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The Effects of Balance of Low Vision Patients on Activities of Daily Living

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Abstract. [Purpose] This research investigated the relationship between balance measured by a TETRAX and activities of daily living (ADL) assessed by NEI-VFQ 25. The results should provide basic data for rehabilitation therapy for low-vision patients. [Methods] We used the NEI-VFQ-25 vision-related Activities of Daily Living evaluation, MMSE-K, and TETRAX to evaluate 30 low-vision outpatients at K hospital in Daejeon, South Korea from July 5 to July 23, 2012. We performed linear regression analysis using a statistical significance level of 0.05. [Results] Balance in the normal eyes open (NO) posture correlated with the normal eyes closed posture and age, but showed no correlation with NEI-VFQ 25. The ADL level correlated with monocular vision, female gender, cognition, and NO posture. These variables explained 54.4% of the aspects of their ADL. [Conclusion] This research proves that low vision adversely affects balance ability, and is influenced by type of vision, gender, and cognitive assessment.
Key words: Activities of daily living, Balance, Low vision

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INTRODUCTION

Low vision is defined as vision or visual field disorders that cause trouble in carrying out usual daily life, even after proper treatment or correction has been made for refractive errors. The World Health Organization (WHO) defines good eye vision as a state having 6/18 vision and a visual field angle of less than 20 degrees[1, 2)]. Vision plays an important role in maintaining a stable body balance by continuously providing information about environment, body movement, and body position to the nervous system[3)]. However, eye-closing causes a 20–70% postural sway increase in humans[4)]. Low vision patients experience difficulties in carrying out reading, leisure activities, and daily life due to eyesight damage[5–7)]. In addition, low vision leads to reduction in the proprioception and vestibular inputs that are required for balance maintenance[8)]. Among the various causes of balance maintenance problems, viewing angle impairment, which commonly occurs in elderly people, is the biggest cause[9)]. Low vision patients are exposed to the risk of falls by losing their postural balance[10)].

Several studies have reported that viewing angle impairment is related to the causes of falls by the elderly population[11–13)]. Other studies have reported that vision and balance ability are the most decisive factors in falls[14)]. In addition, Harry and Rhonda (2003) reported that balance ability declined with the degree of vision loss. In humans, balance ability is an essential element for successful performance of daily life and body movement, and it is balance ability that maintains body balance by using the principal elements[15, 16)]. Langley and Mackintosh emphasized balance ability an important element that affects the ability to carry out daily life[17)]. In addition, postural imbalance causes falls, and the fear of falling lowers independence or mobility limiting daily life[18)]. Previous studies have suggested that falls are caused by impaired balance ability, which is one of the causes the low levels of daily living activities of low-vision patients[26)]. We have to help low vision patients to put priority on their safety and to preserve their independence and quality of life through reducing their risk of falls by improving their balance ability. The evaluation of elements that affect the performance of activities of daily living (ADL) of low-vision patients play an important role in the rehabilitation of patients with low vision. Although many previous studies have been performed by focusing on the relationship between low vision and the performance of ADL or on the clinical analysis of low vision, no study has been performed on the relationship of low vision with balance ability, which is considered a major factor influencing the performance of daily living activities.

The purpose of the present study was to evaluate the relationship of balance ability of low vision patients with their performance of daily living activities to provide basic data for a professional rehabilitation program for low vision patients.

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Table 1. Correlations among the variables (N=30)

	NO	NC	GENDER	AGE	Bi -Monocular	NEI -VFQ- 25
TETRAX (NC)	0.71**					
GENDER	0.03	0.06				
AGE	0.41*	0.32	−0.10			
Bi−Monocular	−0.30	−0.34	−0.23	0.013		
NEI−VFQ 25	−0.45*	−0.36	0.019	−0.14	0.048**	
MME−K	−0.13	−0.19	−0.22	−0.024	−0.09	0.31

