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Determination of Normal Video Head Impulse Test Gain Values in Different Age Groups

Farklı Yaş Gruplarında Normal Video Head İmpulse Testi Kazanç Değerlerinin Tespiti

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ABSTRACT Objective: The vestibulo ocular reflex evaluation is very important because of the valuable information it gives in the evaluation of vertigo. Video head impulse tests (vHIT) are widely used to evaluate the vestibulo ocular reflex. vHIT can be used both in childhood and in adults. Therefore, normal gain value ranges have to be determined for all age groups. **Material and Methods:** Healthy relatives of patients were selected as volunteers. vHIT was performed on all participants by the same experienced right-handed audiologist. An Otometrics ICS Impulse system was used to record measurements. The volunteers were divided into eight groups according to their age; Group 1: 12-20 years, Group 2: 21-30 years, Group 3: 31-40 years, Group 4: 41-50 years, Group 5: 51-60 years, Group 6: 61-70 years, Group 7: 71-80 years, and Group 8: 81-88 years. Gain values were determined for each participant. Differences between groups were compared using the Kruskal-Wallis test. **Results:** One hundred twenty-nine healthy participants were included in the study. The mean age was 44.30±21.14 (range, 12-88) years, there were 62 (48.1%) males and 67 (51.9%) females. The mean values for the right anterior, left anterior, right lateral, left lateral, right posterior, and left posterior canals were 0.90±0.11, 0.88±0.09, 0.97±0.11, 0.87±0.10, 0.90±0.11, and 0.89±0.10, respectively. There were no statitistical significant differences in gain values between the age groups (p>0.05). **Conclusion:** vHIT can be used in nearly all age groups, and gain values are in the same normal ranges in almost all age groups.

Keywords: Vertigo; dizziness; reflex, vestibulo-ocular

ÖZET Amaç: Vestibulo oküler refleksin değerlendirilmesi verdiği değerli bilgiler nedeniyle vertigo yönetiminde çok önemlidir. Video head impulse testi (vHİT), vestibulo oküler refleksi değerlendirmek için yaygın olarak kullanılan bir testtir. vHİT hem çocuklarda hem de yetişkinlerde kullanılabilmektedir. Bu nedenle, tüm yaş grupları için normal kazanç değerleri belirlenmelidir. **Gereç ve Yöntemler:** Hastaların sağlıklı akrabaları gönüllü katılımcı olarak seçildi. vHIT tüm katılımcılara aynı deneyimli sağ elini kullanan odyolog tarafından uygulandı. Ölçümleri kaydetmek için Otometrics ICS Impulse sistemi kullanıldı. Gönüllüler yaşlarına göre 8 gruba ayrıldı; Grup 1: 12-20, Grup 2: 21-30, Grup 3: 31-40, Grup 4: 41-50, Grup 5: 51-60, Grup 6: 61-70, Grup 7: 71-80 ve Grup 8: 81-88. Her katılımcı için kazanç değerleri belirlendi. Gruplar arası farklılık Kruskal-Wallis testi ile karşılaştırıldı. **Bulgular:** Toplam 129 sağlıklı katılımcı çalışmaya dahil edildi. Yaş ortalaması 44.30 ± 21.14 (aralık, 12-88), 62 (%48.1) erkek ve 67 (%51.9) kadın vardı. Sağ anterior, sol anterior, sağ lateral, sol lateral, sağ posterior ve sol posterior kanallar için ortalama değerler sırasıyla 0.90±0.11, 0,88±0,09, 0,97±0,11, 0.87 ± 0.10, 0.90±0.11, 0.89±0.10 idi. Kazanç değerlerinde yaş grupları arasında istatistiksel anlamlı sonuç saptanmadı (p>0.05). **Sonuç:** vHİT, neredeyse tüm yaş gruplarında kullanılabilmektedir ve kazanç değerleri hemen hemen tüm yaş gruplarında aynı normal aralıktadır.

Anahtar Kelimeler: Vertigo; baş dönmesi;refleks, vestibulo-oküler

Vertigo is one of the most common reasons for outpatient clinic and emergency department presentations. Although it is seen frequently, patients usually describe dizziness, presyncope, and motion sensation as vertigo. Vertigo may be caused by several diseases, and the physician's first goal is to diagnose emergency illnesses that can present as vertigo. Therefore, the first objective is usually to

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discriminate peripheral and central vestibular disorders.

