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博　士　論　文

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（人工股関節置換術を受けた日本人女性に対する手段的日常生活動作練習が身体活動レベルに与える効果）

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花　房　謙　一

Effect of Instrumental Activities of Daily Living Training on Physical Activity Levels in Japanese Women Who Underwent Total Hip Arthroplasty

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Abstract

Background: Although there is significant improvement in physical function after total hip arthroplasty (THA) for hip osteoarthritis, physical activity (PA) levels remain largely unchanged.

Purpose: We aimed to determine whether adding instrumental activities of daily living (IADL) training to the post-operative rehabilitation program can help improve PA levels in Japanese women who underwent THA.

Methods: We enrolled 13 women who added IADL training to the conventional rehabilitation program post-THA (intervention group) and 14 women who performed only conventional rehabilitation program post-THA (control group). PA levels, defined as the in daily mean for number of steps and activity duration, were measured pre-operatively and post-operatively using an accelerometer. Comparisons employed two-way repeated measures of analysis of variance with Tukey's post hoc tests.

Results: After THA, the daily mean for number of steps and PA duration increased significantly in the intervention group ($p<0.05$) but not in the control group.

Conclusion: We recommend adding IADL training to post-THA rehabilitation programs to increase PA levels in patients with low pre-operative PA levels.

Keywords

Instrumental activities of daily living training, Occupational therapy, Total hip arthroplasty, Physical activity

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INTRODUCTION

Currently, total hip arthroplasty (THA) is widely used worldwide to treat hip osteoarthritis (OA). Evidence from previous studies suggests that, although there is significant improvement in physical function after THA, physical activity (PA) levels remain largely unchanged[1-5]. PA describes any bodily movement involving skeletal muscles and requiring energy expenditure, and includes common activities such as housework, occupational activities, and leisure. PA levels are generally evaluated using the questionnaire method and an accelerometer, while the energy cost associated with PA is expressed in metabolic equivalents/day or kcal/day[6-9]. Kinkel et al.[9] reported that, after THA, subjects with low PA levels walked 4500–4700 steps/day, whereas those with high PA levels walked 6500–6700 steps/day. Yokohata et al.[10] reported that high PA levels decreased the longevity of the hip prosthesis, but that moderate PA levels were considered necessary to maintain functional status. In previous studies[1, 3, 5] of THA recipients with low pre-operative PA levels, the post-operative improvement in PA levels was substantially higher among subjects with a shorter duration of hip OA. Iwai et al.[3] suggested that the discomfort and limited range of motion in the operated limb in the early stage after THA may discourage patients from increasing their PA levels post-operatively. De Groot et al.[1] and Vissers et al.[5] reported that THA recipients did not change their lifestyle even when their exercise capability improved.

Other key factors such as demographics or disease type and duration should also be considered. Regarding disease type, primary hip OA is typically predominant in Western European countries, whereas secondary hip OA is common in Asian countries, including Japan[11]. Ohfuji et al.[12] reported that, in Japan, approximately 90% of patients with hip OA are female. In many Japanese women, secondary hip OA develops as a result of previous illness such as congenital or developmental dysplasia of the hip. Thus, secondary hip OA develops as a chronic condition and typically has long disease duration at the time of THA.As for most Japanese men with THA, if symptoms of femur head necrosis develop rapidly despite drug treatment, hip OA has short disease duration. Presently, there is very little evidence regarding the effects of these differences on PA levels in Japanese women who underwent THA. Therefore, we focused on Japanese women with long disease duration and risk factors for low PA levels (body weight and lifestyle). We aimed to determine whether post-operative PA levels can be improved by adding instrumental activities of daily living (IADL) training to conventional rehabilitation after THA. We hypothesized that IADL training would be associated with improved post-THA PA levels in Japanese women undergoing THA rehabilitation.

MATERIALS AND METHODS

Participants

Among the female patients diagnosed with secondary hip OA and scheduled for THA at the Department of Orthopedics of Suita Municipal Hospital, we recruited those who had reported an episode of intense pain associated with hip OA at least 3 months prior to evaluation, and whom we thus estimated would have low pre-operative levels of PA. We used the International PA Questionnaire (IPAQ) [13] and body weight measurements to estimate the average weekly energy expenditure (in kcal) of each participant. We defined low PA levels for energy expenditure below 1000 kcal/week, according to Ikeda et al.[14]. We only enrolled patients without sharp pain at sites other than the joint scheduled for THA.

