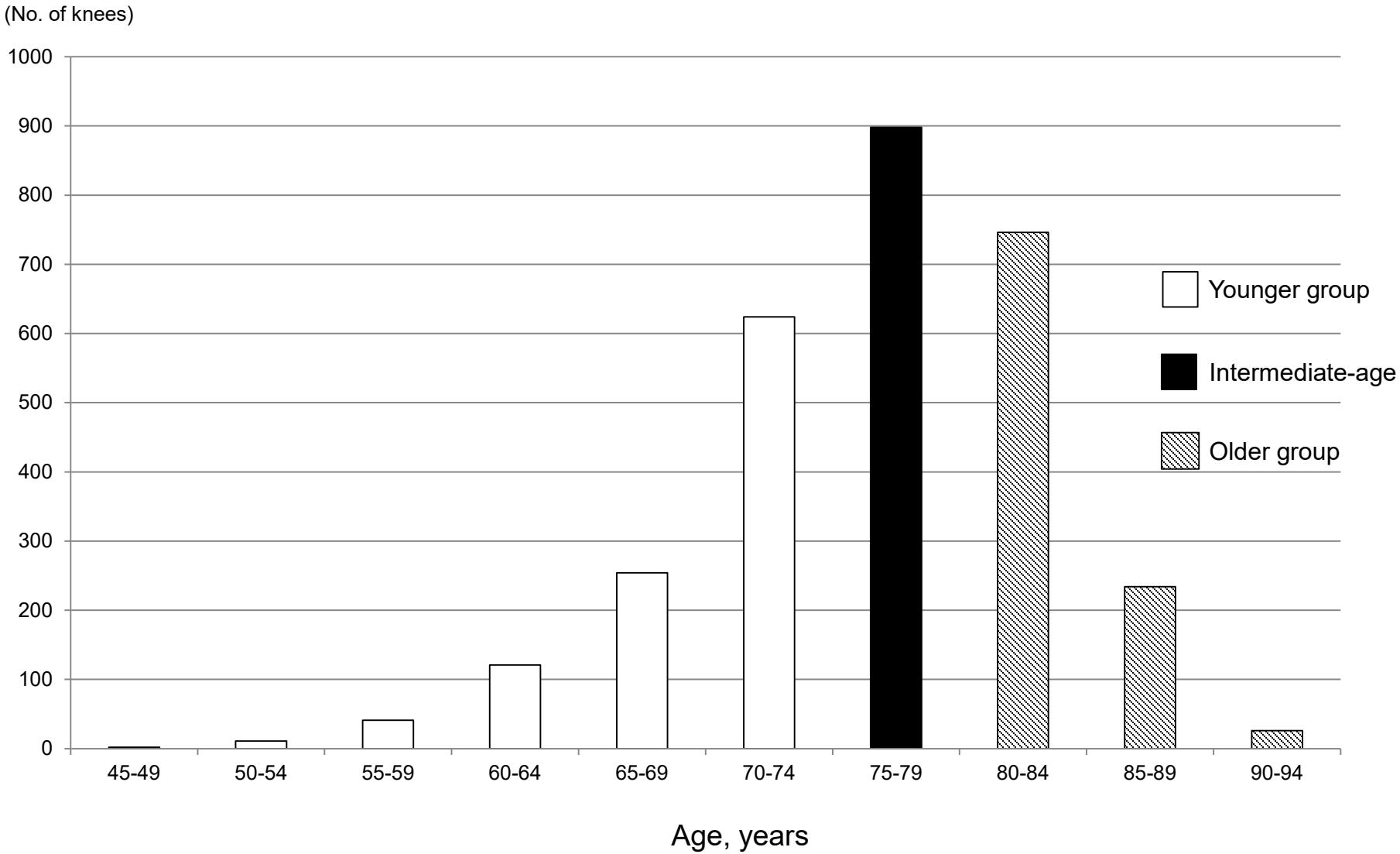

(No. of knees)
1000
900
800
700
600
500
400
300
200
100
0
45-49
50-54
55-59
60-64
65-69
70-74
75-79
80-84
85-89
90-94
Age, years
Younger group
Intermediate-age
Older group

