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Original Article

Patient-reported outcome measures after total knee arthroplasty using knee injury and osteoarthritis outcome score

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Abstract

Objectives: The purpose of this study was to evaluate outcomes after TKA using Knee injury and Osteoarthritis Outcome Score (KOOS). **Methods**: We retrospectively reviewed 60 knees. KOOS was conducted before surgery, 3 weeks, 3 months, 6 months, and 1 year after surgery. Each score was evaluated and compared using a multiple comparison test. Besides, we evaluated the correlation between KOOS and the patient's objective factors. **Results**: Regarding the total score, the value was improved at any point of post-operation ($p<0.001$). Especially, pain score and quality of life score were improved between 6 months and 1 year after surgery (pain score: $p=0.04$, quality of life score: $p=0.007$). The correlation between patient's factors and KOOS, concerning age, showed that there was a positive correlation with preoperative symptom/stiffness score ($p=0.004$) and the pain score ($p=0.04$). Also, the preoperative knee extension range was correlated with symptom/stiffness score and sports/recreation score at 3 weeks after surgery ($p=0.03$), and quality of life score at 6 months ($p=0.04$). The preoperative knee flexion range showed a significant correlation with the sports/recreation score at 1 year after surgery ($p=0.006$). **Conclusions**: In conclusion, it is necessary to follow the progress of 1 year or more even for cases with a seemingly poor outcome at 6 months after surgery.

Keywords: Knee injury and Osteoarthritis Outcome Score, Knee osteoarthritis, Patient reported outcome, Total joint replacement, Total knee arthroplasty

Introduction

The prevalence of osteoarthritis (OA) patients has continued to increase in recent years. It has been reported that more than 30% of individuals over 70 years of age have OA[1]. As the prevalence increases, the number of patients who are subject to Total Knee Arthroplasty (TKA) is expected to continue increasing[2]. TKA for severe OA is considered as a useful treatment, especially for elderly patients[3]. On the other hand, it has also been reported that there are a certain number of cases with low satisfaction after TKA[4], suggesting that up to 20% of patients are not satisfied[5]. In a systematic review evaluating the quality of life (QOL) after TKA, the pain and the function were the most important predictors[6].

We examined the results of TKA using patient-based assessment before and after TKA. Specifically, we obtained Knee injury and Osteoarthritis Outcome Score (KOOS)[7], a patient-based assessment, and assessed patient outcomes. The purpose of this study was to examine the transition of patient outcomes with TKA by patient-based assessment including pain and QOL. In this study, we investigated the successive changes in KOOS before and after TKA as the primary outcome, and as the secondary outcome, we examined the correlation between the objective assessments and KOOS.

The authors have no conflict of interest.

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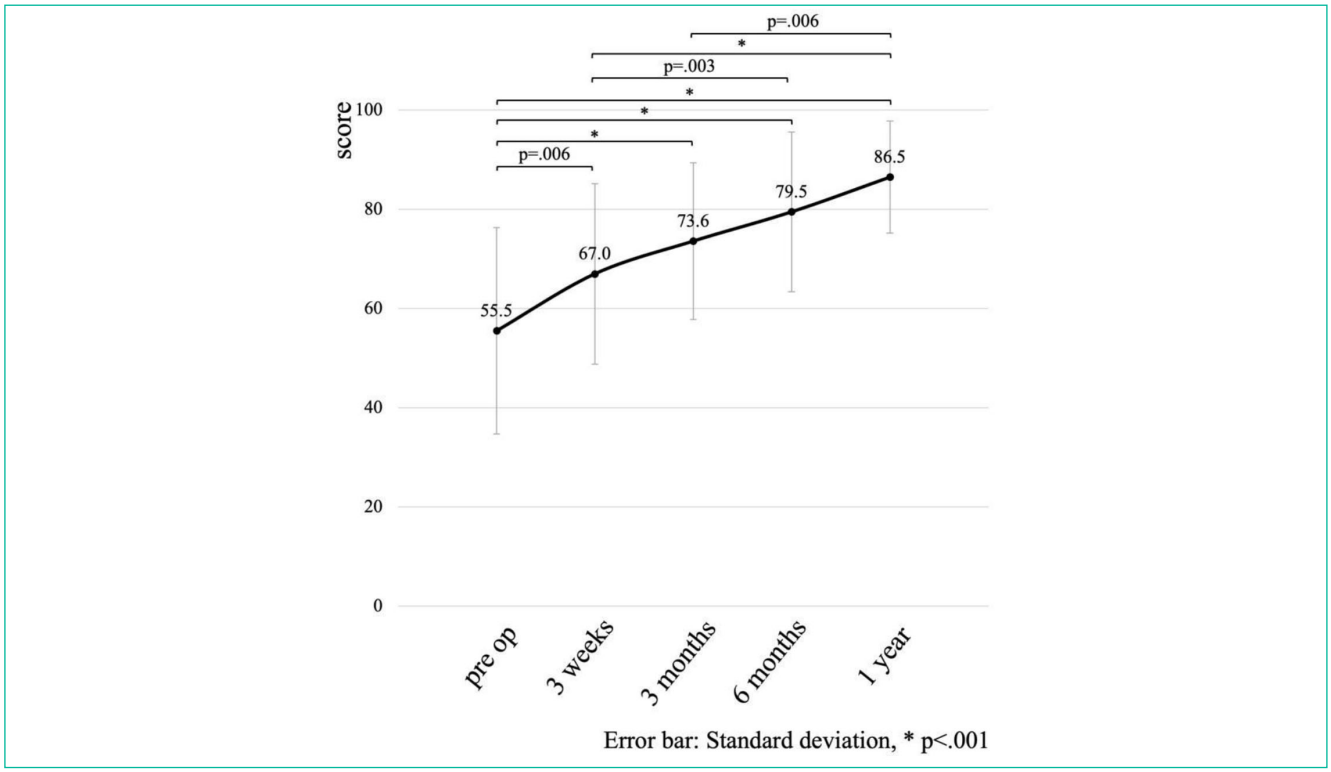

