Hirosaki Med. J. 73 : 40—47, 2023

ORIGINAL ARTICLE

Factors Affecting Kneeling after Total Knee Arthroplasty

Yusuke Koike[1, 2)], Eiki Tsushima[2)], Kazuhiro Ishida[1)], Kazufumi Miyagishima[1)], Masaaki Komatsu[1, 2)], Shoichi Kimura[3)], Noriaki Mori[3)], Yusuke Nishio[3)], and Daisuke Tanaka[3)]

Abstract

The objective of this study was to elucidate the factors affecting kneeling following total knee arthroplasty (TKA). A survey questionnaire was mailed to 324 patients who underwent TKA regarding 1) the necessity of kneeling in daily life; 2) achievement of kneeling; 3) time until kneeling was achieved; and 4) the reasons for the inability in cases where kneeling could not be achieved. Of the 227 responders, 186 responded "I need to kneel" and were enrolled as study participants. Knee range of motion was also measured as an assessment of physical function. Comparison between groups (able vs. not able to kneel) was analyzed using the Mann-Whitney U test. For the reasons for the inability in cases where kneeling could not be achieved, the percentage of each response was calculated. For variables with significant differences, Receiver Operating Characteristic (ROC) curves were calculated and cutoff values were calculated. The rate of kneeling achievement was 34.9%, and the mean duration from surgery to achievement of kneeling was 5.1 months. The item that showed a significant difference was knee range of motion (flexion on the operative side). Pain and fear were the most common reasons for the inability in cases where kneeling could not be achieved. The optimal cut-off value for knee flexion was 122.6° (area under the ROC curve: 0.67, 95% confidence interval 0.59-0.75). It is important that these factors are taken into consideration during the post-operative management of patients who need to kneel.

Hirosaki Med. J. 73 : 40—47, 2023

Key words: Total Knee Arthroplasty (TKA); Kneeling; Activities of Daily Living (ADL).

Introduction

Osteoarthritis is a disease with high morbidity and is reported to affect more than 300 million people globally[1)]. Above all, osteoarthritis of the knee is a disease that causes difficulty in walking and activities of daily living (ADL) due to knee joint pain. The consequent restriction of social participation, hobbies, and leisure activities leads to a decreased quality of life[2)].

The guidelines of the Osteoarthritis Research Society International state that surgery should be considered as a treatment for osteoarthritis of the knee in cases where pain alleviation and functional improvement cannot be achieved with conservative therapies such as arthritis education and structured land-based exercise programs[3)]. The use of total knee arthroplasty (TKA), a surgical treatment for osteoarthritis of the knee, has rapidly increased in recent years[4)]. TKA is performed to relieve knee pain and improve knee function while walking, as well as for improvement of quality of life, and patients have reported high degrees of satisfaction[5)]. However, approximately 10–20% of patients remain dissatisfied[6)]. The expectations for TKA vary widely, and satisfaction can be affected by the ability to squat, get in and out of an automobile, and climb up and down stairs[7)].

While patients are satisfied with the reduction

1) Department of Rehabilitation, Eniwa Hospital
2) Graduate School of Health Science, Hirosaki University
3) Department of Orthopedic Surgery, Eniwa Hospital

Correspondence: Y. Koike
Received for publication, September 7, 2022
Accepted for publication, November 16, 2022

✉ : Yusuke Koike Eniwa Hospital
E-mail: pt.3501@gmail.com

of pain during walking after TKA, some are dissatisfied with being unable to regain kneeling. In fact, the inability to kneel has been reported as a factor associated with post-TKA dissatisfaction[8-10]. While many hobbies, religious customs, leisure activities, and physical labors worldwide require kneeling, in Japan, the requirement of kneeling is particularly high due to the lifestyle of sitting and lying on the floor. In fact, several studies have shown that kneeling is an important patient expectation after TKA[10-15].

Although patients may be able to kneel after TKA, a large proportion do not do so during daily activities due to fear and anxiety[16]. Therefore, in a previous study, we focused on kneeling post-TKA and conducted a survey of its impact on actual daily life activities. We found that while over 80% of patients wanted to kneel after TKA, the rate of achievement was low at approximately 30%, and the causes of this difficulty were varied, including pain, fear, sensory disorders, and anxiety[17]. Additionally, in terms of ADL, kneeling was shown to be highly correlated with the ability to perform floor cleaning and use underfloor storage, which are activities specific to the Japanese lifestyle[17]. This was the first report to demonstrate the inability of TKA patients to regularly engage in daily activities that involve kneeling.