Figure 2

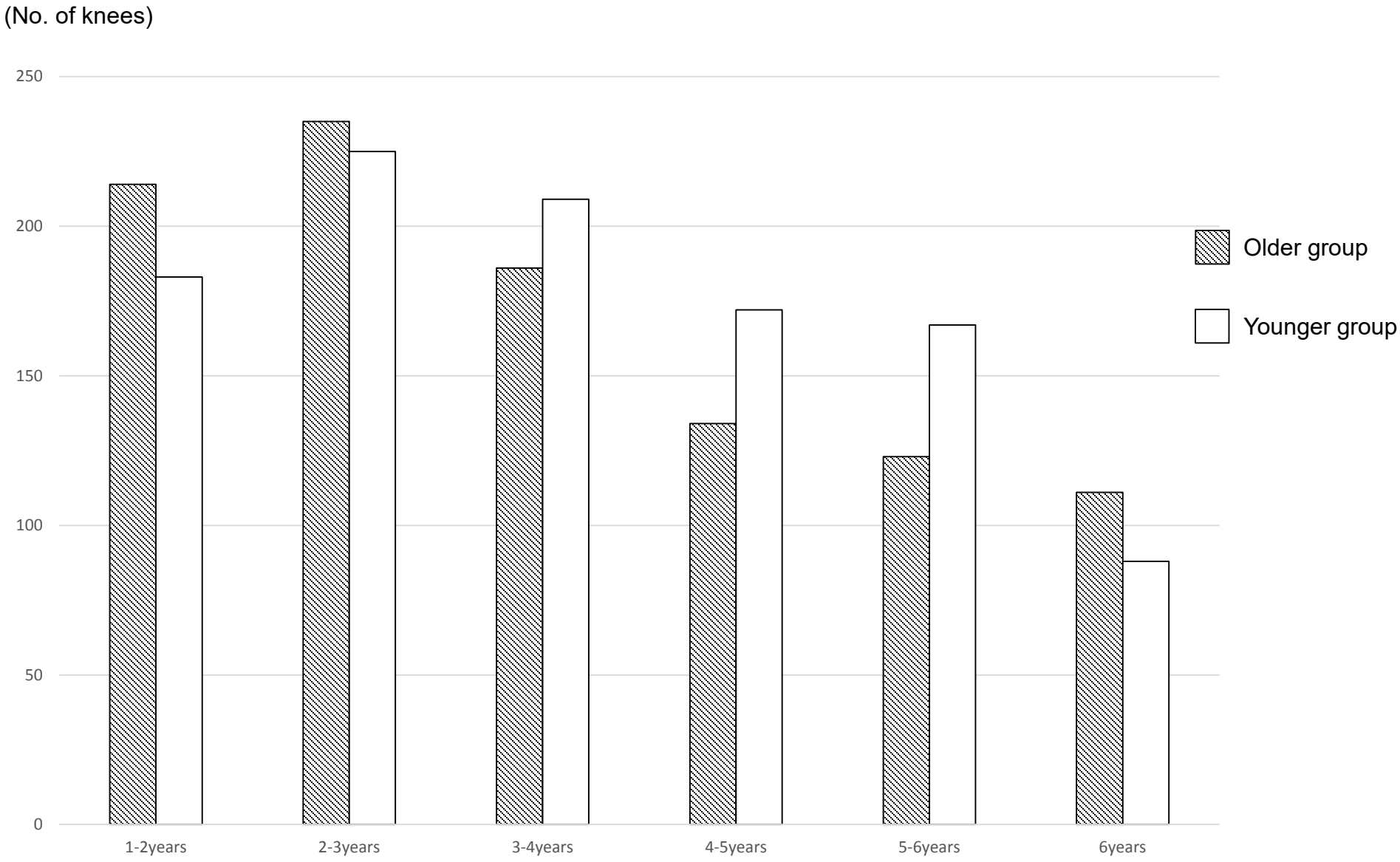

(No. of knees)
250
200
150
100
50
0
1-2years
2-3years
3-4years
4-5years
5-6years
6years
Older group
Younger group