Figure 1. Changes in KOOS symptoms/stiffness score. Significantly improved after surgery compared to pre-operation (p<.001). Significant differences were recognized between 3 weeks and 6 months, 3 weeks and 1 year, 3 months and 1 year (p<.01).

Materials and Methods

This study was approved by the hospital ethics board and performed according to the ethical standards of the Declaration of Helsinki. We retrospectively reviewed 68 consecutive knees that underwent TKA for OA between February 2017 and May 2019. A total of 60 knees were eligible for this study, excluding 8 knees that had some insufficient statements of KOOS. The classification of OA in Kellgren-Lawrence (KL) grade[8] was one knee for grade 2, 40 knees for grade 3, and 19 knees for grade 4. The patients' mean age on the day of the surgery was 74±7.4 years old, the breakdown by gender was 15 knees: 15 males, 45 knees: 42 females, and the mean body mass index (BMI) was 26.1±3.7kg/m^2.

All TKA was performed with the same procedure by an experienced orthopedic surgeon. All cases were performed by the mid-vastus approach with the cementing technique. Postoperative rehabilitation was performed in the same way and the same period in all cases. From the day after surgery, full-weight-bearing walking training, range of motion (ROM) exercise, and quadriceps exercise were conducted for 2 hours a day. The patients were discharged after they acquired free-hand walking without some problems. The average hospitalization period was 26 days. After discharge, weekly visiting rehabilitation was continued up to 3 months after surgery.

As the primary outcome, KOOS was conducted on the day before surgery, 3 weeks, 3 months, 6 months, and 1 year after surgery. The total score, symptom/stiffness, pain, activities of daily living (ADL), sports/recreation, and QOL were scored, and successive changes in KOOS before and after surgery were compared. As the secondary outcome, a single surgeon assessed the age and BMI on the day of surgery, preoperative femorotibial angle (FTA) by the long-leg standing X-ray, and the knee flexion/extension angle before and after surgery. Then examined the correlation between those patient's factors and KOOS.

R version 3.02 was used for statistical analysis (R Foundation for Statistical Computing, Vienna, Austria), and a p-value <0.05 was used as the criterion for a significant difference. The one-way analysis of variance (ANOVA) test was used to verify significant differences in each score, and the Tukey test was used to perform multiple comparisons. Pearson's Correlation Coefficient was used to detect the correlation between the patient's objective factors and KOOS, to compare and verify with each preoperative and postoperative factor. The t-test was used to evaluate the differences in ROM before and after surgery.