Pain and discomfort[18], body mass index (BMI) [12], and the angle of knee flexion on the operative side[19] have been reported to be factors associated with kneeling post-TKA. However, no reports identify the percentage of causes or specific cutoff values. The elucidation of specific factors affecting post-TKA kneeling may be beneficial for the development of physical therapy interventions targeting the achievement of kneeling. Thus, the aim of this study was to identify the physical and psychological factors affecting the ability and performance of kneeling in patients after TKA.

Participants and Methods

Participants

The inclusion criteria were as follows: a diagnosis of osteoarthritis of the knee at the affiliated hospital of the lead author from June 2019 to June 2020; treatment with TKA; and postoperative follow-up period of 6 months or more (6-18 months). The exclusion criteria were as follows: revision TKA cases; TKA for diseases other than osteoarthritis of the knee (for example, trauma or rheumatoid arthritis); and cognitive function disorders.

Of the 324 patients meeting the inclusion criteria, 227 responded to the survey questionnaire sent by mail. Of these, the 186 patients who responded "I need to kneel" in daily activities were enrolled as study participants.

Surgical procedures

The TKA procedure was performed through a midline skin incision (approximately 8 to 10 cm) and a midvastus or trivector approach. Soft tissue managements were minimal. All patients underwent cemented arthroplasty and patella resurfacing[20].

Demographic data

Table 1 shows the demographic data of the study participants.

Rehabilitation protocol

We started rehabilitation (physical therapy/occupational therapy) from the day of TKA surgery in all cases, and this was performed according to the protocol outlined in Table 2. All patients were allowed to kneel after the sutures had been removed by the physician (postoperative day 7). Patients were instructed on how to kneel in a safe manner and were trained through specific exercises until discharge. Ongoing rehabilitation on an outpatient basis was not performed after discharge. The participants

Table 1. Demographic data of the participants (n=186)

Sex (Male: Female)	Male 41: Female 145
Age (years)	74.9 ± 6.9 (58–89)
Height (cm)	153.6 ± 8.3 (137.7–175.6)
Weight (kg)	64.9 ± 12.4 (37.6–110.6)
BMI (kg/m^2)	27.5 ± 4.3 (18.3– 44.6)
Implant design	PS: n=111 CR: n=52 CS: n=23
TKA Side	Bilateral: n=26 Unilateral: n=160

Mean ± standard deviation (minimum–maximum)
BMI: body mass index
TKA: total knee arthroplasty
PS: posterior stabilized
CR: cruciate retaining
CS: cruciate substituting

underwent functional assessment during postoperative visits at 1, 3, and 6 months, and received re-instruction on self-directed training, such as exercises contracting the quadriceps (patellar setting) and knee range of motion exercises.

Ethics

The study was approved by the Ethics Committee of Eniwa Hospital (approval number: 118) and the Ethics Committee of Hirosaki University (approval number: T2021-004). All participants provided informed consent. The participants were fully informed of the priority of protections and rights, freedom to participate or discontinue, the purpose of the study, and the physical effects of the study, based on the Declaration of Helsinki.

Methods

Questionnaire survey

In this study, questionnaire surveys were sent by mail to TKA patients 6-18 months post-operation. The authors created a self-entry type questionnaire to elicit responses regarding whether patients needed to kneel in daily life, whether they were able to do so, when they became able to do so, and the reasons (multiple answers) if they were unable to do so. Figure 1 shows the questionnaire composed of 4 questions. The outcomes included ascertaining whether the patient was able to kneel and perform kneeling in daily life. "Fear" was defined as the fear of kneeling on the floor, and "anxiety" as the fear of causing damage to the operated knee.