Figure 3

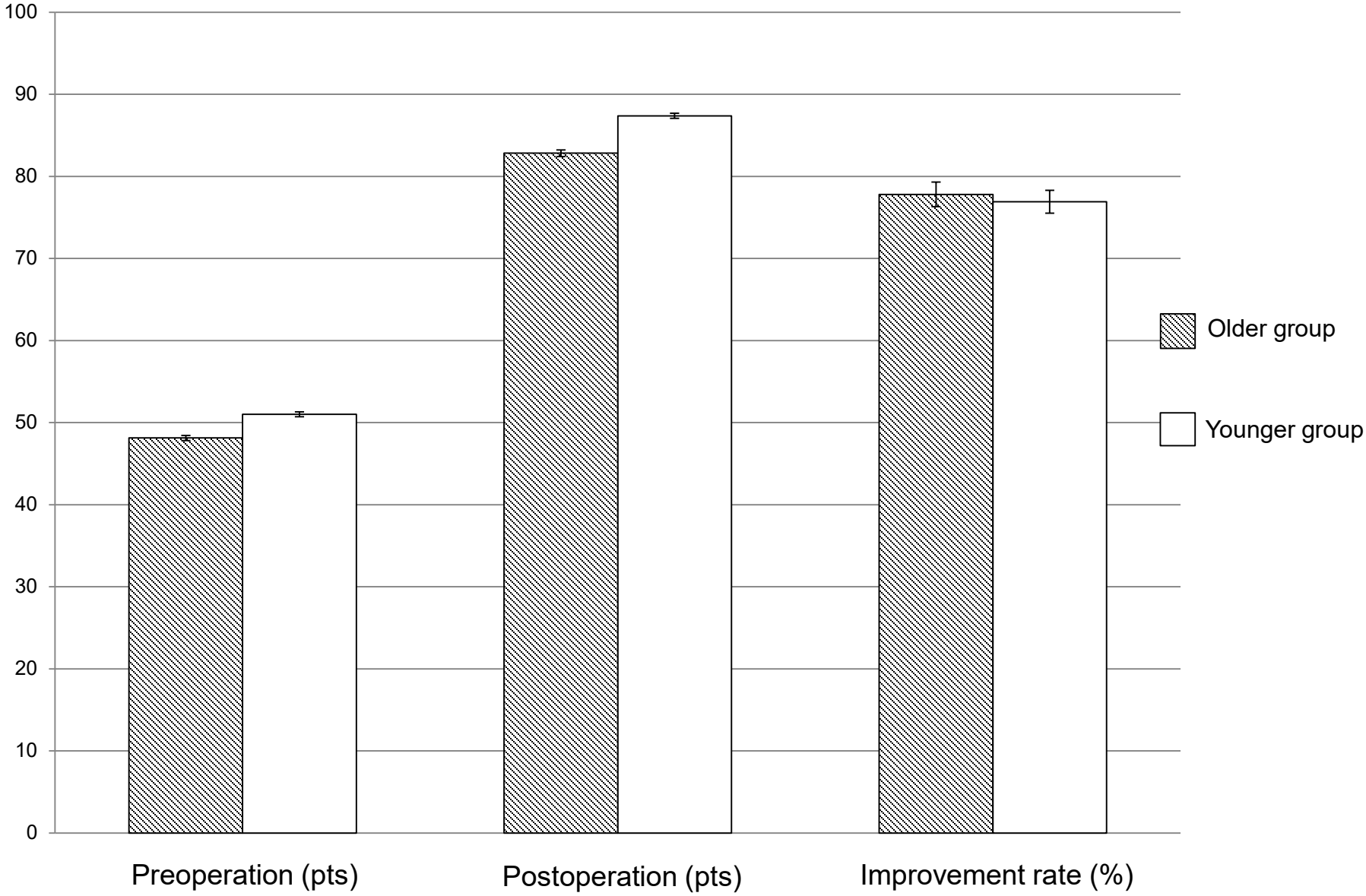

100
90
80
70
60
50
40
30
20
10
0
Preoperation (pts)
Postoperation (pts)
Improvement rate (%)
Older group
Younger group

