

The Effects of using Nintendo Wii Exergames on Hand Function and Depression in Post-Stroke: A Pilot Study

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Abstract: Background/Objectives: Previous studies have not clearly identified whether the Nintendo Wii is effective in improving hand function and reducing depression after stroke. Thus, the aim of this pilot study was to examine the effect of upper limb training using the Wii on hand function and depression in patients with stroke. **Methods/Statistical Analysis:** A total of 16 patients with acute stroke were randomly assigned to either the Wii group (n=8) or the control group (n=8). In both groups, conventional occupational therapy was performed 30 min/day, five times a week, for 4 weeks. In the Wii group, upper limb training using the Wii was additionally performed for 30 min. The control group received the usual care. The Jebsen-Taylor Hand Function Test (JTHFT) was performed to measure hand function. Depression level was assessed using the Beck Depression Inventory (BDI). Statistical analysis was performed using a Wilcoxon signed-rank test, chi-square test, and Mann-Whitney U test. **Findings:** Both groups showed a significant improvement in JTHFT scores, but BDI scores were not significantly improved after the intervention. There was no significant difference between the two groups after the intervention.

Conclusions: The results of this pilot study suggest that Wii training does not seem to improve depression in post-stroke patients.

Keywords: Wii, Nintendo, Exergames, Stroke, Depression, Hand function.

I. INTRODUCTION

The common symptoms occurring after stroke include physical disabilities (e.g., upper extremity functions), speech disorders, and emotional problems [1]. Among them, depression is the most common psychological and social problem faced by stroke patients. It has been reported that 46% of stroke patients experienced acute depression regardless of stroke type or lesion location [2]. Post-stroke depression refers to the occurrence of depression after the occurrence of a stroke without a specific psychiatric illness.

Previous studies have shown that the prognosis was more favorable with less depression [3]. Moreover, it was found

that the occurrence of depression after stroke was associated with low functional recovery and an extent of hospitalization [4]. Additionally, depression increased fatigue and helplessness, decreased motivation, reduced functional abilities [5], and made it difficult to return to work [6]. Therefore, treating post-stroke depression would be essential for improving the status of the stroke patient.

In everyday life, hands are used for conducting specific objectives and they show diverse functions depending on individual lifestyle [7]. More than 20 joints in one hand are optimized to do various functions such as holding, grabbing, writing, and turning an object according to the size and shape of the object. It has been reported that the abnormalities of upper extremity functions were found over 80% of cases [8]. The decreased upper extremity function causes problems in performing the basic daily life actions and they are associated with depression and lower quality of life [9].

Virtual reality refers to the interface between humans and computers that creates a specific environment or situation, which makes a user feel like the user actually interacts with the actual environment [10]. Owing to the abrupt advancement of computer and video technologies, intervention methods based on the virtual reality that can realize realistic virtual environments and activities are rapidly being introduced and changed in medicine [11].

In the field of rehabilitation medicine, the intervention based on virtual reality induces responses to patients by making patients move and operate objects, and perform certain tasks. An advantage of this method is to motivate patients in carrying out tasks by having patients interested [12]. Recent review studies showed that the intervention based on virtual reality has positive effects on stroke recovery [13]. However, the accessibility is low because of the high price, which is a shortfall of virtual reality.

Wii Nintendo has a price advantage compared to other expensive virtual reality programs. Moreover, it has been reported that it offers appropriate intensity exercises for enhancing physical health [14]. Consequently, it increases the level of physical activities and creates a positive mood [14]. Furthermore, previous studies have known to be effective in improving body functions or reducing depression [15-19].

Singh et al. [15] applied an intervention using Wii to people with physical disabilities and reported that it was effective in improving the reaction time of the limb and enhancing psychological well-being.

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The literature review study of Chao et al. [16] also indicated that Wii increased physical functions, decreased depression, and increased the quality of life for the elderly without disabilities. The results of Li et al. [17] revealed that, although Wii training might be helpful in alleviating depression, it would require a higher level of study design. Herz et al. [18] evaluated the effect of Wii training on patients with Parkinson's disease and reported that it improved the quality of life.

The systematic review of Dos Santos showed that the effects of Wii intervention could improve the extremity functions [19]. However, there are not enough studies evaluating the effects of Wii on the hand functions and depression of stroke patients. In other words, the previous studies were not clear whether Nintendo Wii was effective in improving hand function and reduction of depression after stroke. Therefore, The aim of this pilot study was to examine the influences of upper limb training using Wii on hand function and depression patients with acute stroke.

