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Effects of VR-based Rehabilitation Video for Visual Vertigo on Autonomic Nervous System and Subjective Immersion and Interest in the Elderly

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Abstract

Background/Objectives: Many elderly people experience visual vertigo. VR will provide optokinetic stimulation to help reduce visual vertigo. This study is to investigate the rehabilitative effects of VR-based rehabilitation video.

Method/Statistical Analysis: The subjects of this study were 51 elderly people. The rehabilitation video was produced on the basis of traditional visual vertigo rehabilitation video. After watching the rehabilitation video, all subjects were measured for autonomic nervous system activity, heart rate and asked to write a questionnaire on subjective commitment and interest composed of 5 points scale. The collected data were subjected to independent t-test for comparison between groups.

Findings: In subjects who experienced visual vertigo, VR video group showed higher value in sympathetic nervous system activity and parasympathetic nervous system activity after visualization of rehabilitation video than general video group and, subjective immersion and interest showed the same results. In subjects who nonexperienced visual vertigo, on the other hand, VR video group showed higher value than general video group only in subjective immersion and interest after visualization of rehabilitation video. Based on the results of this study, the 360 degree VR rehabilitation video seems to have better therapeutic effect on visual vertigo than the existing video.

Improvements/Applications: Therefore, the convergent use of VR in the vestibular rehabilitation area improved the rehabilitation effect. Future research will increase the participation of active rehabilitation through the development of VR rehabilitation contents and programs.

Keywords: *VR, Rehabilitation video, Visual vertigo, Autonomic nervous system, Immersion.*

Introduction

Vertigo is one of the common symptoms in life. In particular, it is a high frequency in the elderly population and is a major factor in visiting hospitals[1]. Vertigo is problematic in itself but has difficulty in performing daily activities or affects falls[2]. Data released by the KCDC (Korea Centers for Disease Control & Prevention) reports that falls are a serious threat to the health of the elderly and can result in death or permanent disability[3]. Therefore, it is necessary to understand and manage the vertigo of the elderly to avoid this problem.

Vertigo can be caused by an imbalance in the vestibular, visual and proprioception systems that are involved in the equilibrium function. In addition, if one of these functions is lost, the other organ system will compensate. However, in older people, degenerative changes occur in all organ systems, making them more

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difficult to compensate for in other organ systems[4]. Among the symptoms of vertigo, elderly people may feel dizzy due to visual stimulation, such as passing between grocery stands or looking at the escalator stairs. This is called visual vertigo[5]. If people often feel dizzy after seeing moving objects in their daily activities, the elderly will be more likely to be exposed to falls. It is necessary to devise ways to alleviate the symptoms of visual vertigo.

Visual vertigo is deeply related to vestibular-ocular reflex[6]. The eye is reflexively placed in the optimal position according to the eye movement according to the head movement and further the eye movement according to the body movement or alignment. However, elderly people may have errors in eye movements as their functions decrease as they age. This error causes vestibular problems such as vertigo and we must find ways to deal with these systematic problems.

