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RESEARCH

AGE-RELATED VISUAL PERCEPTION IS CORRELATED WITH POSTURAL BALANCE IN OLDER PERSONS.

Abstract

Introduction: Decreased cognition is accompanied by decreased postural balance, and visual perception is one of the cognition. The aim of this study is identified that the difference between visual perception and postural balance according to gender and age, and the relationship between visual perception and postural balance.in older person.

Materials and Method: The participants of 194 older person measured visual perception, measure time of visual perception and postural balance. Visual perception measured using Motor-Free Visual Perception Test-4, and measure time of visual perception was mean the time taken to measure visual perception. The postural balance was measured area (mm^2), length (cm), and average speed (m/s) of center of pressure displacement in a standing position with open eyes.

Results: Spatial relationship, figure-ground and visual memory of visual perception were lower in 85 years or older than in the other group. Measure time of visual perception was significantly correlated with the length and average speed of center of pressure, and visual perception score was significantly correlated with area of center of pressure. Among the spatial relationship and figure-ground were significantly correlated with area of center of pressure, and visual discrimination was significantly correlated with length and average speed of center of pressure.

Conclusion: This result indicated that visual perception is related to age, and slower measure time of visual perception and lower visual perception scores were correlated with poorer postural balance. Slowed visual processing in elderly individuals may affect postural balance.

Key Words: Aged, Postural balance; Visual perception; Posture; Sex

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ARAŞTIRMA

YAŞLI BİREYLERDE POSTURAL DENGEYLE İLİŞKİLİ YAŞA BAĞLI GÖRME ALGISI

Öz

Giriş: Bilişsel durumda gerilemeye postural dengede bozulma eşlik eder ve görsel algılama da bilişsel bir durumu tanımlar. Bu çalışmanın amacı görsel algılama ve postural dengenin cinsiyet ve yaşa göre farklılıklarını ortaya koymak ve yaşlı bireylerde görsel algı ve postural denge arasındaki ilişkiyi incelemektedir.

Gereç ve Yöntem: Araştırmaya katılan 194 yaşlı bireyde görsel algı, görsel algılama zamanı ve postural denge ölçümü yapıldı. Görsel algı, Motor Beceriden Bağımsız Görsel Algı Testi-4 aracılığı ile ve görsel algılama zamanı da algılama için geçen zamanın ortalaması kullanılarak değerlendirildi. Postural denge için, gözün açık olduğu konumda yer değiştirme açısından alan (mm^2), uzunluk (cm) ve ortalama hız (m/s) kategorilerinde değerlendirmeler yapıldı.

Bulgular: Mekansal ilişki, şekil-zemin ve görsel algı 85 yaş ve üzeri grupta diğer yaş gruplarına göre daha düşük bulundu. Görsel algılamanın ölçüm süresi basınç merkezinin uzunluğu ve ortalama hızı ile ve görsel algılama puanı da basınç merkezinin alanı ile anlamlı derecede ilişkili idi. Mekansal ilişki ve şekil zemini arasında basınç merkezi alanı ile anlamlı bir korelasyon vardı ve görsel ayırma, basınç merkezinin uzunluğu ve ortalama hızı ile anlamlı korelasyon içindeydi.

Sonuç: Bu sonuç, görme algılamasının yaşla ve görsel algılama süresinde yavaşlama ile düşük görme algı skorunun kötü postural denge ile ilişkili olduğunu ortaya koymuştur. Yaşlı bireylerde görme işleminin yavaşlaması postural dengeyi etkileyebilir.

Anahtar Sözcükler: Yaşlı; Postural denge; Görsel algı; Duruş; Cinsiyet

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INTRODUCTION

Poor functional mobility and decreased independence in older person may be related to balance confidence (1). Lack of confidence in balance may be related to deteriorated function caused by physical degeneration. Stability is affected by the visual system, which perceives the environment, performs perceptual learning to adapt to stable environments, and drives brain responses to sudden changes in the environment (2). In particular, poor visual function in older person can affect their ability to independently perform activities of daily living (ADL) (3).

Slower visual processing in older persons increases the risk of falls and causes mobility problems, such as postural changes (4). Thus, older persons' ability to perform ADL is affected by functional problems and advancing age and may be related to various aspects of visual function (5). Deterioration of the perceptual process in older persons may be the result of visual dysfunction (6), which causes problems such as inadequate responses to environmental changes and reduced postural stability.