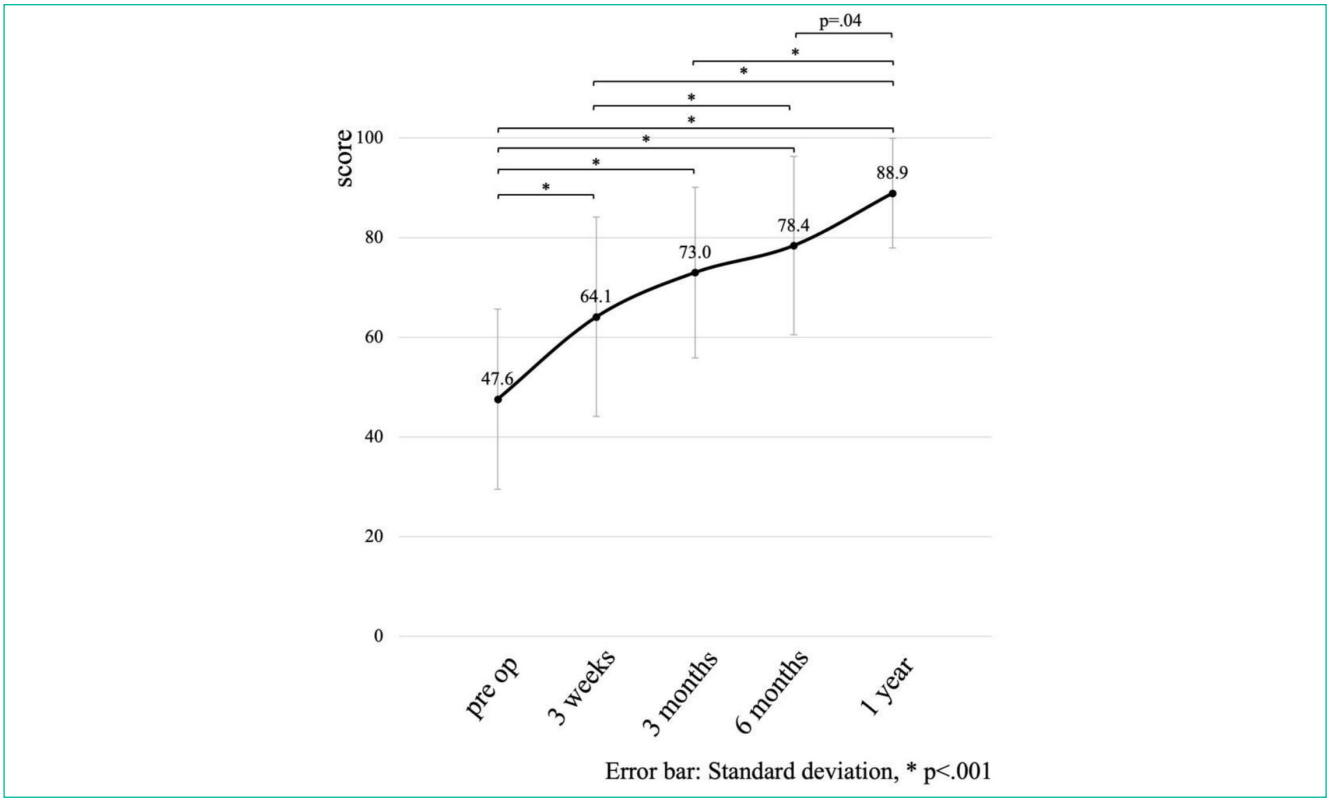

Figure 2. Changes in KOOS pain score. Compared to pre-operation, the numerical value significantly improved after surgery (p<.001). Significant differences were recognized between 3 weeks and 6 months, 3 weeks and 1 year, 3 months and 1 year (p<.001). Furthermore, the pain score improved between 6 months and 1 year (p=.04).

Results

All patients acquired stable gait, and there were no cases of long-term hospitalization for more than one month. Also, there were not any re-operation cases due to infection, trauma, loosening, or other reasons. The average preoperative FTA was 183.0±5.8 degrees. The preoperative knee flexion angle was 101.3±12.9 degrees, which was 117.0±10.6 degrees at 1 year after surgery (p<.001). Similarly, the preoperative knee extension angle was -9.7±7.1 degrees, which -2.6±4.4 degrees at 1 year after surgery (p<.001).

Figure 1-6 showed changes in KOOS before surgery, 3 weeks, 3 months, 6 months, and 1 year after surgery. Compared to pre-operation, the values of each score tended to improve in time series. The one-way ANOVA test resulted showed a significant difference in all items. In the multiple comparison tests by the Tukey test, the results were different for each item when comparing the values at each period. In the symptom/stiffness and the pain section of Figures 1 and 2, compared to pre-operation, it was shown that the numerical values were significantly improved at any point in time after surgery (p<.001). Significant differences were recognized between 3 weeks and 6 months, 3 weeks and 1 year, and 3 months and 1 year in the comparisons at each postoperative time point (p<.01). There were no significant differences in a short period between 3 weeks and 3 months, and 3 months and 6 months. Concerning the pain score, the score was significantly improved between 6 months and 1 year (p=.04). Regarding the ADL score, it serially improved after surgery (p<.001). In comparison to each time point after surgery, significant differences were recognized only between 3 weeks and 1 year (p<.001) and 3 months and 1 year (p=.02) (Figure 3). Regarding the sports/recreation score, significant differences were not recognized between pre-operation and 3 weeks. The scores were significantly improved at 3 months, 6 months, and 1 year after surgery in comparison with pre-operation (p<.001) (Figure 4). Apart from that, improvements were shown between 3 weeks and 6 months (p=.02), 3 weeks and 1 year (p<.001). As for the QOL score, compared to pre-operation, it was serially improved time after surgery (p<.01) (Figure 5). There was significant improvement between 3 weeks and 6 months (p=.02), 3 weeks and 1 year, and 3 months and 1 year