Figure 4

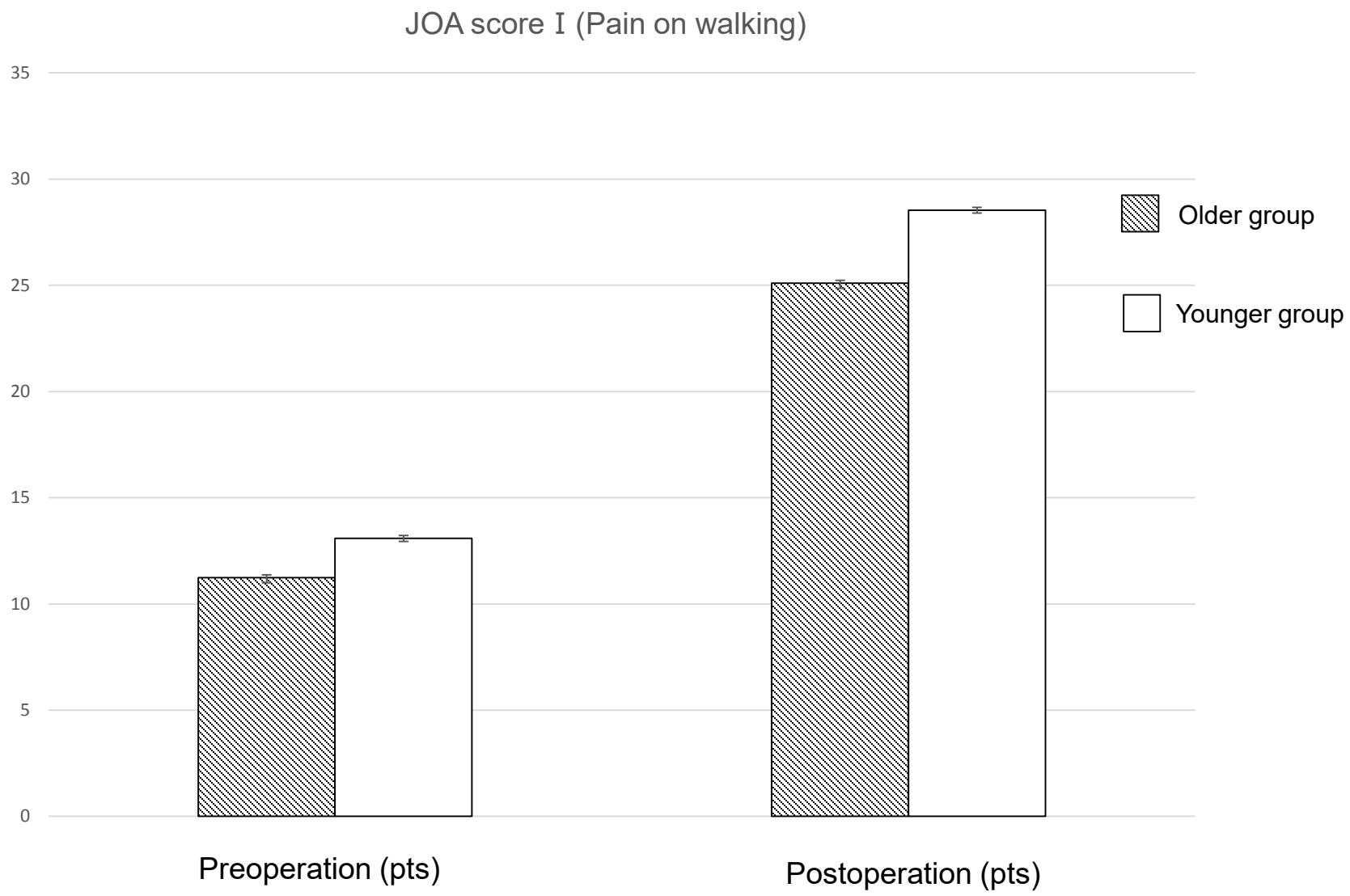

JOA score Ⅰ (Pain on walking)
35
30
25
20
15
10
5
0
Older group
Younger group
Preoperation (pts)
Postoperation (pts)