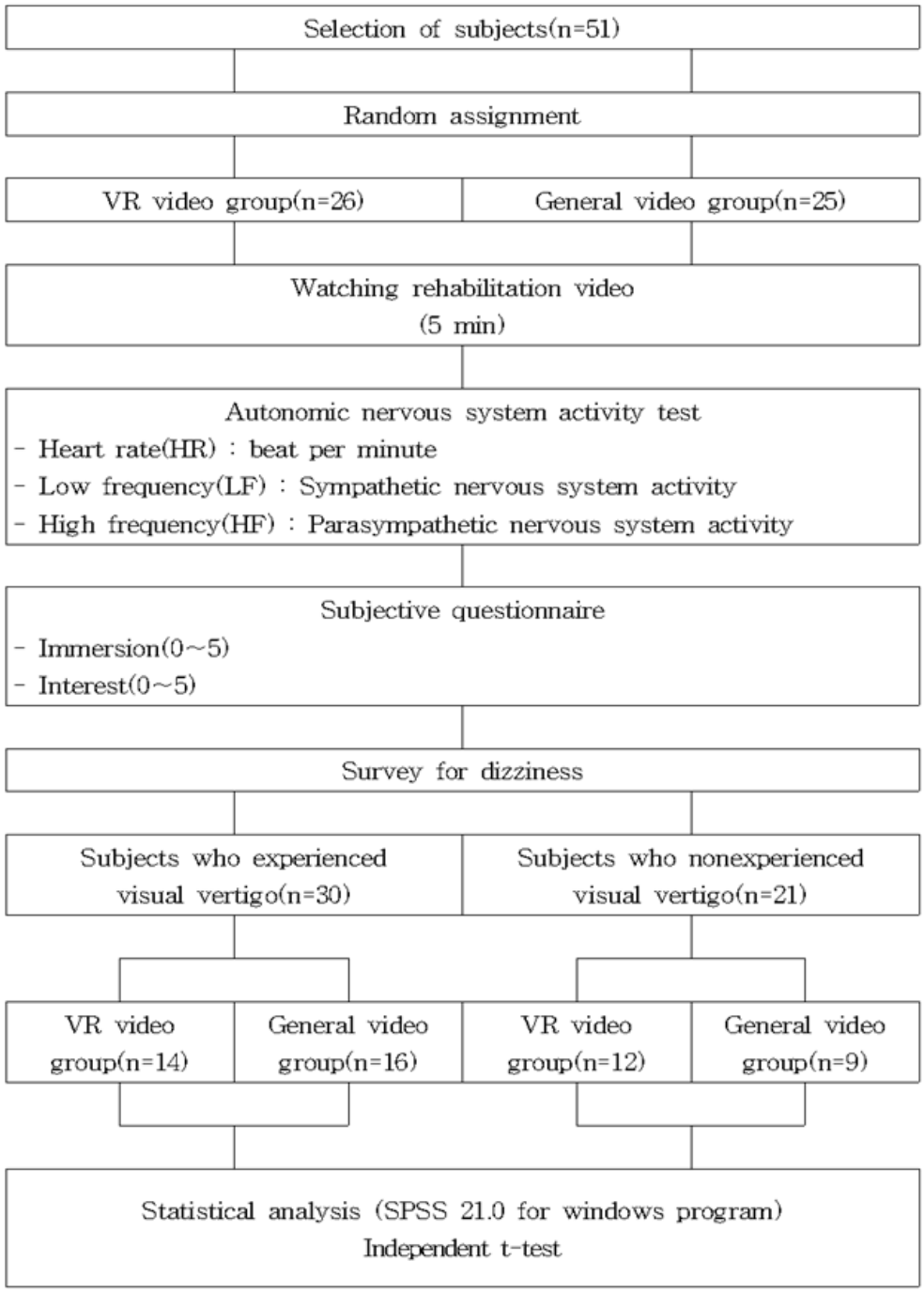

Figure 1. Schematic diagram of study design

Vestibular rehabilitation is implemented as a way to solve problems in the vestibular system. In general, the mechanism of vestibular rehabilitation is explained by mechanisms through compensation, adaptation and substitution[7]. Compensation uses a method ofinducing habituation as a recovery method through the neuroplasticity of the central nervous system and it seems to have applied this principle to previous studies.

Figure 2. Galaxy Gear360

Recently, with the development of technology, virtual reality(VR) technology is further advanced. Since the first mention of "la realite virtuelle" in the Theatre of Cuelty of French writer Antonin Artaud, virtual reality has evolved to the extent that virtual reality feels as immersed. Previous studies have reported that the application of immersive VR in VR rehabilitation enhances the effect of rehabilitation[8-9]. From this point of view, in the vestibular rehabilitation for visual vertigo patients, it is thought that VR using 360-degree video will show more effective rehabilitation effect than conventional rehabilitation.

In a recent study, Pavlou[10] 's study, published in 2009, conducted vestibular rehabilitation to stimulate optokinesis in subjects with visual vertigo, suggesting that it would be a new innovation in vestibular rehabilitation. In addition, pavlou suggested the therapeutic potential for the method of kinetic stimulation using high-tech as well as traditional therapies such as low-tech DVD. Pavlou[11], follow-up study, published in 2012, conducted a pilot study of patients with peripheral vestibular disease using optokinetic stimulation. As a result, dynamic VR reported the results of therapeutic effects as a useful adjunct to vestibular rehabilitation programs.

Motivation in rehabilitation as well as therapeutic effects is an important factor influencing the outcome of rehabilitation. Immersive imaging will be of interest to vestibular patients and have a positive impact on rehabilitation[12]. From a variety of perspectives, it's still unknown how VR using 360-degree video will benefit vestibular rehabilitation.

Figure 3. Ubpulse T1

Therefore, the purpose of this study is to investigate the effects of 360-degree VR video on autonomic nervous system, subjective immersion and interest in elderly people who experience visual vertigo and to investigate the rehabilitative effect of 360-degree VR video.

Method

This study was performed on 51 elderly people over 65 years of age living in Guri city, 18 males and 33 females participated in the study. The average age of the subjects was 72.16 ± 1.78 years and the average height and weight were 157.05 ± 5.06cm and 58.72 ± 5.06kg. All subjects participated in the experiment after hearing and agreeing with the purpose and method of the study. This study was conducted in compliance with the Helsinki Convention and the Research Ethics Standards. The schematic diagram of the study is shown in Figure 1.