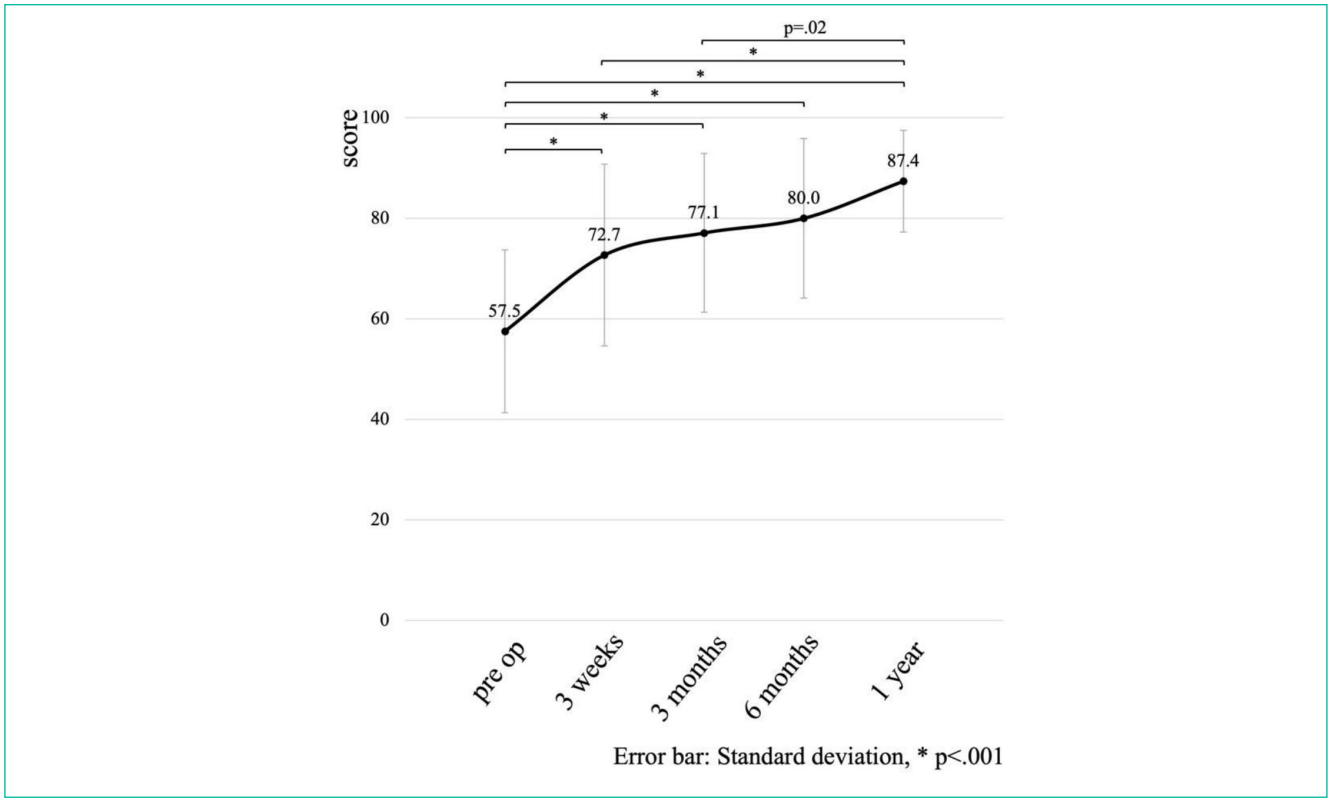

Figure 3. Changes in KOOS ADL score. Compared to pre-operation, the numerical value significantly improved after surgery (p<.001). Significant differences were recognized between 3 weeks and 1 year (p<.001), and 3 months and 1 year (p=.02).

(p<.001). Especially, the QOL score showed a significant difference between 6 months and 1 year (p=.007). Regarding the total score, the value improved at any point of post-operation (p<.001) (Figure 6). There were significant differences between 3 weeks and 6 months (p=.004), 3 weeks and 1 year, and 3 months and 1 year (p<.001).

Next, regarding the results of the correlation between patient factors and KOOS at each postoperative period. We examined KOOS item-wise, in the correlations with age, BMI, preoperative FTA, and preoperative and postoperative knee flexion/extension angle. Concerning age, there was a positive correlation with preoperative KOOS symptom/stiffness score (p=.004), and similarly with pain score (p=.04). The other items showed some correlations with a preoperative extension range of motion. The better the preoperative extension range of motion, the significantly higher the symptom/stiffness score and the sports/recreation score at 3 weeks after surgery (p=.03). Similarly, there was also shown an increase of the QOL score at 6 months (p=.04). Apart from that, preoperative knee flexion showed a significant correlation with sports/recreation score at 1 year after surgery (p=.006). There was no correlation between the postoperative knee flexion/extension angle at 1 year after surgery and KOOS. Besides, preoperative FTA showed a positive correlation with the symptom/stiffness score at 3 weeks (p=.05).