Figure 5

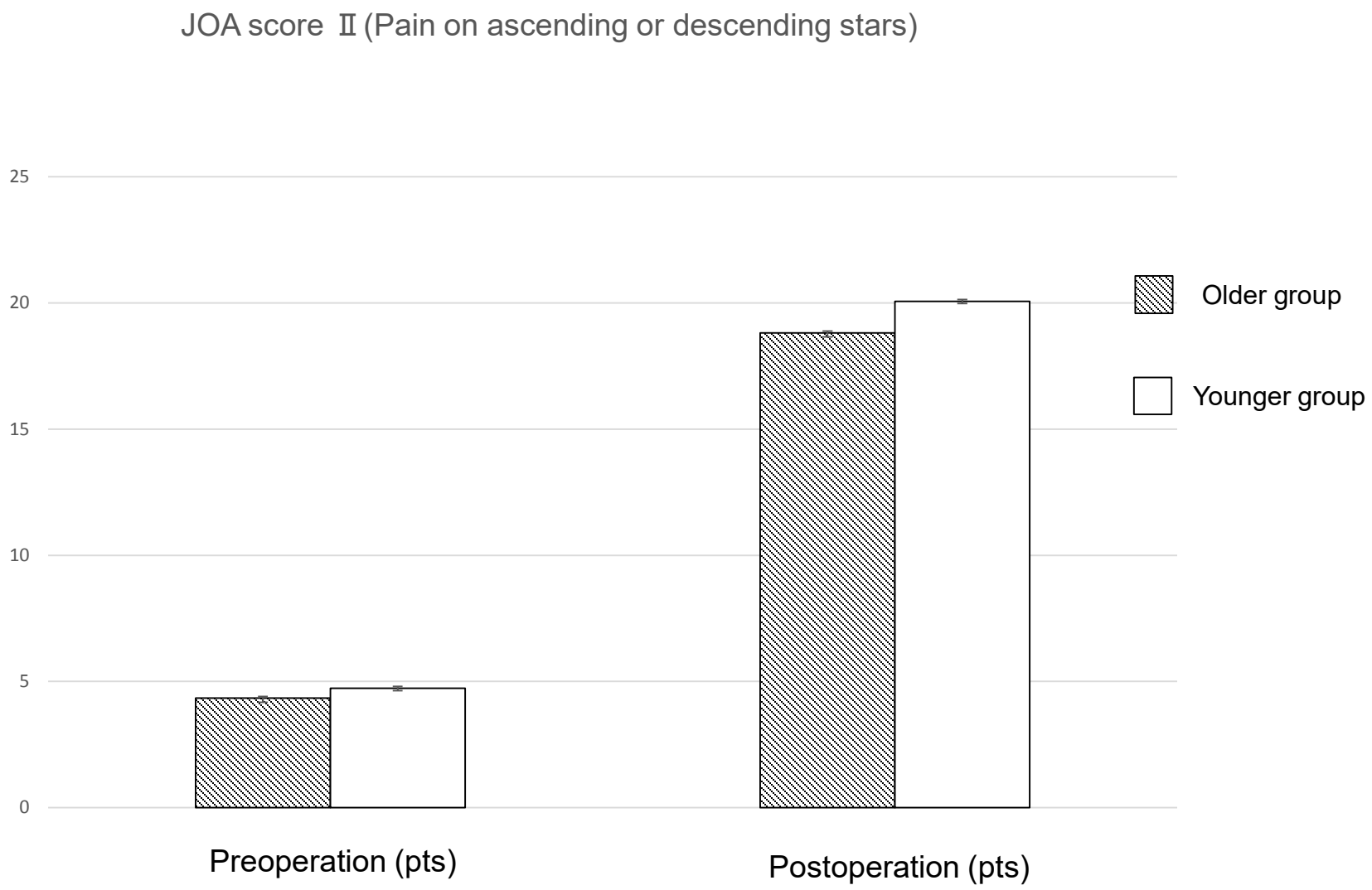

JOA score Ⅱ(Pain on ascending or descending stars)
25
20
15
10
5
0
Preoperation (pts)
Postoperation (pts)
Older group
Younger group