The vestibulo ocular reflex (VOR) is one of the most commonly tested reflexes for analyzing semicircular canals. The VOR is tested with high-speed, abrupt, unpredictable, head impulses. The test can be performed using goggles and a video recording [video head impulse test (vHIT)] or detected by examiners [clinical head impulse test (cHIT). vHIT enables seeing both covert and overt saccades and is superior to cHIT, which can only observe overt saccades. Yip et al. recommended vHIT as being complementary to cHIT.[1] For peripheral vestibular disorders, it is recommended to perform vHIT for each semicircular canal and then a caloric test, except with the suspicion of Meniere disease.[2] Although the search coil system is the gold standard for measuring VOR, vHIT results are comparable. With recent studies, it is understood that vHIT can be tolerated by children aged as young as 4 years, and it can also be used in the elderly.

Therefore, we aimed to investigate the effect of aging on VOR gains for each semicircular canal, and to determine the normalized VOR ranges in our population.

MATERIAL AND METHODS

Ethics approval was obtained from the local ethics committee (number: 2018-66). The study was conducted in accordance with the principles set out in the Helsinki Declaration 2008.

VOLUNTEER SELECTION

Volunteers were selected from the relatives of patients admitted to our outpatient clinic. Written informed consent was obtained from each participant. The exclusion criteria were hearing abnormalities, vestibular disorder history, tinnitus, dizziness, visual problems, and neck disorders. A total of 129 eligible volunteers were included in the study. The participants were separated into eight groups according to age.

TESTS

All vHIT tests were performed by the same experienced right-handed audiologist (LK). The participants' measurements were recorded using an Otometrics ICS Impulse system (GN Otometrics). In this system, lightweight goggles, integrated with a high-speed camera (250 Hz), was focused on the right eye and tri-axial gyroscopes recorded head and eye movements.

Each participant was seated on a chair, located 1 m from the wall. A visual target was located on the wall at a height of 1.5 m. An ideal position for the operator to deliver horizontal or vertical impulses was achieved because the chair was rotatable and height-adjustable. The ICS Impulse system goggles were placed firmly, according to the manufacturer's instructions, to avoid slippage, which could cause incorrect measurements.

The gain was described as the ratio of the area under the eye velocity curve to the area under the head velocity curve during head movement.[3]

STATISTICAL ANALYSIS

First, the Kolmogorov-Smirnov test was performed to check normality in the distribution for each canal gain. We decided to use nonparametric tests because the group distribution was not homogenous. Then, the Kruskal-Wallis test was performed to investigate the difference in age groups. A p-value less than 0.05 was accepted as statistically significant.

RESULTS

The mean age was 44.30±21.14 (range, 12-88) years. There were 62 (48.1%) males and 67 (51.9%) females. In Group 1, there were eight males and 12 females, in Group 2 there were 11 males and 10 females, in Group 3 there were 10 males and nine females, in Group 4 there were nine males and 12 females, in Group 5 there were 10 males and eight females, in Group 6 there were five males and five females, in Group 7 there were seven males and three females, and in Group 8 there were two males and eight females. There was no significant relation between gain values and sex for all age groups ($p>0.05$).

There were 20 (15%) participitants in Group 1, 21 (17%) in Group 2, 19 (14%) in Group 3, 21 (17%) in Group 4, 18 (13%) in Group 5, 10 (8%) in Group 6, 10 (8%) in Group 7, and 10 (8%) participitants in Group 8. There was no statitistical significant difference in gain values between the age groups ($p>0.05$).

TABLE 1: Vestibulo ocular reflex gain values for each six semisircular canal and their distrubiton with age groups.

Age group	n	Right ant p=0.63	Left ant p=0.84	Right lat p=0.12	Left lat p=0.53	Right post p=0.41	Left post p=0.06
12-20	20	0.86±0.06	0.86±0.10	0.96±0.09	0.85±0.09	0.92±0.12	0.87±0.05
21-30	21	0.91±0.10	0.85±0.09	0.98±0.10	0.85±0.07	0.87±0.13	0.85±0.08
31-40	19	0.89±0.10	0.90±0.12	1.01±0.13	0.88±0.09	0.94±0.14	0.86±0.10
41-50	21	0.93±0.08	0.88±0.08	0.96±0.15	0.87±0.12	0.94±0.10	0.95±0.12
51-60	18	0.89±0.10	0.87±0.07	0.98±0.05	0.89±0.05	0.87±0.09	0.88±0.07
61-70	10	0.90±0.09	0.88±0.10	0.99±0.13	0.86±0.15	0.90±0.13	0.89±0.09
71-80	10	0.90±0.12	0.90±0.08	0.94±0.10	0.94±0.13	0.90±0.09	0.91±0.07
81-88	10	0.95±0.25	0.89±0.11	0.88±0.11	0.88±0.12	0.88±0.06	0.91±0.17
Total	**129**	**0.90±0.11**	**0.88±0.09**	**0.97±0.11**	**0.87±0.10**	**0.90±0.11**	**0.89±0.10**

The VOR gain for each of the six semi-circular canals and their distribution according to age groups is shown in Table 1.