Visual perception (VP) includes five components: spatial relationship, visual discrimination, figure-ground perception, visual closure, and visual memory (7). Spatial relationship specifies how objects are located in space in relation to a reference object. Visual discrimination refers to the ability to differentiate between positions, shapes, forms, and colors of objects and letter-like forms. Figure-ground is a type of visual discrimination that refers to the ability to distinguish an object from the background or from another object. Visual closure is also a type of visual discrimination that refers to the ability to perceive a whole figure when only fragments are presented. Finally, visual memory refers to the ability to perceive and remember a viewed stimulus item after a very brief interval. These five categories are most commonly used for assessing VP (8).

In older persons with slow perceptual processes, the length and area of center of pressure (COP) displacement is increased during cognitive tasks (9). Slower perceptual processes may be related to failure to maintain posture, and VP in particular may be related to functional independence (10). Functional independence and good postural balance can be an important factor of the quality of life in older person (11). Also, VP is important for detecting perception of aging and should be tested regularly from age 50 (12). According to the above, visual perception may be a correlation the aging and postural balance (PB).

The purpose of this study was to examine how changes in sex and age can difference VP and PB, and identify correlations between VP and PB in older persons.

MATERIALS AND METHOD

Participants and procedures

Participants were recruited through various community center advertisements, such as posters. Then researcher was interviewed by telephone and recruited as a suitable people for inclusion and exclusion criteria. Inclusion criteria were older person above 65 years and who has the ability to stand and walk without walking aid of 5m or more. Exclusion criteria included a history of lower extremity surgery, falls or dizziness, previous balance and neurological or vestibular impairment, and any contraindications for measurement procedures. In this study, 203 people were recruited, but participants were 194 people, excluding the 9 people who did not perform the VP test.

All participants signed written informed consent forms. This study was approved by the Gachon University Institutional Review Board and was carried out in accordance with the Helsinki Declaration. Before initiating the study, the general characteristics of all participants were measured. During the study, PB was measured with eyes open, and VP was subsequently analyzed.

Outcome Measures

Visual perception assessment: VP was assessed using the Motor-Free Visual Perception Test-4 (MVPT-4), which was designed for screening, diagnostic, and research purposes. The MVPT-4 provides a quick, reliable, and valid measure of the overall visual perceptual ability of individuals aged 4 to ≥ 85 years; it is suitable for use in clinical practice and is highly reliable (13). MVPT-4 divided 5 categories, such as spatial relationship, visual discrimination, figure-ground perception, visual memory, and visual closure, and each category consists of 9 questions. It is a total of 45 questions. Visual perception was measured by face-to-face interview. The question of the MVPT-4 was drawn the picture. After researchers explained the each categories of MVPT-4, the participant was answer to the question on 9 questions, which is a multiple choice response form. In this study, row scores of MVPT-4 were measured. The row score was the number of correct answer and row scores range from 0 to 45. The higher score, the better the VP ability.

Visual perception time (VP-T) is the time taken to measure MVPT-4. The total time taken for a participant to answer each item was measured, excluding the time taken for the researcher to explain an example, and VP-T for each unanswered item was recorded as 30 s. If the participants did not answer an item for more than 30 s or answered after 30 s, the item was scored as an incorrect answer.

MVPT-4 was translated into Korean and the Cronbach alpha value of this study was 0.772.

Postural balance measurement: PB is conventionally assessed by displacement in COP during quiet standing. PB was measured using a BioRescue system (RM Ingenierie, Rodez, France). The BioRescue system consists of a platform, software, and monitor. The platform (610×580×10 mm) is very thin and equipped with approximately 1,600 pressure sensors. The platform safely and accurately measures the length and area of COP in both feet of an individual and then transmits data to the computer software. Data measured from the platform are visualized as a COP trajectory and displayed on the monitor while the participant maintains a stance with postural stability.

Center of pressure is the outcome of inertial forces acting on the body as the postural control system acts to restore equilibrium, and COP is commonly defined as the point of application of the ground reaction force vector. The area and length include the total area and the distance of the COP trajectory during the time measured. The average speed indicates the speed of the COP trajectory during the time measured. Larger values indicate poor postural stability.