Figure 6

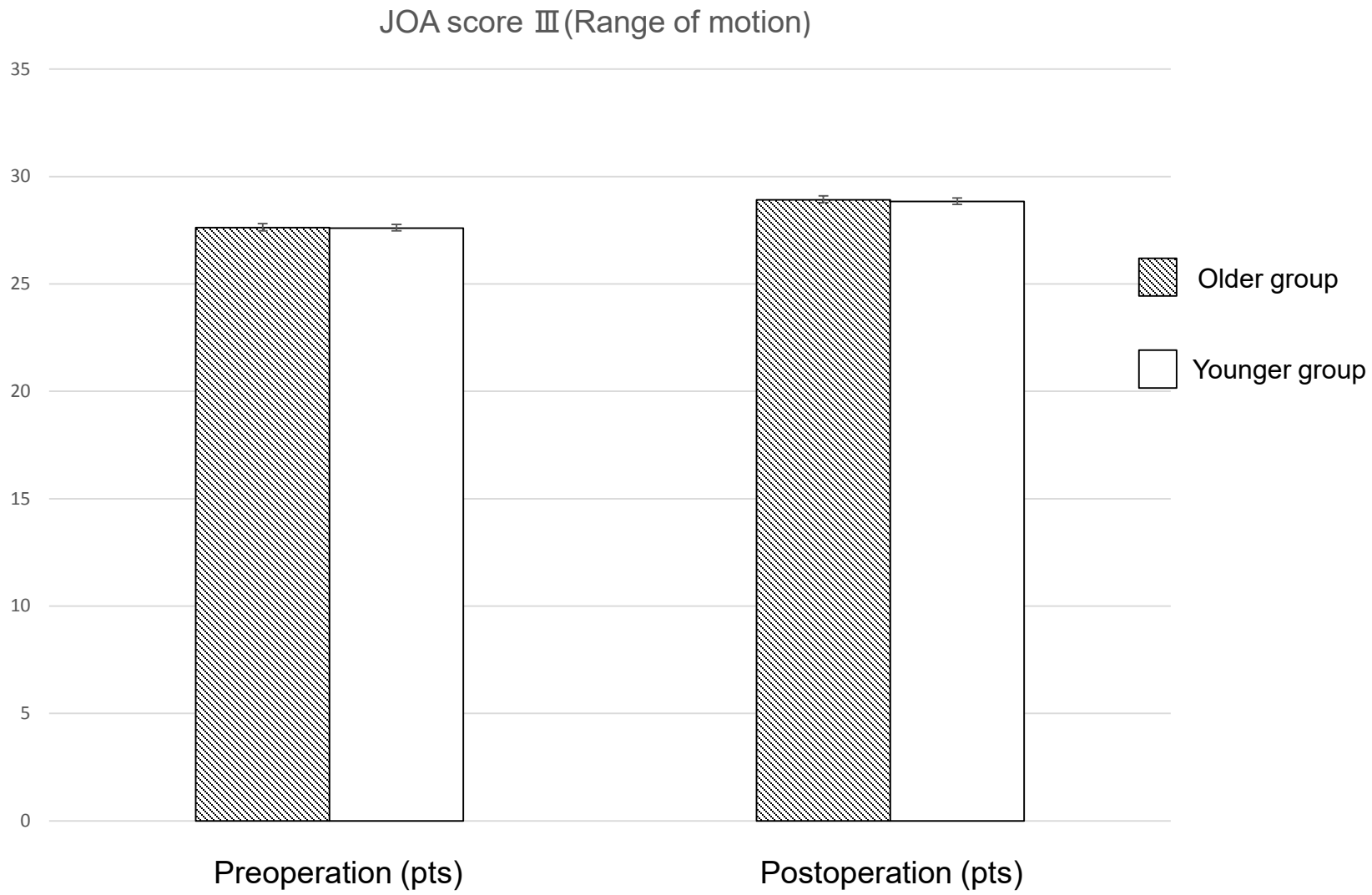

JOA score Ⅲ(Range of motion)
35
30
25
20
15
10
5
0
Preoperation (pts)
Postoperation (pts)
Older group
Younger group