Table 2. Rehabilitation protocol

Time	Transition	Movements
Preoperative	Assessment-based decision	① Ankle plantar dorsiflexion movement ② Patellar setting
Day 1 Postoperation	Start walking with walker	Confirmation of ① and ② ③ Ambulation practice with walker
Day 2 Postoperation		①~③ ④ Knee ROM exercise ⑤ Physical therapy (icing)
Day 3 Postoperation	Start walking with cane	①~⑤ ⑥ Training outside the affected area • Trunk, hip joints, ankles, non-operative knee
Day 7 Postoperation	Walking independently with cane	①~⑥ ⑦ Activities of daily life training • Kneeling practice • Ascending and descending stairs • Bathing practice • Walking outdoors * ROM Target: 90°
Day 14 Postoperation	Walking with a cane or independently	Confirmation of self-exercise * ROM Target: 120°
Day 18 Postoperation	Discharge	

*ROM: range of motion

To Everyone who has Received an Artificial Knee Joint

We are conducting a questionnaire survey about "**Kneeling**" after receiving an artificial knee joint. Please place a check mark ☑ against the applicable items. In addition, enter **content** in the (_____) as well.

Name:_____ Age:_____yrs.

For everybody

Q1 : Have you needed to kneel following the surgery?

Response 1: ☐ Yes ☐ No

For persons who answered "Yes" in Q1: (If you answered "No", please return the survey with the remainder left blank)

Q2 : Have you been able to kneel following the surgery?

Response 2: ☐ Able (Yes) ☐ Not Able (No)

Q3: After discharge, when were you first able to kneel? (Not to be filled out by persons unable to kneel)

Response 3: [ ] months after discharge

Entry examples: 1 and a half months would be [1.5] months; Immediately after discharge would be [0] months

Q4: Please tell us why you are unable to kneel.
(Not to be filled out by persons able to kneel)

Response 4:
☐ It hurts to kneel
☐ It hurts to bend deeply to kneel
☐ I'm afraid to kneel
☐ The sensation around my knee(s) is dull
☐ I'm not sure if it's OK to kneel
☐ I'm worried I might damage my artificial knee(s)
☐ Other (Content: _____)

Fig. 1 Questionnaire Survey on Time of Achieving Kneeling

Demographic data

Information on age, sex, height, weight, BMI, implant type, operative side (unilateral, bilateral), and other surgical histories involving the lower limbs were collected from the medical records.

Functional assessment

We recorded knee range of motion (flexion of left and right knees) at the time of discharge as a functional assessment, based on previous research[19]. Joint range of motion was measured using the method of The Japanese Orthopedic Association and The Japanese Association of Rehabilitation Medicine[21].

Statistical analysis

The rate and time of kneeling achievement were calculated from the questionnaire results. Comparison between groups (able to kneel vs. not able to kneel) was analyzed using the Mann-Whitney U test. For the reasons for the inability in cases where kneeling could not be achieved, the percentage of each response was calculated. For variables with significant differences, receiver operating characteristic (ROC) curves were calculated and cutoff values were calculated.

All analyses were performed using R 4.0.2 (freeware) and the statistical significance level was set to 0.05.

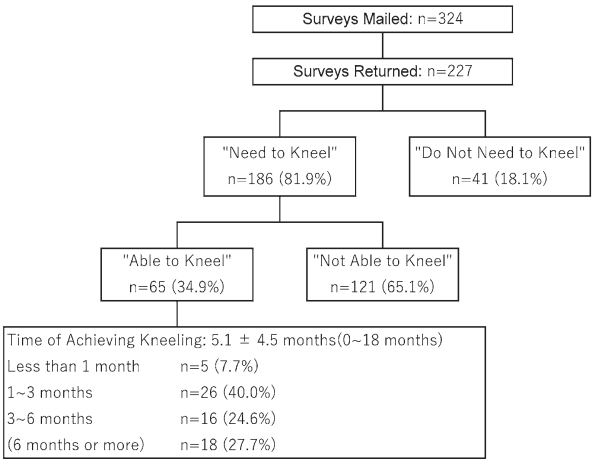

Fig. 2 Results of questionnaire survey

Results

Rate and duration for achievement of kneeling

The participants' mean number of hospitalization days was 20.5 ± 2.5 (minimum 16/maximum 21 days). The mean number of postoperative days at the time of survey was 460.5 ± 114.9 days (minimum 259/maximum 645 days). A total of 65 of 186 participants (34.9%) were able to kneel. The mean duration from surgery to achievement of kneeling was 5.1 ± 4.5 months (minimum 0/maximum 18 months), and only 7.7% were able to kneel in the early post-operative period (1 month or less). (Fig. 2)

Participant characteristics (able to kneel vs. not able to kneel)