*p<0.05, **p<0.01

SUBJECTS AND METHODS

The subjects of the present study were 30 patients who visited the ophthalmology department of a University hospital located in Daejeon, Korea who had an eye condition of less than 6/18 of vision in one or both of their eyes. Data was collected performed during a 3-week period from July 5 to July 23, 2012. All the test subjects understood the purpose of the study, and consented to participation in the study. This study had a correlational research design. The study was approved by the research ethics committees of Konyang hospital. We trained raters for 2 weeks in the use of the assessment tools to increase the assessment reliability. Raters were blinded to the subjects' characteristics. The evaluation tool that was used in the present study was the National Eye Institute 25-Item Visual Function Questionnaire (NEI-VEQ-25) that was developed by Mangione et al. at the National Eye Institute (NEI). The NEI-VFQ-25 questionnaire is composed 12 sub-domains which contain a total of 26 questions. All questions are in objective form, and 5–6 sample answers are presented for each question. Since the 6th of the sample answers indicates that the stoppage of the activity is due to causes that are not related to vision, its scoring was excluded. For the balance ability test, we used the TETRAX the biofeedback training system (Tetrax Portable Multiple System, Tetrax Ltd., Ranmat Gan, Israel) that was developed by Sunlight Company of Israel was used. The equipment is a device which is used to measure the risk of falls and body balance state. It measures the postural sway on 4 forceplates located under the left and right forefeet and heels. It not only calculates the stability index, an index which can be measured on other balance measuring devices, but also various factors of posture such as diagonal postural sway and weight displacement pattern. Examinations were performed with the subjects adopting the following 8 examination postures: looking straight ahead with the eyes open (NO), and looking straight ahead with the eyes closed (NC); to limit somatosensory input, looking straight ahead with the eyes open and an elastic pillow (31×2 cm) under the feet (PO), and looking straight ahead with the eyes closed and an elastic pillow under the feet (PC); looking to the right with the eyes closed (HR); and looking to the left side with the eyes closed (HL); and with the head tilted back looking at the ceiling (HB), and head tilted downward with the eyes closed (HF). For the safety of the test subjects, when they stood on the elastic pillow with their eyes closed, an examiner stood at their side. In the present study, to assess the balance ability of patients with low vision, the NO posture incorporates visual, somatosensory and vestibular organ information for the maintenance of balance was compared with the stability index measured in the NC posture, which excludes visual information. The reliability of NEI-VFQ-25 is 0.85, and its validity is 0.90. In order to be assessed by the NEI-VFQ-25, patients need to be able to communicate with the raters. For cognitive examination tool, the Korean edition of the Mini-Mental State Examination (MMSE-K), that was developed by Kwon & Park for the Korean elderly, was used. It is a modified version of the Mini-Mental State Examination (MMSE) that was developed by Folstein, Folstein, & McHugh. The reliability of this examination tool was found to be 0.90 with a validity of 0.93.

For the statistical analysis of the data, the Win SPSS 18.0 program was used. To analyze the correlation of each variable, Pearson's correlation coefficient was calculated. Finally, to confirm the causality of the balance ability of the low vision patients in their performance of daily living activities, regression analyses were performed using independent variables.

RESULTS

Among the 30 test subjects, 17 test subjects were male (56.67%) and 13 test subjects were female (43.33%). The test subjects had a mean age of 64.37 years old with minimum age of 43 years and maximum age of 89 years. Eight test subjects were found to have low vision in both eyes (26.7%) and 22 test subjects had a low vision in one eye (73.33%). The NO posture found a positively correlated not only with the NC posture ($p<0.01$), but also with age ($p<0.05$). In addition, the NO posture was found to have a negative correlation with the NEI-VFQ-25 score ($p<0.05$). Both binocular and monocular recognition showed a positive relationship with the NEI-VFQ-25 score ($p<0.01$) (Table 1).

To confirm the variables that affect ability to perform daily living activities, linear regression analyses were performed using the TETRAX stability indexes of the NO and NC postures, type of vision impairment(monocular, binocular), cognitive capacity, gender, and age variables. When these variables were analyzed as a single model, the order of statistical significance showed the type of vision impairment had the highest B value of 23.86, and females showed

Table 2. Regression estimates of ADL

	Unstandardized Coefficients		T	p
	B	SE		
Bi−Monocular	23.86	5.72	−4.17	0.00
GENDER	16.71	4.90	3.41	0.00
MMSE−K	2.80	0.78	3.57	0.00
TETRAX(NO)	−0.38	0.17	−2.18	0.03
TETRAX(NC)	0.13	0.19	0.69	0.49
AGE	0.38	0.24	1.57	0.12
Constant	−62.43	31.87	−1.95	0.06
F		6.77***		
Adjusted R^2		0.54		

*p<0.05, **p<0.01, *** p<0.001

higher values than males in both monocular and binocular vision impairment. Also, a higher balance ability in the NO posture was associated with higher levels of daily living activities. The model fit was statistically significant with an F value of 6.77 (Table 2).