Procedures

THA was carried out on the next day after admission, and post-operative rehabilitation was started on the next day after THA. For rehabilitation after THA, our hospital's physical therapy program involved exercises to improve the range of motion, muscular strength, and the ability to walk using crutches. Additionally, our hospital's conventional occupational therapy program after THA provided information with respect to activities of daily living (ADL) such as going to bed, using the affected limb while bathing, and using of self-help devices in various environments. Furthermore, before discharge, the patients underwent specific training focused on getting up from the tatami floor and bathing. The main purpose of conventional occupational therapy was to enable functional recovery of ADL to an extent that would help avoid hip dislocation during at-home recovery after THA. The conventional rehabilitation program did not focus on PA levels.

Intervention

Participants allocated to the control group underwent conventional rehabilitation between June 2013 and May 2014, whereas participants allocated to the intervention group underwent conventional rehabilitation plus IADL training between August 2014 and October 2015.The IADL training program was focused on target activities including getting on and off the bus, climbing the stairs, and walking on dirt roads, as well as housework-related training focused on shopping, washing, and cleaning. In addition, we carefully assessed the environment of each participant, and carried out IADL training focused specifically on walking around the home. All other protocols (procedures and evaluations) were applied in the same way in the control and intervention groups. Evaluation of PA levels and quality of life (QOL) was performed pre-operation and post-operation in all patients enrolled in the study.

Data collection

As an indicator of PA levels, we used the number of steps per day, averaged over the recordings performed in 1 month. The number of steps was measured using the Kenz Lifecorder GS uniaxial accelerometer (Suzuken Co., Ltd., Nagoya, Japan; Figure 1, left), which provides reliable and validated output data and can be used continuously for 200 days[15]. All participants wore the accelerometer on a belt at waist level just above either leg, and the accelerometer was to be worn until bedtime and affixed again when waking up (Figure 1, right). The participants received the accelerometer and instructions at one month before admission, and used the device to record PA levels continuously until admission (Figure 2). When analyzing the accelerometer data at the time of admission, we decided to exclude patients who walked >6500 steps/day during the month leading up to admission[9] (Figure 3). PA levels were measured also post-operatively. Specifically, the patients received the accelerometer and instructions at two months after THA, and performed continuous recording of PA levels for one month. Thus, the post-operative PA data were obtained at 3 months after THA.

Health-related quality of life (HRQOL) was assessed using the Japanese version of the Medical Outcome Study 36-Item Short Form Health Survey (SF-36), which consists of 36 items representing physical function , role-physical, body pain, general health, vitality, social functioning, role-emotional, and mental health[16]. SF-36 measures multidimensional properties of HRQOL on a scale from 0 to 100, with higher scores representing higher HRQOL. We evaluated HRQOL at 1 month before THA and 3 months after THA (Figure 2).

Figure 1. Device for measuring physical activity levels. Left: Lifecoder GS (Suzuken Corp., Nagoya, Japan). Right: A study participant wearing the accelerometer.

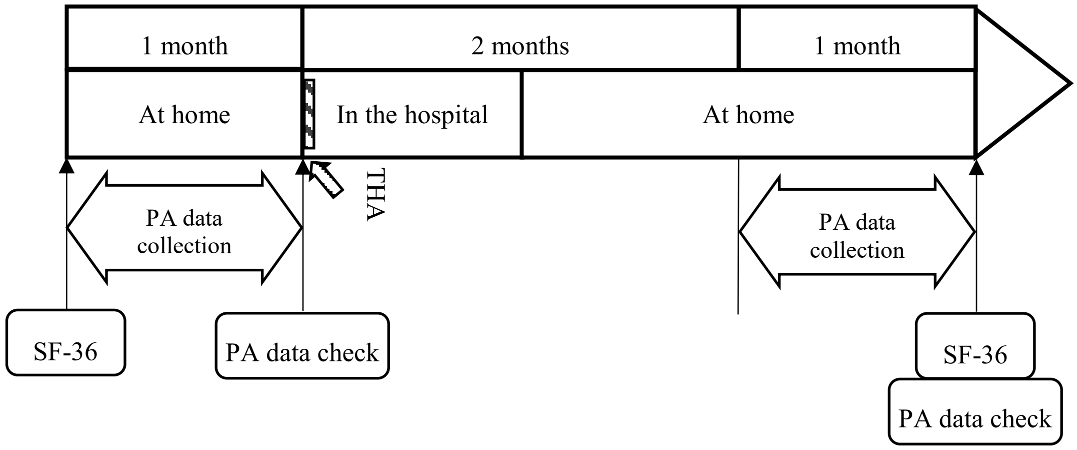

Figure 2. **Data collection schedule**

Abbreviations: PA, physical activity; SF-36, Medical Outcome Study 36-Item Short Form Health Survey; THA, total hip arthroplasty