Postural balance was measured by area (mm^2), length (cm), and average speed (cm/s) of COP displacement while participants maintained a static posture with eyes open for 30 s. Mean values for measurements were used.

Statistical analysis

All statistical analyses were performed using SPSS 21.0. The general characteristics of the participants were analyzed using descriptive statistics. Correlations between dependent variables of VP and postural stability were analyzed using the Pearson's correlation test. In addition, dependent variables of VP and postural stability were compared between groups and in terms of sex and age (young older, 65–74 years; middle older, 75–84 years; old older, ≥85 years) using the independent t-tests and one-way analysis of variance (ANOVAs). The significance level was set at $p<0.05$.

RESULTS

The mean age of the 194 participants was 76.36±6.25 (range, 65–88) years, and the general characteristics of the participants are shown in Table 1. VP and postural stability were compared in terms of sex, and males were found to have significantly higher scores in figure-ground perception than females ($p<0.05$), whereas there was no significant difference in postural stability in terms of sex (Table 2). In the comparison in terms of age, scores in VP, spatial relationship, figure-ground perception, and visual memory were significantly lower in the old older group than in the young older group ($p<0.05$). COP area was significantly increased in the old older group compared with the young older group ($p<0.05$) (Table 3). Analysis of correlations between VP and PS in all participants revealed that VP-T was significantly correlated with COP length and COP average speed ($p<0.05$) and VP was significantly correlated with COP area ($p<0.05$). Spatial relationship ($p<0.05$) and figure-ground perception ($p<0.05$) were significantly correlated with COP area. Visual discrimination was significantly correlated with COP length ($p<0.01$) and average speed ($p<0.05$) (Table 4).

Table 1. Baseline characteristics of the participants.

Characteristics	Male (n=84)	Female (n=110)	Total (n=194)
Age (years)	75.47±7.29	76.51±6.25	76.36±6.25
Height (cm)	164.30±7.44	151.09±5.39	156.90±7.90
Weight (kg)	66.27±10.10	58.24±7.56	59.34±8.38

Values are presented as means±SD.

Table 2. Comparison of visual perception and postural stability according to sex.

Characteristics	Male (n=84)	Female (n=110)	p
COP area (mm^2)	36.13±5.43	36.65±2.09	0.972
COP length (cm)	11.50±1.04	12.33±0.48	0.515
COP average speed (cm/s)	0.37±0.04	0.41±0.02	0.436
Visual perception score	30.73±1.32	26.96±0.53	0.059
VP-T (min)	18.62±0.94	19.11±0.38	0.664
Spatial relationship	5.73±0.36	4.87±0.78	0.076
Visual discrimination	6.67±0.39	6.00±0.14	0.079
Figure-ground perception	5.60±0.46	4.68±0.15	0.030
Visual closure	5.87±0.36	5.42±0.17	0.319
Visual memory	6.87±0.35	5.98±0.18	0.068

Values are presented as means±SE. COP: center of pressure, VP-T: visual perception measurement time

Table 3. Comparisons of visual perception and postural stability according to age.

Characteristics	Young older (n=64)	Middle older (n=84)	Old older (n = 46)	p
Age (years)	67.20±0.49	75.14±0.36[a]	85.84±0.31[a]	0.000
COP area (mm^2)	32.92±4.72	34.88±2.77	41.76±3.23[a]	0.022
COP length (cm)	10.98±0.73	11.98±0.59	13.38±0.92	0.152
COP average speed (cm/s)	0.35±0.02	0.39±0.02	0.44±0.03	0.130
Visual perception score	29.90±1.23	27.70±0.69	25.61±0.85[a]	0.014
VP-T (min)	18.81±0.49	19.08±0.87	19.67±0.64	0.684
Spatial relation	5.55±0.44	5.18±0.21	4.33±0.28[a]	0.023
Visual discrimination	6.25±0.30	6.19±0.19	5.82±0.22	0.389
Figure-ground perception	5.60±0.34	4.75±0.19	4.42±0.26[a]	0.022
Visual closure	5.80±0.35	5.30±0.21	5.61±0.29	0.423
Visual memory	6.70±0.31	6.28±0.23	5.42±0.32[a]	0.018

Values are presented as means±SE. COP: center of pressure, VP-T: visual perception measurement time. [a]$p<0.05$ indicates a significant difference compared with the young older group.