The results of the univariate analysis of age,

Table 3. Results of the univariate analysis

	Able to Kneel	Not Able to Kneel	p-value
Age (years)	75.3 ± 6.4	74.5 ± 7.5	n.s.
BMI (kg/m^2)	26.8 ± 4.9	27.9 ± 08.4	n.s.
Other surgical histories of lower limbs※ (n)	9	4	n.s.
Knee flexion on the operative side (°)	123.7 ± 11.0	117.3 ± 11.0	<0.01

※ total hip arthroplasty, fracture of the lower limb
n.s. : not significant

Table 4. Percent distribution of reasons for being unable to kneel

Reasons for being unable to kneel	n	%
It hurts to kneel	101	55.2
It hurts to bend deeply to kneel	81	44.3
I'm afraid to kneel	87	47.5
The sensation around my knee (s) is dull	60	32.8
I'm not sure if it's OK to kneel	33	18.0
I'm worried I might damage my artificial knee (s)	51	27.9

BMI, surgical history, knee flexion range of motion in participants who were able to kneel vs. those who were unable to kneel are shown in Table 3.

Percent distribution of reasons for being unable to kneel

The distribution (number and percentages) of responses for the reasons for being unable to kneel are shown in Table 4.

Cutoff value for knee flexion

According to the ROC analysis, the optimal cut-off value for knee flexion was 122.6°. The area under the ROC curve was 0.67 (95% confidence interval [CI] 0.59-0.75). Sensitivity and specificity were 79.4% and 45.1%, respectively. (Fig. 3)

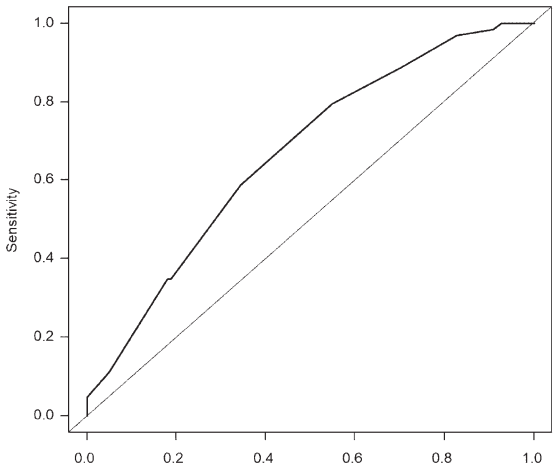

Fig. 3 Results of the Receiver Operating Characteristic curve for knee flexion

Discussion

In this study, we calculated the rate and time of kneeling achievement in participants who responded that kneeling was necessary in their daily lives. We found that 81.9% of the study participants needed to kneel. The actual rate of kneeling achievement was 34.9%. The mean duration from surgery to achievement of kneeling was 5.1 ± 4.5 months. The item that showed a significant difference was knee range of motion (flexion on the operative side). Pain and fear were the most common reasons for the inability in cases where kneeling could not be achieved. The cutoff value for knee flexion was set at 122.6°.

Rate and duration for achievement of kneeling

Weiss et al.[22] reported that post-TKA kneeling is very important in life. The results of this study also suggest that, in patients who

need to kneel, achieving kneeling post-TKA can improve life satisfaction. In previous studies, kneeling achievement rates of 60 to 80% have been reported 1-year post-operation[13, 23]. However, since these reports were outside of Japan, it is highly likely that the lifestyles differed from that of Japan where a lot of movements and activities are performed on the floor. In addition, these rates were evaluated based on whether kneeling could be performed or not, rather than whether it could be performed in ADL. Meanwhile, in a research report from Japan, 22% of patients had the ability to kneel in daily activities[24], roughly on a par with this study. Since the necessity of kneeling is high and the achievement rate is low, the elucidation of the factors contributing to the ability to kneel is highly significant.

The proportion of patients who are able to kneel has been shown to increase with longer follow-up periods (47.6% after a minimum of 3 years follow-up) [25]. This study was conducted with a maximum follow-up period of 18 months; thus, we believe that long-term studies are needed in the future.

Reasons for being unable to kneel

Pain and fear

Singelyn et al. stated that postoperative pain in TKA reduces motor function[23]. In addition, it has been reported that post-TKA kneeling is affected by pain[26], which is consistent with the results of this study also. Since all patients in this study underwent surgery with a midline skin incision, residual swelling around the surgical site caused pain when the knee came into contact with the floor, thus giving rise to a lower achievement rate for kneeling (7.7%) in the early postoperative period.