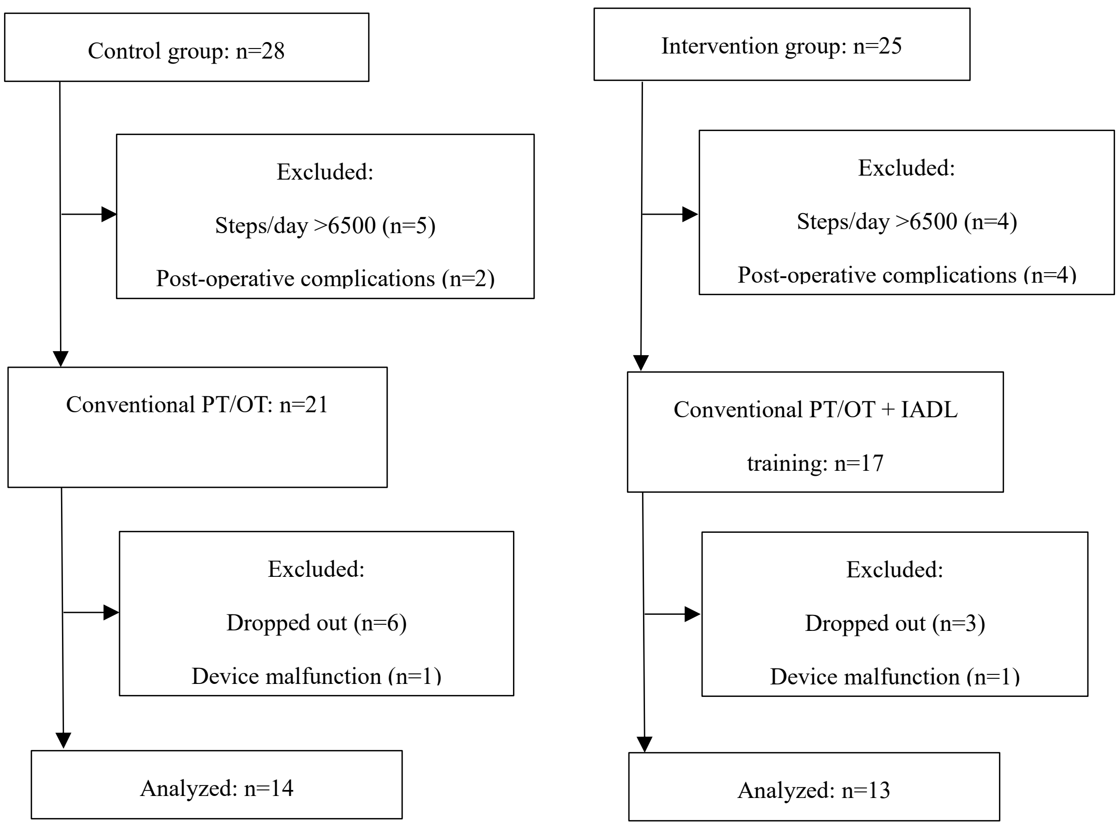

Figure 3. Flowchart of participant inclusion into the study

Abbreviations: IADL, instrumental activities of daily living; OT, occupational therapy; PT, physical therapy

Statistical analysis

Results are expressed as mean ± standard deviation. The unpaired t-test and chi-square test were used to analyze differences in patient clinical profiles, because comparisons between the control group and intervention group were performed for PA levels (number of steps and PA duration) and HRQOL (SF-36 scores). Data were also analyzed using two-way repeated measures of analysis of variance (ANOVA) with Tukey's post hoc tests. We performed between-group comparisons for the same time point and within-group comparisons for different time points. Post-hoc testing was performed if a statistically significant main effect or interaction was detected. A p-value of <0.05 was considered to indicated statistical significance. Statistical analyses were performed using EZR[17].

Ethical review committee statement

This study was approved by the Ethical Review Board of the Suita Municipal Hospital. All study participants provided written informed consent for participation. Data collection was performed in accordance with the directives of the Declaration of Helsinki.