II. MATERIALS AND METHODS

2.1. Subjects

This study was conducted on 16 patients with acute stroke. The selection criteria of the participants were as follows: 1) those who were diagnosed with stroke by a medical specialist; 2) those who had stroke less than one month; 3) those who had Korean-mini-mental state examination (K-MMSE) ≥ 21 ; 4) those who had manual muscle strength of the shoulder and elbow equal to or better than Fair; and 5) those who had a stable medical condition. The exclusion criteria were as follows: 1) those who had another nervous disease; 2) those who had severe aphasia, unilateral neglect, and apraxia; and 3) those who had severe depression. The study was conducted after receiving consent from study participants voluntarily.

2.2. Measurements

2.2.1. Jebsen-Taylor Hand Function Test

The Jebsen-Taylor Hand Function Test is an objective assessment tool that is standardized with seven subtests and includes the hand functions most commonly used in everyday life. This test was devised by Jebsen [20], and provides the standardized data of each age healthy group and presents the reliability between test-retest. The reliability of the dominant hand is between .67 and .99 and that of non-dominant hand is between .60 and .92 [20]. This study obtained scores by using the timetable revised by Han et al. [21] for South Koreans.

2.2.2. Beck Depression Inventory

Beck Depression Inventory (BDI) was used as a depression measure. DBI was originally developed by Beck et al. [22] in 1961 and is one of the most widely used depression scales. In South Korea, Han et al. [23] in 1986 translated it and proved its reliability ($r = .942$) and validity. The translated version is composed of 21 items including emotional, cognitive, synchronic, and physiological symptoms of depression. The advantages of BDI are (1) it is economical because it can be conducted easily solely using standardized instructions, (2) it can reduce the confusion in the process of quantifying the psychological status of a responder since it asks the responder to answer specific questions, and (3) it can be easily applied to patients with disabilities. The score scale ranges from 0 to 3

and the total score ranges from 0 to 63. Symptoms are classified by the total score: 0 ~ 9 (no depression); 10 ~ 15 (mild depression); 16 ~ 23 (severe depression); and 24 ~ 63 points (very severe depression).

2.3. Procedures

Subjects who met the selection criteria were randomly assigned to a Wii group ($n=8$) and a control group ($n=8$). An initial test was conducted after immediately after placement. Both groups received a conventional occupational therapy. The period of intervention was 30 minute one session per day and five days per week for four weeks (20 sessions in total). The goal of the conventional occupational therapy was to enhance the functions of the shoulder, elbow, wrist, grasp, and pinch. The intervention was performed by occupational therapists. The contents of the intervention consisted of repeated training, strengthening, ROM exercise, and stretching. The Wii group received the upper limb training using Nintendo Wii (Nintendo, company Ltd, Japan) for an additional 30-minute after completing the conventional occupational therapy.

The Wii group used either Wii SportResort or Wii Sport in the market. Training conducted in Wii SportResort were table tennis, bowling, swordplay, cycling, and archery. Training of Wii Sport were boxing and tennis. The table tennis, bowling, and tennis can be played by one hand. The swordplay, cycling, archery, and boxing should be played with two hands. The occupational therapists explained the games included in Wii SportResort and Wii Sport and a pose should be repeated in the first and second sessions. They trained with subjects. When a subject expressed a lot of fatigue on the affected upper extremity, the subject was asked to play games using both hands or an unaffected side. It was to prevent fatigue since the strength of the upper extremity is very low at the beginning of the stroke. If the subject had a hard time to grab a remote controller, it was fixed using the strap. The control group received a guardian education and usual care. All subjects took post-evaluation after the intervention, and there was no drop-out during the study period.

2.4. Statistical analysis

The data were analyzed using SPSS 22. The general characteristics between the two groups were analyzed using Mann-Whitney U test (age, onset period, K-MMSE) and chi-square test (gender, lesion side). Wilcoxon signed rank test was used for the change of hand function and depression level before and after intervention. Comparisons of hand function, depression between the two groups were analyzed by Mann-Whitney u test. Statistical significance was set at .05.

III. RESULTS AND DISCUSSION

There was no significant difference between the Wii group and the control group ($p > 0.05$) in the comparison of the general characteristics and hand function and depression of the stroke patients before and after the intervention [Table 1]. Table 2 shows that hand function was significantly improved ($p < 0.05$),



and depression was not significantly improved ($p > 0.05$) in both groups before and after the intervention [Table 2]. The changes in hand functions and depression were not different between the both groups ($p > 0.05$) [Table 3].