DISCUSSION

The determination of normal ranges of gains in VOR and vHIT has become important because these evaluations are widely used, informative, and easily applicable in patients with vertigo. There are a limited number of studies with different age groups in the current literature. We tested 129 healthy volunteers aged 12-88 years. Our study results showed that vHIT could be used between the ages of 12 and 88 years, and the same gain range could be used in all.

In a study by Young et al. consisting of 50 healthy participants aged between 20-70 years, the results showed that vHIT gains showed no differences between the age groups.[4] Maheu et al. investigated the effect of aging on vHIT gains of the anterior and posterior semicircular canals.[5] The authors found that a 0.012 decline existed every decade, and a statistically significant decrease was seen in those aged over 90 years. Although anterior canals were not affected by age, the gain of posterior canals was slightly decreased. Kim et al. analyzed the effect of aging with 835 participants for horizontal semicircular canals and 434 participants for vertical semicircular canals.[6] They reported that horizontal canal decline was seen in those aged over 70 years and vertical canal decline was seen in participants aged over 80 years. Matino-Soler et al. studied 212 healthy adults and found that high-speed vHIT gains decreased in adults aged over 71 years, and vHIT gains decreased independent from speed in participants aged over 90 years.[7] McGarvie et al. investigated the effect age with healthy participants aged 10-89 years and found that age had a minimal effect on vHIT gains.[8] As mentioned above, the decrease in VOR gains by age is controversial and a generally accepted cut-off age has yet to be determined. In our study, we found no significant decline in the 80+ age group.

The applicability of vHIT in the pediatric age group has also been investigated. vHIT is an important well-tolerated, sensitive, and efficient test that can be used for both vertical and horizontal semicircular canals in the pediatric age group.[9-11] Hamilton et al. investigated vHIT in pediatric age groups for the lateral semi-circular canal (LSSC) and found it to be superior to the caloric test and rotation chair; vHIT has high sensitivity and specificity for detecting vestibular dysfunctions in pediatric age groups.[9]

Bachmann et al. investigated normative values in pediatric age groups (4-12 years).[12] They analyzed three groups as 4-6 years, 7-9 years, and 10-12 years, and found no differences between the pediatric groups. However, when they compared the pediatric groups (4-12 as a single group) with adults, they found that horizontal SSC gain was similar, but left anterior-right posterior and right anterior-left posterior SSC showed different variable gain values. Our

results showed that vHIT gain values were not significantly different from adults. We observed no differences between horizontal and vertical semicircular canals.

CONCLUSION

Based on our findings and the literature, it is clear that vHIT can be used in nearly all age groups. Normal volunteers gain values are not significantly different across different age groups, and they are also not affected by sex.

Informing

Due to the presence of the name of the journal editor's among the authors, the assessment process of the study was conducted by the guest editor.

Source of Finance

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Mehmet Akif Abakay, Levent Kufeciler, Zahide Mine Yazıcı, Filiz Gülüstan, Baver Maşallah Şimşek, Selçuk Güneş, İbrahim Sayın;* ***Design:*** *Mehmet Akif Abakay, Levent Kufeciler, İbrahim Sayın;* ***Control/Supervision:*** *Zahide Mine Yazıcı, Filiz Gülüstan, Baver Maşallah Şimşek, Selçuk Güneş;* ***Data Collection and/or Processing:*** *Mehmet Akif Abakay, Levent Kufeciler, Zahide Mine Yazıcı, Filiz Gülüstan, Baver Maşallah Şimşek, Selçuk Güneş, İbrahim Sayın;* ***Analysis and/or Interpretation:*** *Mehmet Akif Abakay, Levent Kufeciler, Filiz Gülüstan;* ***Literature Review:*** *Mehmet Akif Abakay, Levent Kufeciler, Filiz Gülüstan, Baver Maşallah Şimşek, Selçuk Güneş;* ***Writing the Article:*** *Mehmet Akif Abakay, Levent Kufeciler, Filiz Gülüstan, Baver Maşallah Şimşek, Selçuk Güneş, Zahide Mine Yazıcı, İbrahim Sayın;* ***Critical Review:*** *Zahide Mine Yazıcı, İbrahim Sayın;* ***References and Fundings:*** *Mehmet Akif Abakay, Levent Kufeciler, Filiz Gülüstan, Baver Maşallah Şimşek, Selçuk Güneş, , Zahide Mine Yazıcı, İbrahim Sayın.*

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