All subjects were randomly assigned to the VR video group and general video group. The rehabilitation video was produced based on the previous visual vertigo rehabilitation video, which was a roadside drive, a street walk and a grocery store corridor. In the case of VR video, images were taken using Galaxy Gear360(Samsung, ROK)[Figure 2] and the general video was taken using Galaxy Tab 3(Samsung, ROK). The video was applied by wearing Galaxy Gear(Samsung, ROK) products and watched the Galaxy Tab 3(Samsung, ROK) at eye level

and placed at a proper distance in view of eyesight. Subjects in each group watched VR and general video for 5 minutes according to their assigned group. After watching the rehabilitation video, all subjects were evaluated for autonomic nervous system activity and heart rate and a questionnaire about subjective immersion and interest composed of five-point scale was prepared. Autonomic nervous system activity and heart rate were measured usingthe heart rate variability measuring device (ubpulse T1, Laxtha, ROK) [Figure 3]. Collected results were classified into two groups and analyzed: experienced vertigo and non experienced group.

All measured data were independent t test using SPSS 21.0 to test the comparison between groups according to 360 degree VR application. The statistical significance level was set at 0.05.

Result and Discussion

According to the results of this study, In subjects who experienced visual vertigo, VR video group showed higher value in sympathetic nervous system activity(LF, low frequency) and parasympathetic nervous system activity (HF, high frequency) after visualization of rehabilitation video than general video group and, subjective immersion and interest showed the same results[Table 1]. In subjects who nonexperienced visual vertigo, on the other hand, VR video group showed higher value than general video group only in subjective immersion and interest after visualization of rehabilitation video[Table 2]. The results of this study showed that VR video was more immersive and interesting than general video and subjects who experienced visual vertigo were more affected by autonomic nervous system after visualization of rehabilitation video.

Table 1: The changes in subjects who experienced visual vertigo after visualization of rehabilitation video

	VR video	General video
Immersion*	4.07±0.83	2.93±0.44
Interest*	4.29±0.99	2.19±1.17
Heart rate	80.57±7.57	79.94±12.92
Low frequency*	5.44±0.80	4.76±0.97
High frequency*	4.84±0.46	4.19±0.94

*:$p<0.05$

unit: point, point, bpm, ms^2, ms^2

The change of autonomic nervous system in this study can be regarded as change of vestibular system by visual response. Indeed, according to Kim[13]'s research, the vestibular system and the autonomic nervous system are closely related as the Vestibulo-Autonomic System. In particular, Kim also showed an increase in the low frequency reflecting the sympathetic nervous system activity and the high frequency reflecting the parasympathetic nervous Table 2: The changes in subjects who nonexperienced visual vertigo after visualization of rehabilitation video

	VR video	General video
Immersion*	4.07±0.83	2.93±0.44
Interest*	4.29±0.99	2.19±1.17
Heart rate	80.57±7.57	79.94±12.92
Low frequency*	5.44±0.80	4.76±0.97
High frequency*	4.84±0.46	4.19±0.94

*:$p<0.05$

unit: point, point, bpm, ms^2, ms^2

system activity. The results presented in this study suggest that the visual stimulation by VR video caused the change of autonomic nervous system and that stimulation by visual vestibular reflex can be effectively applied to vestibular rehabilitation.

In addition, according to Kim[9]'s research, VR increased the immersion, the effect of rehabilitation and thus also affected the balance. Other studies have shown the similar result and it can be seen that the rehabilitation through VR enhances the effect of rehabilitation by increasing the immersion feeling compared to the existing video media[14-15]. Therefore VR video is expected to show more effective rehabilitation effect than conventional therapeutic general video.

Miled[16]'s study also provided rehabilitation that provided interesting visual stimuli and reported that interesting stimuli increased the effectiveness of rehabilitation. In this study, the subjective interest score was higher in VR video. Many other studies are also aimed to make interest in using VR games[17-18]. In this respect, VR video is more interesting, so it will enhance the effect of rehabilitation in vestibular rehabilitation. In a recent Riches[19]'s study, VR rehabilitation was performed using Computer graphic(CG), patients were evaluated and mediated. In this CG environment, it is expected that the therapeutic effect, immersion and interest will be higher through active participation rather than passive rehabilitation. But we are facing the

limitation of VR content shortage. Future research will verify the effects of VR rehabilitation using CG along with content development.

Conclusion

Based on the results of this study, the 360-degree VR rehabilitation video would be more effective than the previously used rehabilitation video for visual vertigo. Therefore, the converging use of VR in vestibular rehabilitation has enhanced the rehabilitation effect. Future research will increase the participation of active rehabilitation through the development of VR rehabilitation contents and programs.

Ethical Clearance: Not required

Source of Funding: Self

Conflict of Interest: Nil

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