Table 1. General characteristics and hand function, depression

| | | Wii group (n=8) | Control group (n=8) | P |
|----------------------------------|--------|-----------------|---------------------|------|
| Gender, n (%) | Male | 4(50.0) | 3(37.5) | .614 |
| | Female | 4(50.0) | 5(62.5) | |
| Age (year) ^a | | 58.13±5.17 | 59.25±10.23 | .809 |
| Lesion side | Right | 4(50.0) | 5(62.5) | .614 |
| | Left | 4(50.0) | 3(37.5) | |
| Onset period (days) ^a | | 7.25±4.71 | 7.50±3.89 | .901 |
| K-MMSE (score) ^a | | 24.63±2.77 | 24.88±3.18 | .869 |
| JTHFT (score) ^a | | 37.63±7.27 | 38.75±8.75 | .752 |
| BDI (score) ^a | | 12.13±3.72 | 11.50±5.40 | .712 |

Footnotes. a mean±SD, K-MMSE: Korean-mini-mental state examination, JTHFT: Jebsen-Taylor hand function test, BDI: Beck depression inventory.

Table 2. Changes of hand function and depression in the both groups

| | Wii group (n=8) | | | Control group (n=8) | | |
|-------|-----------------|------------|-------|---------------------|------------|-------|
| | Pre | Post | p | Pre | Post | p |
| | Mean±SD | Mean±SD | | Mean±SD | Mean±SD | |
| JTHFT | 37.63±7.27 | 57.63±8.83 | .011* | 38.75±8.75 | 52.75±5.23 | .012* |
| BDI | 12.13±3.72 | 10.50±2.98 | .222 | 11.50±5.40 | 10.38±6.30 | .237 |

Footnotes. * $p < .05$. JTHFT: Jebsen-Taylor hand function test, BDI: Beck depression inventory.

Table 3. Change score between the both groups after intervention

| | Wii group (n=8) | Control group (n=8) |
|-------|-----------------|---------------------|
| | Change score | Change score |
| | Mean±SD | Mean±SD |
| JTHFT | 20.00±11.43 | 14.00±9.01 |
| BDI | -1.63±3.82 | -1.13±5.67 |

Footnotes. JTHFT: Jebsen-Taylor hand function test, BDI: Beck depression inventory.

To our best knowledge, this preliminary study was the first study to evaluate whether the upper extremity training using Wii was effective for the hand functions and depression of acute stroke patients. The interpretation of the results of the study discussed hand function and depression.

First, the intervention significantly improved the hand functions of the Wii group and control group. However, no significant change was found in depression. It seemed that the significant improvement in hand functions was also positively affected by the voluntary recovery and the conventional occupational therapy [6]. The Wii group performed additional Wii training. Although the effects of Wii training were not significantly ($p < 0.05$) higher compared to the control group, the improvement rate of the Wii group (34.7%) was 1.3 times more than that of the control group (26.5%).

The results suggested that we could observe a significant difference if we had a larger sample size.

Secondly, there was no significant difference in hand functions between the two groups. Previous studies reported that upper extremity training using Wii for stroke patients was effective [19]. Upper extremity functions include hand functions. The Wii Sport Resort and Wii Sport of this study require the appropriate timing of the shoulder, elbow, and wrist but they are not the training requires fine movements such as hand manipulation. Therefore, we speculate that the upper extremity training using Wii Sport Resort and Wii Sport may not have significant effects on hand functions.



Thirdly, there was no significant difference in depression between before and after the intervention. Moreover, the depression of the two groups was not significantly different, either. Previous studies have suggested that Wii Nintendo may be effective in improving the depression and psychological problems of adults with physical disabilities and the elderly [15-18]. However, the results of this study did not agree with them. Several factors explain why the Wii group did not improve stroke patients' depression compared to the control group. Wii is a game, and as such training using games may not be suitable for the patient's motivation. In a situation of sadness after stroke, the game may have a negative effect on the patient. Laver et al. [24] reported that rehabilitation using Wii in older people was negatively perceived, and recognized that treatment costs were high. The elderly were more likely to seek treatment directly from therapists than games. The subjects of this study were nearly 60 years old. The authors support these previous results. In the meta-analysis of Li et al. [17], Wii intervention indicated that a high-level research design is required to demonstrate the effect of depression improvement. Therefore, it is required to prove this again using a more robust study design based on this preliminary study. When we calculated the required sample size (G Power 3.1) at $\beta=0.80$, the required sample size for hand function was 48 subjects for each group and that for depression was 1,469 subjects for each group.

There are several limitations of this preliminary study. First, this study had a small sample size and evaluated the effect of the intervention only after 4 weeks. That is, the intervention period was too short. Moreover, subjects with severe depression were excluded. Considering these limitations, a randomized controlled trial using a power analysis will be required in future studies.

IV. CONCLUSION

This preliminary study examined the effect of upper extremity training using Wii on the hand functions and depression of acute stroke patients. The results of this study showed that the hand functions were significantly improved by the intervention in both groups. However, the level of depression was not significantly changed. The changes in hand functions and depression were not different between the two groups. These results suggest that the upper extremity training using Wii may not be effective for enhancing the hand functions or depression of post-stroke patients. Randomized controlled studies will be required to test it further.

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