Discussion

TKA is well-established surgery, and excellent results have been reported for both the short-term and long-term. In this study as well, compared before surgery, the numerical value of the total score of KOOS improved at any point of time after surgery. Also, KOOS at 1 year after surgery was a significant improvement compared to the scores at 3 weeks after surgery for all items. It was reported that the patients-based assessment results after TKA, using Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)[9], visual analog scale (VAS) for pain, and Short Form (SF)-36[10], compared to pre-operation, all results have been improved at 6 months after surgery[11]. Furthermore, in the short-term results, Kilic et al[12] evaluated post-TKA outcomes using SF-36 and the Knee Society Clinical Rating System (KSCRS), the results were improved by 6 weeks after surgery. Also, according to our results, the score of KOOS was significantly improved by 3 weeks after surgery compared to the

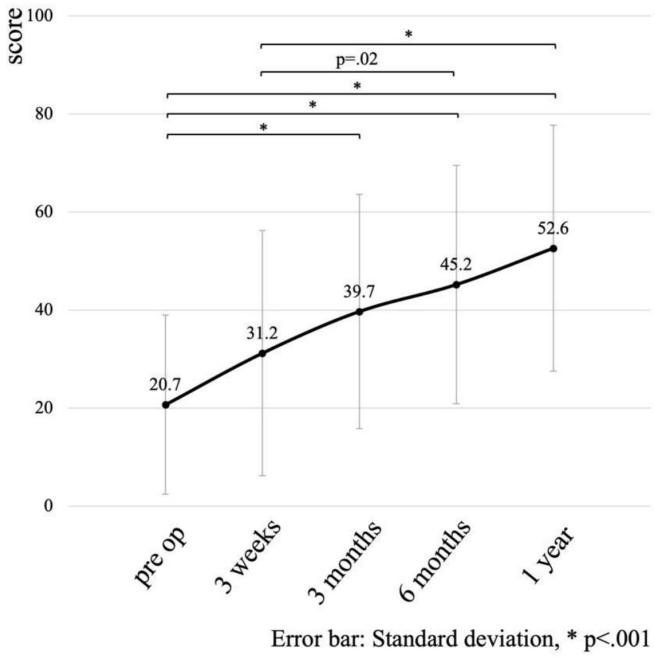

Figure 4. Changes in KOOS sports/recreation score. Compared to pre-operation, the numerical value significantly improved after surgery (3 weeks, 6 months and 1 year) (p<.001). Significant differences were recognized between 3 weeks and 6 months (p=.02), and 3 weeks and 1 year (p<.001).

preoperative score. On the other hand, KOOS pain and QOL scores were significantly improved between 6 months and 1 year. Regarding the ADL score, the numerical value improved significantly between 3 weeks and 1 year. In other words, as can be seen from Figure 3, the ADL score was the sharp increase by 3 weeks after surgery, and only a moderate improvement is recognized until 6 months thereafter, and further improvement is recognized by 1 year after surgery. When assessing individual outcomes, we would like to emphasize that 1 year is necessary to assess the progress of the patient's outcomes. Canfield et al[13] recently reported patient satisfaction after total joint replacement surgery. They prospectively assessed 866 total cases and evaluated the satisfaction using several patient-based assessments such as WOMAC, SF-12, KSCRS, the Oxford Hip Score (OHS), and UCLA activity level rating. The scores after TKA were significantly improved at 6 months after surgery. There was a slight improvement at 6-12 months and no improvement at 12-24 months. Besides, another report suggested that the patient-based assessment after total joint replacement surgery is not useful for assessing patient satisfaction[14]. Specifically, they assessed the correlation between patient-based assessment and patient satisfaction. As a result, only a weak or moderate correlation was recognized. WOMAC pain score and KSCRS pain score were highly correlated with satisfaction among their results (p<.001). They concluded that the patient-based assessment is not sufficient to assess patient satisfaction after total joint replacement surgery and that a pain-focus assessment using a more concise assessment is needed. If pain is highly correlated with patient satisfaction, the pain can be conceived as one of the causes of dissatisfaction after TKA. When focusing on the pain, the point of difference between previous studies and our study is that 6 months is not enough to assess that. According to our results, the pain score was significantly improved between 3 weeks and 6 months, but there was not significant between 3 months and 6 months. The score changed only 4.6 points from 3 months to 6 months. On the other hand, the score was improved by 14.3 points from 3 weeks to 6 months, and 10.5 points from 6 months to 1 year. When referred to the pain score, our results show significant changes between 6 months and 1 year, which is not a moderate improvement. The pain score was 80 points or less up to 6 months while it showed an almost good value of 88.9 points in 1 year after surgery. Furthermore, we would like to emphasize KOOS QOL score showed significant improvement from 6 months to 1 year. Particularly for the QOL score, the preoperative mean value was 32.1 points, which was significantly improved to 45.5 points at 3 weeks after surgery, but it was less than 50 points. After that, it moderately improved to 57.8 points by 6 months, and there was a significant difference between 3 weeks and 6 months, but the score was still less than 60