RESULTS

The control group initially enrolled 28 participants, of whom 14 were excluded for the following reasons: accelerometer reading could not be ascertained (n=1); high pre-operative levels of PA, defined as a mean of 6500 steps/day in the month leading up to THA (n=5); post-operative complications (n=2); and answering the questionnaire improperly or incompletely, or accidentally damaging the accelerometer (n=6). Finally, 14 participants in the control group were included in the analysis (Figure 3).

The intervention group initially enrolled 25 participants, of whom 12 were excluded due to the following reasons: accelerometer reading could not be ascertained (n=1); high pre-operative levels of PA, defined as mean of 6500 steps/day in the month leading up to THA (n=4); post-operative complications precluding IADL training (n=4); and answering the questionnaire improperly or incompletely, or accidentally damaging the accelerometer (n=3). Finally, 13 participants in the control group were included in the analysis (Figure 3).

An overview of the patient characteristics is provided in Table 1. The age was 63.2±9.0 years in the control group and 67.8±8.6 years in the intervention group. The result of the unpaired t-test indicated no significant difference between the groups with respect to height, weight, body mass index, disease duration, or duration of hospitalization.

Not adverse events were noted, and all participants were able to carry out post-THA rehabilitation safely.

Table 1. Demographics characteristics of 27 Japanese women who underwent total hip arthroplasty for hip osteoarthritis

Characteristic	Control group (n=14)	Intervention group (n=13)	p-value	t- value
Age (years)	63.2±9.0	67.8±8.6	0.19	-1.34
Height (cm)	154.9±5.4	153.5±4.4	0.47	0.73
Body weight (kg)	55.6±8.2	59.7±7.7	0.20	-1.33
BMI (kg/m^2)	23.2±3.2	25.3±3.2	0.09	-1.77
Disease duration (months)	27.2±27.6	47.5±44.5	0.17	-1.41
Length of hospital stay (days)	26.9±4.1	24.2±6.9	0.22	1.25
Living situation				
Living alone	0	1		
Living with family	14	12		

Abbreviations: BMI, body mass index.
All participants performed post-operative rehabilitation. Participants in the intervention group also underwent instrumental activities of daily living training. No statistically significant differences in baseline characteristics were noted between the control group and the intervention group ($p<0.05$ on the unpaired t-test).

PA levels described in term of number of steps and activity duration

A comparison of the PA levels is provided in Table 2. First, we tested the normality of data distribution using the Kolmogorov-Smirnov test, and found that not all data subsets had normal distribution. Therefore, we performed subsequent analyses for non-normally distributed data. Two-way repeated ANOVA indicated that the main factor to affect the PA levels was the measurement time point ($p=0.002$), with no significant between-group differences regarding the effect of this factor. In addition, we applied Tukey's post hoc test because we recognized a significant interaction effect between group and time point for the mean number of steps per day ($p=7.047e-12$) and the mean PA duration per day ($p=6.484e-12$). The mean number of steps per day and mean PA duration per day changed significantly after THA in the intervention group ($p=0.02$ and $p=0.01$, respectively), but this was not true for the control group.

Table 2. Physical activity levels (mean number of steps per day and mean activity duration per day) of the control group and intervention group before and after total hip arthroplasty

	Control group (n=14)			Intervention group (n=13)		
	Preoperative	Postoperative	p-value	Preoperative	Postoperative	p-value
Mean number of steps/day	3778.6±1565.9	4091.1±1303.0	0.98	2916.2±1710.1	5284.6±3086.3	0.02*
Mean activity duration/day	43.6±18.2	46.3±14.2	0.99	33.2±18.9	60.7±33.6	0.01*

Statistical significance: *p<0.05 on Tukey's post hoc test.
All participants performed post-operative rehabilitation. Participants in the intervention group underwent instrumental activities of daily living training. In the intervention group, a statistically significant difference was noted between the preoperative and postoperative values both indicator.
No statistically significant differences in physical activity were noted between the control group and the intervention group.

QOL described in terms of the SF-36 scores

An overview of the SF-36 scores and their comparison is provided in Table 3.We first tested the normality of data distribution using the Kolmogorov-Smirnov test, and found that not all data subsets had normal distribution. Therefore, further analyses were performed for non-normally distributed data. Two-way repeated ANOVA indicated that the main factor to affect SF-36 scores was the measurement time point (physical function, p=1.770e-05; role-physical, p=0.0004; body pain, p=0.00000006; general health, p=0.007; vitality, p=1.492e-05; social function, p=0.0004; role-emotional, p=0.01; mental health, p=0.01), with no significant between-group differences regarding the effect of this factor. In addition, we applied Tukey's post hoc test because we recognized a significant interaction effect between group and time point for all scores (physical function, p=3.693e-16; role-physical, p=6.434e-16; body pain, p<2.2e-16; general health, p=2.759e-15; vitality, p=6.484e-16; social function, p<2.2e-16; role-emotional, p=6.168e-16; mental health, p<2e-16). While the control group showed substantial improvement in many SF-36 scores following THA, the intervention group showed substantial improvement only in the scores for physical function and body pain.