DISCUSSION

The present study investigated the effect of the balance ability of low-vision patients on their ability to perform ADL, to provide a basic data for a professional rehabilitation program for use with low-vision patients. Although other clinical evaluation tools that measure balance ability are useful, there is a high possibility that they are subjectively influenced by examiners or test subjects, and the evaluation of changes in balance ability is difficult[19]. In addition, a study of 27 healthy elderly people with approximate age of 60 years showed that both their Berg balance scale and TUG (Timed up and go) test times were normal and not significantly different from young adults suggesting the presence of a problem in the precise evaluation of balance abnormalities in the elderly[20]. Therefore, the present study used the highly sensitive TETRAX that is not affected by physical indexes such as body weight or height.

Daily living activities are the most basic and important activities of human life[21]. For those people having impaired vision, many vision-dependent activities and daily tasks are difficult or impossible to perform, reducing their ability to perform ADL and independence, which has a negative impact on their quality of life[22]. With the progression of vision loss, walking speed slows and the frequency of collision with obstacles increases, and daily living activities such as walking become impossible[23]. Therefore, rehabilitation specialists emphasize the necessity of providing rehabilitative education, such as the magnifier or recorder methods, to compensate for lowered vision and to raise the level of daily living activities of low-vision patients, along with the reorganization of their environments.

In the causality analysis results of the present study, the type of vision impairment (monocular, binocular) showed the most significant effect on daily life. Monocular patients were found to maintain significantly higher levels of daily living activities than the binocular patients. Patient interviews revealed that patients with monocular impairment had normal vision in the other eye, or the correction of refractive errors made it possible to perform general daily living activities. Even when they reported failure to hold an object at once because of problems of depth perception in one eye, they did not experience any major difficulties in their daily living activities. Therefore, we consider it most important for patients with monocular low vision to have not only ophthalmological treatments and regular periodic examinations, but also to make efforts to prevent the development of binocular eye impairment through therapeutic health interventions redesigning and checking their living patterns, delivering health promotion programs and appropriate education, preventing complications, and improving their living environments. Also, rehabilitation for visual perception (such as depth perception) is necessary[24]. Gender also had a large on the performance level of daily living activities, with the females showing higher levels than the males. Since the NEI-VFQ-25 includes activities that are considered gender specific such as needlework, cooking, clothing, shopping and meetings, the results are expected to be higher for women. Since frequently conducted activities can be performed by training of other sensory organs without dependence on vision, the daily living activity levels of the female would tend to be higher. The MMSE-K score was also confirmed to have an important effect on the daily living activities of low vision patients. It indicates that better cognitive ability of low-vision patients is suggestive of a higher level of daily living activities. Studies of the elderly population have shown that the relationship between daily living activities and cognitive capacity has a positive correlation ($p<0.001$)[25, 26], similar to the result of the present study. According to result of the present study, maintaining and improving the cognitive capacity of low vision patients would have important positive consequences for daily living activities. Among the test subjects, 2 cognitive disorder patients were included. Due to their advanced age, they were highly susceptible to dementia, which indicates the incorrectness of their NEI-VFQ-25 evaluations. A previous study compared the balance ability of an elderly population having vision loss and an elderly population without vision loss[9], and reported that the elderly population with vision loss showed lower balance ability ($p<0.001$). Based on that,

we considered the balance ability of low-vision patients is impaired, and investigated its effect on daily life. Most of the low-vision patients had balance scores below of the mean of healthy subjects, and the stability index of NO posture, but not that of the NC posture, was significant in the causality analysis ($p<0.05$). We consider that the NO posture is affected by both visual inputs and the inputs from the somatosensory and vestibular organs, but the NC posture only is affected by inputs from the somatosensory and vestibular organs. This indicates that the balance is affected by visual input, and the inputs, which has an important influence on the performance of daily living activities, and low-vision patients maintain their balance and carry out their daily living activities dependent on their remaining vision, and inputs from the somatosensory, and vestibular organs. Since the balance ability of low-vision patients is lower than normal, raising their risk of falls and negatively affecting their daily life, rehabilitation specialist should remind them of this when proving treatment. Problems with spacial cognition and object perception occur due to low vision, reducing balance ability and raising the risk of falls[17]. Accordingly, it will be necessary for rehabilitation specialists to reorganize the living and working spaces of low-vision patients, and efforts should be made to develop interventions and supplementary tools to improve the balance ability of low-vision patients, along with efforts to enhance their performance of daily living activity.

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