In addition, as kneeling is a movement where the surgical wound site contacts the floor, patients are prone to chronic pain and feelings of fear, not just in the early postoperative period. There have been reports of the effectiveness of graduated exposure therapy for chronic pain in reducing fear and pain[27], and of patient education in reducing pain[28]. As such, performing educational interventions after discharge, such as graduated exposure from soft to hard surfaces, could be associated with increased rates of kneeling achievement.

Range of motion (knee flexion on the operative side)

Although kneeling is possible with a knee flexion angle of around 90°, a large range of knee joint flexion is thought to be necessary to kneel without discomfort and pain in ADL. In particular, there are many circumstances in which a large range of knee flexion is needed to perform ADL related to the Japanese lifestyle, such as floor cleaning, using underfloor storage, moving on the floor, etc.[29]. Wilding previously reported a higher rate of acquisition of kneeling movements when the knee joint flexion angle was 100° or greater. This study is the first to provide a specific target value for the Japanese population. We believe that a minimum knee flexion angle of 122.6° will lead to an improvement in the acquisition rate of kneeling movements in this particular population.

Study limitations

This study has several limitations. First, physical function was only assessed at the time of discharge, and not when kneeling was achieved. In addition, the condition of the opposite knee was not assessed in cases of initial TKA. In the future, it will be necessary to perform further studies taking these issues into account.

Second, the participants of this study did not undergo ongoing outpatient rehabilitation, and we think that the verification of the effect of outpatient rehabilitation is a topic worthy of future study.

Future prospects

It will be important to use the results of the present study to conduct an interventional study on kneeling after TKA, including the use of supporters and gel packs, patient education, etc., to verify the effect thereof.

Conclusion

In this study, we investigated the kneeling ability of TKA patients from this hospital. As a result, among patients who needed to kneel, the rate of kneeling achievement was 34.9%, and the mean postoperative time to achievement was 5.1 months.

Knee range of motion (flexion on the operative side) showed a significant difference. Pain and fear were the most common reasons for the inability in cases where kneeling could not be achieved. The optimal cut-off value for knee flexion was 122.6°. It is important to take these factors into consideration during the post-operative management of patients who need to kneel.

Conflict of Interest

There were no conflicts of interest in this study.

References

1) Safiri S, Kolahi AA, Smith E, Hill C, Bettampadi D, Mansournia MA, Hoy D, et al. Global, regional and national burden of osteoarthritis 1990-2017: a systematic analysis of the Global Burden of Disease Study 2017. Ann Rheum Dis. 2020;79:819-28.

2) Yamada H, Ino T. Rehabilitation for Total Knee Arthroplasty. Rev. 1. Tokyo: Bunkodo; 2018, p2.

3) Bannuru RR, Osani MC, Vaysbrot EE, Arden NK, Bennell K, Bierma-Zeinstra SMA, Kraus VB, et al. OARSI guidelines for the non-surgical management of knee, hip, and polyarticular osteoarthritis. Osteoarthritis Cartilage. 2019;27:1578-89.

4) 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;89:780-5.

5) Shan L, Shan B, Suzuki A, Nouh F, Saxena A. Intermediate and long-term quality of life after total knee replacement: a systematic review and meta-analysis. J Bone Joint Surg Am. 2015;97:156-68.

6) Bourne RB, Chesworth BM, Davis AM, Mahomed NN, Charron KD. Patient satisfaction after total knee arthroplasty: who is satisfied and who is not? Clin Orthop Relat Res. 2010;468:57-63.

7) Nakahara H, Okazaki K, Mizu-Uchi H, Hamai S, Tashiro Y, Matsuda S, Iwamoto Y. Correlations between patient satisfaction and ability to perform daily activities after total knee arthroplasty: why aren't patients satisfied? J Orthop Sci. 2015;20:87-92.

8) Yapp LZ, Clement ND, Macdonald DJ, Howie CR, Scott CEH. Changes in expectation fulfillment following total knee arthroplasty: a 10-year follow-up study. J Arthroplasty. 2020;35:1826-32.

9) Ghomrawi HMK, Lee LY, Nwachukwu BU, Jain D, Wright T, Padgett D, Bozic KJ, et al. Preoperative expectations associated with postoperative dissatisfaction after total knee arthroplasty: a cohort study. J Am Acad Orthop Surg. 2020;28:e145-50.