Table 3. SF-36 scores of the control group and intervention group before and after total hip arthroplasty

	Control group (n=14)			Intervention group (n=13)		
	Preoperative	Postoperative	p-value	Preoperative	Postoperative	p-value
Physical function	44.3±16.3	72.1±12.2	0.004**	42.3±26.5	68.1±24.8	0.01*
Role-physical	42.0±24.8	71.4±12.7	0.003**	50.0±23.2	62.0±20.8	0.46
Body pain	35.9±10.1	60.1±13.8	0.0005***	34.2±14.1	66.8±21.1	0.000008***
General health	49.1±20.9	60.9±21.3	0.42	66.6±19.6	71.3±18.6	0.93
Vitality	42.9±27.2	71.9±11.7	0.003**	51.5±24.5	70.7±14.8	0.09
Social function	42.0±20.6	74.1±19.9	0.001**	62.5±23.4	72.1±21.1	0.66
Role-emotional	58.3±29.1	86.3±17.8	0.02*	62.8±25.4	66.7±25.7	0.98
Mental health	65.4±21.6	80.0±10.2	0.16	68.1±20.8	75.4±18.5	0.74

Abbreviations: SF-36, Medical Outcome Study 36-Item Short Form Health Survey.
Statistical significance: *p<0.05, **p<0.005, ***p<0.0001 on Tukey's post hoc test.
All participants performed post-operative rehabilitation. Participants in the intervention group underwent instrumental activities of daily living training.
A statistically significant difference between the preoperative and postoperative values was noted for most scales in the control group, but only for two scales in the intervention group.
No statistically significant differences in SF-36 scores were noted between the control group and the intervention group.

DISCUSSION

Conventional rehabilitation programs after THA do not focus on increasing PA levels. Instead, the purpose of physical therapy is to improve post-operative range of motion, muscular strength, and walking ability, while the purpose of occupational therapy is to prevent dislocation and other post-operative complications, as well as to promote self-care independence after THA. In our study, we indeed found that patients with low pre-operative levels of PA who underwent only conventional rehabilitation did not improve their PA levels after THA (mean number of steps per day and mean PA duration per day), which is in agreement with previous observations. Therefore, despite the success of the THA procedure, it is not easy for such patients to change an ingrained lifestyle, as suggested by de Groot et al.[1)]. After THA, PA levels do not increase in the absence of increased opportunities to perform activities that involve exercise, such as housework, certain types of work, or leisure activities. However, in our study, IADL training was associated with a significant improvement in PA levels (mean number of steps per day and mean PA duration per day) after THA, suggesting that our IADL training program provided increased opportunities to participate in activities such as housework, work, and leisure after the discharge. Hagsten et al.[18)] reported the usefulness of IADL training and ADL training early after THA for preventing hip joint bone fracture. Although ADL (self-care) may not differ significantly from one individual to another, IADL is highly dependent on lifestyle. We carefully assessed the environment of each participant, and before discharge, we performed IADL training focused on specific activities such as shopping or walking around the house. Such precise instructions and practice seemed to help establish noticeable lifestyle changes after THA in the intervention group, and we believe it this lifestyle change that led to increased PA levels. Lifestyle change post-surgery appears to be important for improving physical function and prosthesis durability. The benefits of the operation include alleviation of body pain and promotion of patient participation in activities previously limited by body pain, with restoration of ADL as desired by the patients, thus highlighting the true essence of rehabilitation. In our patients, who had low pre-operative levels of PA, THA followed by conventional rehabilitation improved body pain and physical function, but did not increase PA levels. Occupational therapy was expected to contribute to patient self-realization and general improvement in QOL. We evaluated the living environment of each participant, and designed the IADL training routine accordingly. Patients who undergo an operation after enduring long periods of body pain typically do not show immediate improvement in PA levels. The conventional rehabilitation program does not aim to improve exercise habits, which may not be a problem for patients with relatively short disease duration. However, for patients with longer disease duration, it may be necessary to design individual therapeutic programs involving occupational therapy to restore exercise habits lost because of body pain. Grotle et al.[19] suggested that, post-operatively, an occupational therapist may promote ADL and leisure activities more positively through team rehabilitation. Our conventional therapy program focused only on preventing dislocation and ensuring ADL training, and it did not attempt to improve leisure activity or PA participation. In addition to dislocation prevention and ADL training, IADL training should aim to restore patient participation in leisure activities. Among seniors, participation in leisure activities is more common in Europe and the United States than in Japan, where many seniors tend to stay indoors. In this context, it seems important that we were able to improve post-operative PA duration by adding IADL training to a conventional rehabilitation program.