Figure 7

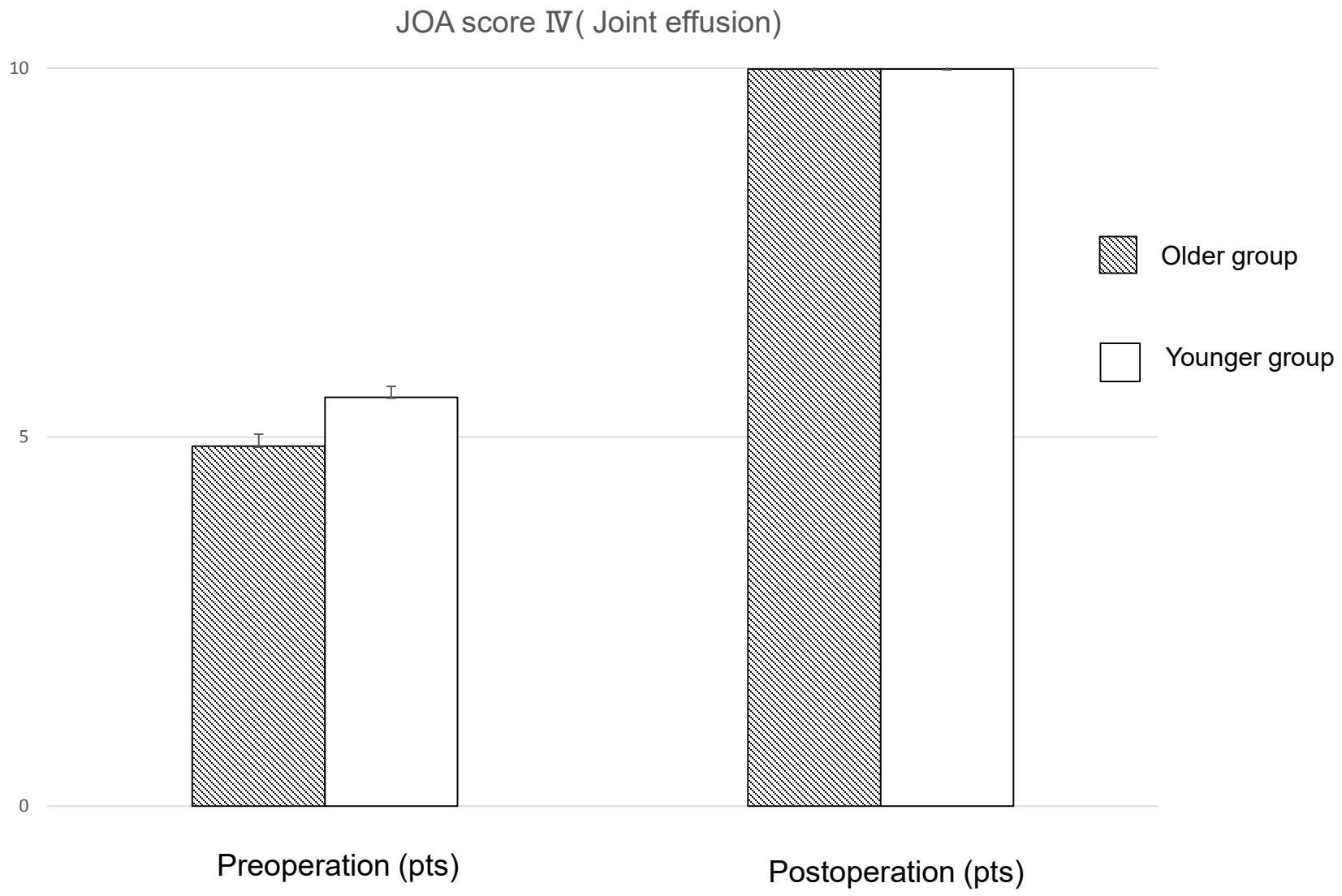
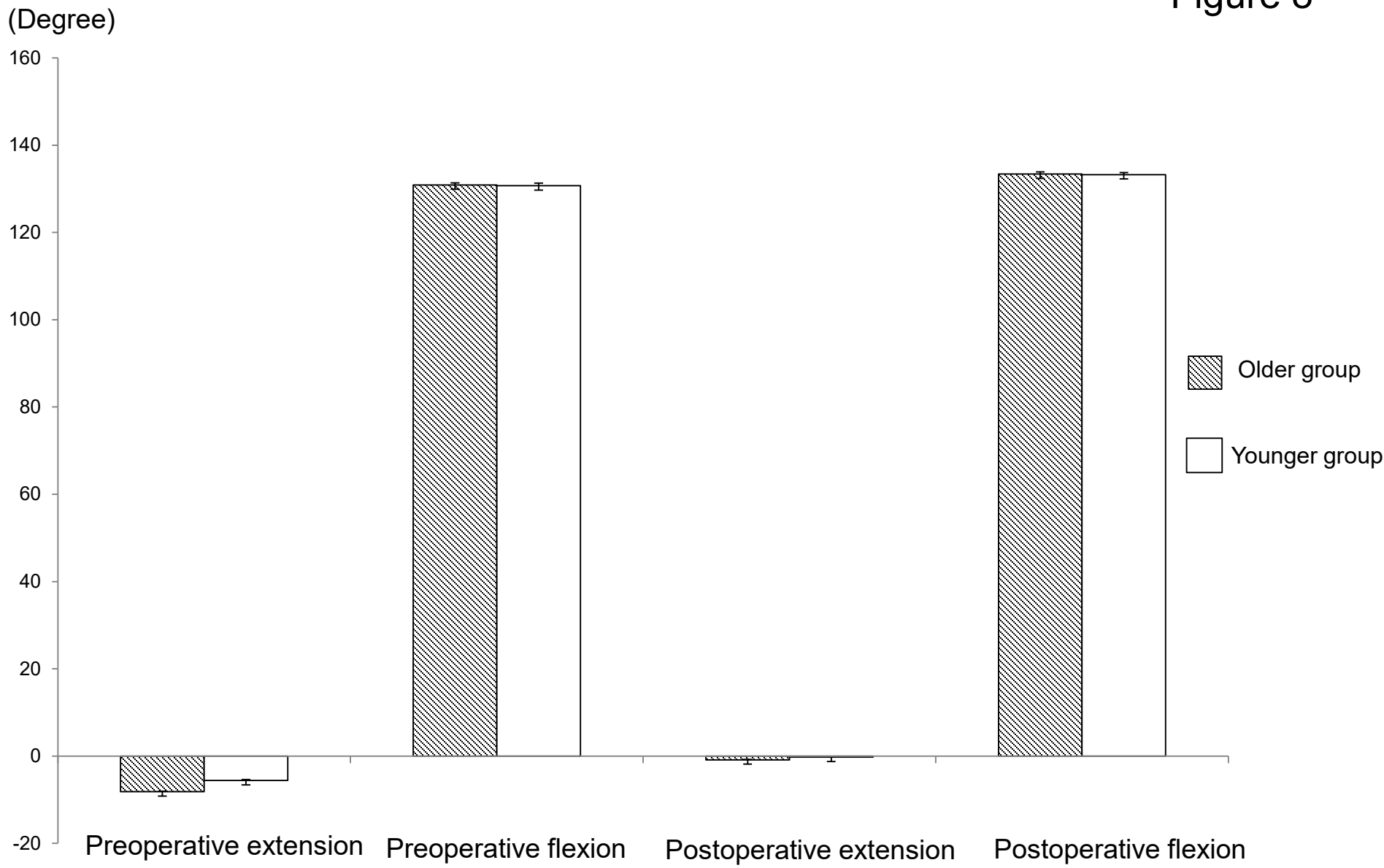

JOA score Ⅳ(Joint effusion)
10
5
0
Older group
Younger group
Preoperation (pts)
Postoperation (pts)

Figure 8


(Degree)
160
140
120
100
80
60
40
20
0
-20
Preoperative extension
Preoperative flexion
Postoperative extension
Postoperative flexion
Older group
Younger group