10) Fletcher D, Moore AJ, Blom AW, Wylde V. An exploratory study of the long-term impact of difficulty kneeling after total knee replacement. Disabil Rehabil. 2019;41:820-5.

11) Benfayed R, Moran M, Simpson A, Macdonald D. Perceptions of kneeling ability after total knee arthroplasty. Orthop Muscular Syst. 2017;6:1000239.

12) Sabeh KG, Hernandez VH, Cohen-Levy WB, Ong A, Orozco F, Bennett V, Post Z. The effects of patient occupation, hobbies, and body mass index on kneeling after total knee arthroplasty. J Knee Surg. 2021;34:772-6.

13) van Zaanen Y, van Geenen RCI, Pahlplatz TMJ, Kievit AJ, Hoozemans MJM, Bakker EWP, Blankevoort L, et al. Three out of ten working patients expect no clinical improvement of their ability to perform work-related knee-demanding activities after total knee arthroplasty: a multicenter study. J Occup Rehabil. 2019;29:585-94.

14) Lee TQ. Biomechanics of hyperflexion and kneeling before and after total knee arthroplasty. Clin Orthop Surg. 2014;6:117-26.

15) Scott CE, Bugler KE, Clement ND, MacDonald D, Howie CR, Biant LC.: Patient expectations of arthroplasty of the hip and knee. J Bone Joint Surg Br. 2012;94:974-81.

16) Amin RM, Vasan V, Oni JK. Kneeling after total knee arthroplasty. J Knee Surg. 2020;33:138-43.

17) Koike Y, Tsushima E, Ishida K, Miyagishima K, Komatsu M, Kimura S, Mori N, et al. The status of kneeling after total knee arthroplasty and relationship between kneeling and activities of daily living. The Hokkaido Journal of Physical Therapy Japan. 2022;39:4-10.

18) White L, Stockwell T, Hartnell N, Hennessy M, Mullan J. Factors preventing kneeling in a group of pre-educated patients post total knee arthroplasty. J Orthop Traumatol. 2016;17:333-8.

19) Wilding CP, Snow M, Jeys L. Which factors affect the ability to kneel following total knee arthroplasty? An outpatient study of 100 postoperative knee replacements. J Orthop Surg (Hong Kong). 2019;27.

20) Mori N, Kimura S, Onodera T, Iwasaki N, Nakagawa I, Masuda T. Use of a pneumatic tourniquet in total knee arthroplasty increases the risk of distal deep vein thrombosis: A prospective, randomized study. Knee. 2016;23:887-9.

21) Matsuzawa T. Physical therapy assessment, Rev. 2, Tokyo: Kanehara Shuppan; 2004.

22) Weiss JM, Noble PC, Conditt MA, Kohl HW, Roberts S, Cook KF, Gordon MJ, et al. What functional activities are important to patients with knee replacements? Clin Orthop Relat Res. 2002;404:172-88.

23) Singelyn FJ, Deyaert M, Joris D, Pendeville E, Gouverneur JM. Effects of intravenous patient-controlled analgesia with morphine, continuous epidural analgesia, and continuous three-in-one block on postoperative pain and knee rehabilitation after unilateral total knee arthroplasty. Anesth Analg. 1998;87:88-92.

24) Maehara H, Aso K, Dan J, Izumi M, Ikeuchi M. Kneeling activity in daily life after total knee arthroplasty. Osteoarthritis Cartilage. 2019;27:S448.

25) Nadeem S, Mundi R, Chaudhry H. Surgery-related predictors of kneeling ability following total knee arthroplasty: a systematic review and meta-analysis. Knee Surg Relat Res. 2021;33:36.

26) Wallace SJS, Berger RA. Most patients can kneel after total knee arthroplasty. J Arthroplasty. 2019;34:898-900.

27) Fowler CA, Ballistrea LM, Mazzone KE, Martin AM, Kaplan H, Kip KE, Murphy JL, et al. A virtual reality intervention for fear of movement for veterans with chronic pain: protocol for a feasibility study. Pilot Feasibility Stud. 2019;5:146.

28) Goff AJ, De Oliveira Silva D, Merolli M, Bell EC, Crossley KM, Barton CJ. Patient education improves pain and function in people with knee osteoarthritis with better effects when combined with exercise therapy: a systematic review. J Physiother. 2021;67:177-89.

29) Yoshimoto Y. Hip and knee motion measurements for selected activities of daily living. Physical Therapy Japan. 1988;15:247-250.