We employed SF-36 to evaluate HRQOL, expecting that the IADL-associated improvement in PA levels would be reflected in increased QOL. However, while the control group had substantial improvement in many SF-36 scores following THA, the intervention group had substantial improvement only in the scores for physical function and body pain. Moreover, the control and intervention groups did not differ significantly in terms of pre-operative or post-operative QOL scores. Therefore, we cannot conclude that IADL training had an effect regarding QOL. The improvement in body pain is related to the THA procedure, while the improvement in physical function is likely the result of THA and post-operative rehabilitation. If IADL training increases PA levels by promoting lifestyle changes, we should expect to see differences between the control and intervention groups in terms of role-physical, social functioning, and mental health scores. However, we did not observe such differences. We believe that this observation is related to the follow-up duration (3 months), which is likely too short to reflect substantial improvement in self-efficacy after THA. Indeed, Öberg et al.[20] reported that, at 6 months post-THA, the only SF-36 scores that had significantly improved were those for physical function, role-physical, and body pain. Therefore, a follow-up period of at least 6 months is likely necessary in order to judge whether IADL training had an influence on QOL after THA.

Study strengths in the context of current knowledge

Previous studies [1-5, 9] using the accelerometer typically evaluated daily PA levels in terms of number of steps or metabolic equivalents. In our study, we measured the number of steps and activity duration. In the intervention group, a significant increase in the mean daily PA duration was observed post-THA. Rolving et al.[21] used a questionnaire to record PA duration in patients with THA, and reported an average of 480 min/week at 1 year post-THA. Other researchers also used a questionnaire to evaluate PA duration, including Wagenmakers et al.[8], who reported an average of 1468.1 min/week (approximately 209.7 min/day), and Paxton et al.[22], who reported a median of 150 min/week at 1-2 years after THA. The wide variability in these previous observations is likely related to differences in patient demographics (sex and age), length of follow-up post-operation and method employed for assessing PA. In our study, we measured real PA time but our sample size was small. As evidenced in a meta-analysis by Vissers et al.[23], very few studies conducted real-time measurements of PA. Nevertheless, Wagenmakers et al.[8] and Rolving et al.[21], investigated the type of activity that the patients participated in, which was not assessed in our study. Our inability to ascertain what kind of activities accounted for the recorded PA time constitutes one of the limitations of our study. Vogel et al.[24] assessed the amount of physical exercise that patients preferred to engage in after THA, and concluded that the prerogatives were participation in leisure activities and lifestyle activities.

Study limitations

This was a comparative study (IADL training intervention vs. control) with measurements at two time points (before vs. after THA). However, the handling of the groups was not simultaneous (2013-2014for the control group vs. 2014-2015 for the intervention group). Another limitation of this study is that only women were enrolled. In addition, many participants dropped out of the study after THA. These aspects should be understood in the context of this specific patient population. Our participants had long disease duration, and many had significant functional disorders, limited joint range of motion, and muscle weakness. Thus, for these patients, the duration of hospitalization may have been longer because of additional osteotomy procedures or post-operative complications. Because of the high rate of drop-out, the analyzed sample size was small. Finally, it was not possible to assess the effect of factors related to medical staff other than the rehabilitation therapists. Future investigations with more rigorous design and enrolling a larger number of participants are warranted to verify the findings of our present study.

CONCLUSION

Among Japanese women who underwent THA, adding IADL training to conventional rehabilitation was associated with a significant increase in post-operative PA levels for participants with low pre-operative PA levels, although no substantial effect on QOL was noted. Our results suggest that training should be added to the conventional rehabilitation program after THA to increase PA levels in patients with low pre-operative PA levels. Future studies should examine the long-term outcome of adding IADL training to post-THA rehabilitation.

Conflicts of interest

The authors declare no conflict of interest.

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