Table 4. Pearson's correlation coefficients between visual perception and postural stability.

Characteristics	Pearson correlation coefficient	p
Visual perception score vs. COP area	−0.258	0.000
VP-T vs. COP length	0.246	0.023
VP-T vs. COP average speed	0.237	0.032
Spatial relation vs. COP area	−0.192	0.045
Visual discrimination vs. COP length	−0.251	0.008
Visual discrimination vs. COP average speed	−0.207	0.030
Figure-ground perception vs. COP area	−0.194	0.043

DISCUSSION

This study aimed to identify correlations between VP and PB in older persons during quiet standing. As age increased, VP decreased, and VP scores and VP-T were significantly correlated with PB.

For older persons who have difficulty with independent living, their perception of the external environment, rather than their sensation of the external environment, is fundamentally important for their movements (14). VP is the perceptual process of visual stimulation, and Tobis et al. (15)

stated that VP is correlated with age and sex. Although this study found no significant differences in terms of sex, the VP score in the old older group was significantly lower. Therefore, authors suggested that age rather than sex may affect VP.

In this study, PB was measured in an upright standing posture. The standing posture requires more attention than the sitting posture, and impaired visual attention or slow visual processing in the older person may be related to poor mobility (16). In this study, VP-T was significantly correlated with the length and average speed of COP displacement, which may indicate that visual processing speed is reduced because of aging; VP was also found to be deteriorated in this study, similar to that reported in previous study. PB is required for mobility (14). Therefore, if visual processing is slow in older persons, it may cause PB problems in dynamic and static postures, such as standing. Further studies comparing static and dynamic postures are necessary in the future.

Tobis et al. (17) reported that VP was low in older persons and in patients with previous falls and decreased PB, indicating an association between VP and PB. They confirmed that VP was significantly correlated with the area of COP displacement and that VP-T was correlated with the length and speed of COP displacement. Our finding indicates that VP and VP-T in community-dwelling older persons are associated with PB.

In this study, there was a difference in spatial relations in terms of sex, similar to results from a study reporting that men have advantages in visuospatial ability (18). This indicates that older females have decreased spatial perception ability compared with older males. In addition, aging may increase the delay in individuals' form perception or affect their shape discrimination (19) and figure-ground separation (20). Results of this study, there were significant differences in spatial relation, figure-ground perception, and visual memory between the old older group and the other groups. Our findings are consistent with those of previous studies, which estimated that spatial perception ability, the ability to perceive the structure of objects are located in space, may decrease because of aging (19,20).

Age is closely related to COP displacement (21), and COP displacement increases in older persons with balance impairment (22). In this study, the area of COP displacement, a measure of PB, increased in the old older group, indicating that VP and PS declined with age. This study also found that VP score and VP-T were significantly correlated with the area, length, and speed of COP displacement. Taken together, these data suggest that slowed visual processing in older persons may be affected by PB.

In particular, previous study found that visual discrimination, figure-ground perception, visual memory, and spatial relations were all decreased in older persons (23). If the VP ability declines, it affects basic and critical ADL (24) and may result in poorer balance and increased risk of falls (25). These results are consistent with those of the present study, which showed negative correlations between PB and spatial relation, visual discrimination, and figure-ground perception among VP items. VP is closely correlated with PB and may affect physical function for maintaining ADL. In this study, the authors predict that decreased VP score and delayed VP-T may be factors for deficits in PB. Therefore, VP measures may be used to evaluate which older persons have poorer PB and greater risk of falls.

In conclusion, this study showed that VP is an association between age rather than sex, and VP-T and VP scores are significant correlated with postural balance, and spatial relationship, figure-ground perception, and visual discrimination are significantly correlated with postural balance. These findings suggest that VP and VP-T may be predicted poor PB in older persons and that maintaining good VP ability is essential as people age.

The present study has a few limitations. First, the authors used self-reported information on VP ability. Second, this study had a cross-sectional design, and 194 participants were not enough to generalize the results of this study. Therefore, authors suggest that further cohort studies of the association between VP and PB in older adults are needed to confirm the present findings.

Conflict of interest

The authors declare no potential conflicts of interest.

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