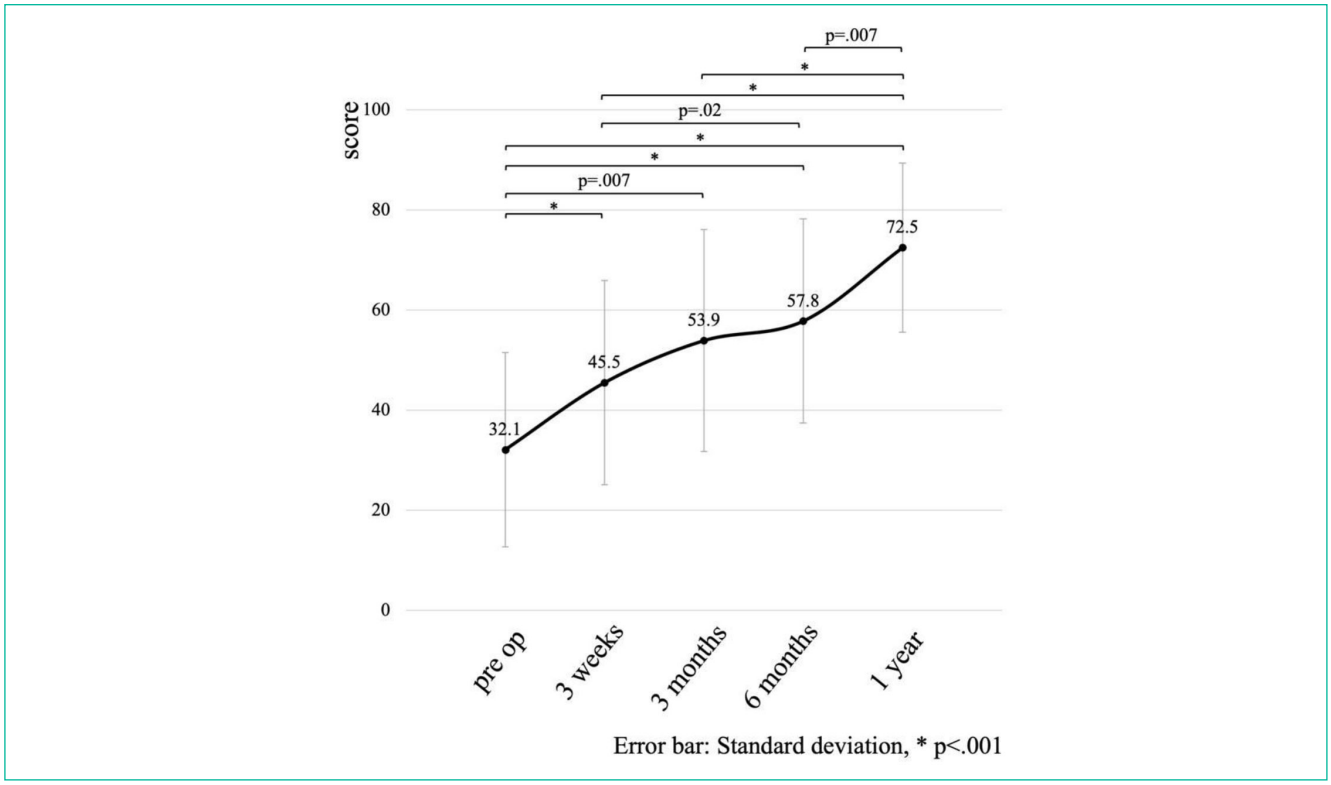

Figure 5. Changes in KOOS QOL score. Compared to pre-operation, the numerical value significantly improved after surgery (p<.01). Significant differences were recognized between 3 weeks and 6 months (p=.02), 3 weeks and 1 year, 3 months and 1 year (p<.001). As with the pain score, there was a significant improvement between 6 months and 1 year (p=.007).

points, and only 12.3 points improved from 3 weeks to 6 months. The value was improved to 72.5 points at 1 year after surgery, improving 14.7 points from 6 months to 1 year. Although it does not reach 80 points, this result shows that it needs 1 year to improve QOL to 70 points or more.

Sasaki et al. reported comparing KOOS and the other conventional objective assessments. They concluded that patient-based assessments such as KOOS can capture slight changes in the pain and the QOL. Also, they referred to KOOS pain score consist of 9 questions with 5 options, which is useful for detailed pain assessment[15]. WOMAC is used as a patient-based assessment in many studies, that consists of symptom/stiffness, pain, function/daily living, and the pain scale includes 10 questions with 5 options. The QOL score and sports/recreation score are one of the characteristics of KOOS. The sports/recreation score consists of characteristic questions such as squatting, running, jumping, twisting/pivoting, and kneeling. KOOS is used not only in the assessment after TKA but also in the assessment for younger people such as assessment after reconstruction of the anterior cruciate ligament[16]. Based on our results, the sports/recreation score was improved after surgery, even in the average 74 years-old groups. Although it was still low with 52.6 points at 1 year after the surgery, it improved more than twice as better as the pre-operative scores, and sufficient improvement can be expected regardless of the patient's age. KOOS consists of detailed questions such as the ADL and the pain and simple and short questions such as the sports/recreation and the QOL. Regarding the QOL, it consists of only 4 questions, it possibly useful to reflect the patient's satisfaction.

Next, regarding the correlation between KOOS and several patient factors, as a result, correlations in some items were found sporadically. The older age scores that the symptom/stiffness score and the pain score at the preoperative time showed better results. However, this result might be the effect of being selection biased that the TKA for the younger generation is only performed for patients with strong symptoms or unbearable physical pain. Another thing that can be predicted from the results is how the flexion/extension motions affect the outcomes of TKA. Concerning the extension, there is a correlation with the early postoperative symptom/stiffness score and the sports/recreation score. Therefore, there is a considerable possibility that the extension contractures affect the early postoperative period. On the other hand, the flexion angle showed a clear

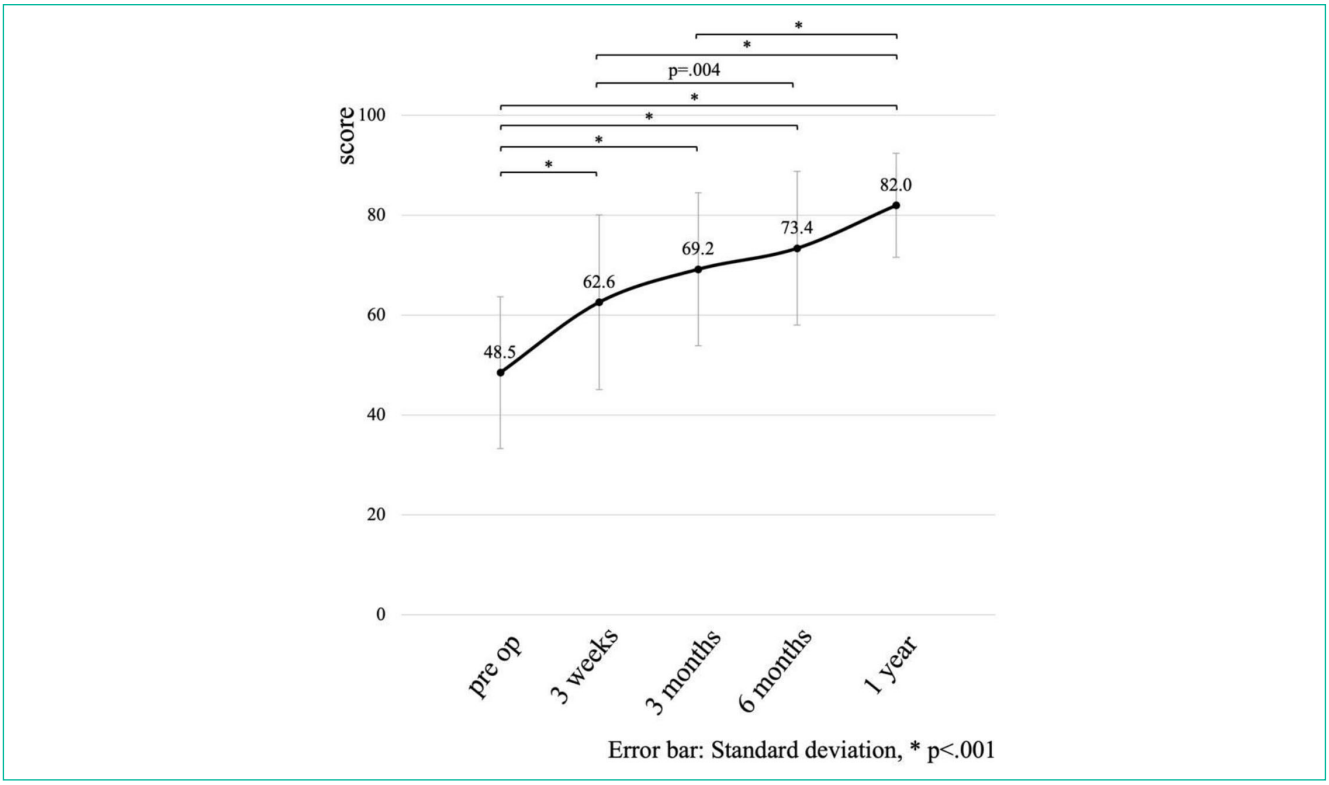

Figure 6. Changes in KOOS total score. Compared to pre-operation, the numerical value significantly improved after surgery (p<.001). Significant differences were recognized between 3 weeks and 6 months (p=.004), 3 weeks and 1 year, 3 months and 1 year (p<.001).

positive correlation with the sports/recreation score 1 year after surgery. As we mentioned, that the sports/recreation score of KOOS should be assessed without exception even if the elderly patients. All of the squatting, running, jumping, twisting/pivoting, and kneeling are involved in the flexion motion of the knee. In another study assessed the correlation between WOMAC and objective quantitative measurements of walking activities. The correlations were recognized with only WOMAC function, stiffness, and pain score. Therefore, the objective assessment was insufficient to predict abnormalities in WOMAC because that is affected by other factors[17]. Whereas, Park et al[18] investigating 333 knees about the correlation between the maximum flexion angle in 1 year after TKA and the American Knee Society score, WOMAC, and SF-36. The social function score of SF-36 showed a significant correlation with the postoperative maximum flexion angle. According to their results, the WOMAC functional score was excellent, especially in the case of a good flexion angle of 135 degrees. Furthermore, pain, function, and QOL show a weak correlation with the maximum flexion angle. They suggested that it is necessary to sufficiently improve the maximum flexion angle after TKA. Although it is not possible to simply compare, similarly, there was a high correlation between the flexion angle in 1 year after surgery, which might help predict the sports/recreation score of KOOS.

There are some limitations to our study. This study is retrospective, the number of cases is relatively small, and there is no control group. Besides, we are performing patient-based assessments using KOOS, and do not use WOMAC or SF-36 as in previous reports. Therefore, it should be mentioned that this study is not enough to show the usefulness of KOOS. Also, KOOS does not have a score on patient satisfaction. In the future study, to show the usefulness of KOOS, studies with an increased number of cases will be necessary, and consideration and comparison with other patient-based assessments will also be considered. Furthermore, patient satisfaction must be measured independently.

Conclusions

The patient outcomes after TKA were evaluated using KOOS. Notably, the pain and QOL scores were significantly improved 6 months to 1 year after surgery. In correlation to the objective assessments, especially there was a significant correlation between flexion angle and sports/recreation score 1 year after surgery. Even in elderly people,

improvement in sports/recreation was recognized 1 year after surgery, suggesting that KOOS is useful regardless of age. It is necessary to follow the progress of 1 year or more even for cases with poor outcome at 6 months.

References

1. Kopec JA, Rahman MM, Berthelot JM, et al. Descriptive epidemiology of osteoarthritis in British Columbia, Canada. J Rheumatol 2007; 34(2):386-393.
2. Deshpande BR, Katz JN, Solomon DH, et al. Number of Persons With Symptomatic Knee Osteoarthritis in the US: Impact of Race and Ethnicity, Age, Sex, and Obesity. Arthritis Care Res (Hoboken) 2016;68(12):1743-1750.
3. Kurtz S, Ong K, Lau E, Mowat F, Halpern M. Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. J Bone Joint Surg Am 2007;89(4):780-785.
4. Anderson JG, Wixson RL, Tsai D, Stulberg SD, Chang RW. Functional outcome and patient satisfaction in total knee patients over the age of 75. J Arthroplasty 1996;11(7):831-840.
5. Scott CEH, Howie CR, MacDonald D, Biant LC. Predicting dissatisfaction following total knee replacement: A prospective study of 1217 patients. J Bone Joint Surg Br 2010;92(9):1253-1258.
6. Silva RR, Santos AAM, Sampaio Carvalho Júnior J, Matos MA. Quality of life after total knee arthroplasty: systematic review. Rev Bras Ortop 2014;49(5):520-527.
7. Roos EM, Lohmander LS. The Knee injury and Osteoarthritis Outcome Score (KOOS): From joint injury to osteoarthritis. Health and Quality of Life Outcomes 2003;1:64
8. Kellgren JH, Lawrence JS. Radiological Assessment of Osteo-Arthrosis. Ann Rheum Dis 1957;16(4):494-502.
9. Bellamy N, Buchanan WW, Goldsmith CH, Campbell J, Stitt LW. Validation study of WOMAC: A health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patients with osteoarthritis of the hip or knee. J Rheumatol 1988;15(12):1833-1840.
10. Ware JE. Scales for measuring general health perceptions. Health Serv Res 1976;11(4):396-415.
11. Shah AMUD, Afzal F, Ans M, et al. Quality of life before and after total knee arthroplasty in clinical settings across Lahore, Pakistan. Pak J Pharm Sci 2019;32 Supple:769-772.
12. Kilic E, Sinici E, Tunay V, Hasta D, Tunay S, Başbozkurt M. Evaluation of quality of life of female patients after bilateral total knee arthroplasty. Acta Orthop Traumatol Turc 2009;43(3):248-253.
13. Canfield M, Savoy L, Cote MP, Halawi MJ. Patient-reported outcome measures in total joint arthroplasty: defining the optimal collection window. Arthroplast Today 2019;6(1):62-67.
14. Halawi MJ, Jongbloed W, Baron S, Savoy L, Cote MP, Lieberman JR. Patient-Reported Outcome Measures are not a Valid Proxy for Patient Satisfaction in Total Joint Arthroplasty. J Arthroplasty 2020;35(2):335-339.
15. Sasaki E, Tsuda E, Yamamoto Y, Meada S, Otsuka H, Ishibashi Y. Relationship between patient-based outcome score and conventional objective outcome scales in post-operative total knee arthroplasty patients. Int Orthop 2014;38(29:373-378.
16. Meynard P, Pelet H, Angelliaume A, et al. ACL reconstruction with lateral extra-articular tenodesis using a continuous graft: 10-year outcomes of 50 cases. Orthop Traumatol Surg Res 2020;106(5):929-935.
17. Witvrouw E, Victor J, Bellemans J, et al. A correlation study of objective functionality and WOMAC in total knee arthroplasty. Knee Surg Sports Traumatol Arthrosc 2002;10(6):347-351.
18. Park KK, Chang CB, Kang YG, Seong SC, Kim TK. Correlation of maximum flexion with clinical outcome after total knee replacement in Asian patients. J Bone Joint Surg Br 2007;89(5):604-608