Video head impulse test in different age groups

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Received 22 April 2017
Accepted 11 July 2017

The Egyptian Journal of Otolaryngology
2018, 34:90–93

Background and objective
The head impulse test is a well-known clinical test that uses video-oculography to quantify vestibulo-ocular reflex (VOR). Normative data for VOR gain are accessible, but most studies just report horizontal-plane VOR characteristics, overlooking variations in vertical-plane VOR gains. The aim of this study is to supply normative data for different age groups to permit future comparison of results to the matching norms.

Patients and methods
The study was accomplished on 50 individuals who have normal peripheral hearing sensitivity, no otological disorder, and have no history of vestibular disorder, and were divided according to age into five groups, each one comprising 10 participants: individuals in the first group were aged 10–25 years, individuals in the second group were aged 25–35 years, individuals in the third group were aged 35–45 years, individuals in the fourth group were aged 45–55 years, and individuals in the fifth group were aged more than 55 years. Video head impulse test was done using GN Otometrics ICS Impulse in the lateral, left anterior right posterior, and right anterior left posterior semicircular canal planes.

Results
This study demonstrated that age has no impact on VOR gain, and it can be applied indifferently to all ages.

Conclusion
These normative values permit the correlation between the results of any specific patient and the values of healthy people of the same age range.

Keywords:
vestibular, video head impulse test, vestibulo-ocular reflex

Egypt J Otolaryngol 34:90–93

1012-5574

Introduction

The role of vestibulo-ocular reflex (VOR) throughout head movement is to stabilize images on the retina by moving the eyes at a similar speed but in the opposite direction of the head movement; the gain of VOR is defined as the relationship between head and eye movements [1–3]. The magnetic scleral search coil technique is without a doubt the cornerstone regarding measuring the function of the VOR [4,5].

Considering scleral search coil technique as a semi-invasive technique and only a small number of centers are capable of using this method, and the fact that it needs some preparations, the video head impulse test (vHIT) was created to reinforce bedside clinical testing [6,7].

Recent studies examined the direct correlations between the magnetic scleral search coil technique and the vHIT, and they demonstrated that the last was a reliable test [6,8].

vHIT is qualified for recording eye and head movements; therefore, it will decide the gain of the VOR in addition to the temporal onset and amplitudes of catch-up saccades in relation to head movements [6,7,9,10].

The vHIT is a respectable tool for distinguishing unilateral from bilateral horizontal semicircular canal loss. Lately, vHIT has been reached out to testing vertical canal function. This permitted rapid, easy, simple, precise, and individual testing of each of the six semicircular canals [11–13].

The aims of current study are to supply normative data for different age groups to permit future comparison of results with the matching norms.

Aim

The aim of this study was to help in the accurate diagnosis of balance pathology through stabilizing age-appropriate normative data.

Patients and methods

Patients

The study was accomplished on 50 individuals with normal peripheral hearing, no otological disorder, and no history of vestibular disorder. The study was accomplished in the Audiology Unit of Alexandria Main University Hospital. The studied population was divided according to age into five groups, and all groups contained 10 individuals: individuals in the first group were aged 10–25 years, individuals in the second group were aged 25–35 years, individuals in he third group were aged 35–45 years, individuals in the fourth group were aged 45–55 years, and individuals in the fifth group were aged over 55 years.

Methods

Medical ethics were considered, participants were informed that they were a part of a study, and they were asked to sign a written consent.

All of them were subjected to history taking, otoscopic examination, and assessment of peripheral hearing sensitivity.

vHIT was done using GN Otometrics ICS Impulse video goggles (GN Otometrics, Taastrup, Denmark), in the lateral, left anterior right posterior (LARP), and right anterior left posterior (RALP) semicircular canal planes. The patient was seated 1 m from the target mark and was instructed to fixate on this target while his head was passively thrust into a 15° angle.

About 20 head impulses in every direction were manually delivered with unpredictable temporal order and direction, within the planes of the horizontal and vertical canals.

During testing the horizontal canals, a small, abrupt, horizontal head rotation was delivered passively, with minimal 'bounce-back' at the end of the head impulse and with an unpredictable direction and magnitude.

During testing the vertical canals, patients were sitting with their head turned to be situated about 45° to the left and their body facing the target on the wall for testing in the RALP plane or 45° to the right for testing the LARP plane. This is to make sure that the correct vertical canals in the respective planes would reach the upper limit of stimulation by the head pitch stimuli.

The average gain of the VOR responses was calculated for every direction.

Results

The current study was a prospective study. It was conducted on 50 healthy individuals (13 male and 37 female), and the age ranged from 17 to 66 years with a mean age of 39.34±13.36 years (median: 38.0).

Comparison was done between vHIT gain at each age group and other groups.

Comparison between lateral canal gains showed no significant difference among the five studied age groups (Table 1).

Comparison between LARP canal gains showed no significant difference among the five studied age groups (Table 2).

Comparison between RALP canal gains showed no significant difference among the five studied age groups (Table 3).

Discussions

In the current study, the gain remained around one in all studied groups in the six tested canals, with no significant difference between all groups.

The VOR response was tested and it was found that the it is under control of the cerebellum, and much research

Table 1 Comparison between the five studied groups according to Lateral canals

Lateral canals	Age groups					*P*
	10–25 (*n*=10)	25–35 (*n*=10)	34–45 (*n*=10)	45–55 (*n*=10)	>55 (*n*=10)	
Left						
Min.–max.	0.84–1.20	0.83–1.18	0.88–1.20	0.80–1.20	0.84–1.16	0.991
Mean±SD	0.99±0.12	1.0±0.10	0.98±0.12	0.99±0.11	0.97±0.10	
Median	0.98	0.99	0.93	0.98	0.96	
Right						
Min.–max.	0.85–1.13	0.90–1.20	0.86–1.16	0.89–1.20	0.88–1.20	0.686
Mean±SD	1.0±0.11	1.01±0.09	1.01±0.10	1.06±0.09	1.03±0.11	
Median	0.99	1.0	0.99	1.05	1.02	

Max., maximum; min., minimum. *P* value for ANOVA test.

Table 2 Comparison between the five studied groups according to left anterior right posterior

Left anterior right posterior	Age groups					*P*
	10–25 (*n*=10)	25–35 (*n*=10)	35–45 (*n*=10)	45–55 (*n*=10)	>55 (*n*=10)	
LA						
Min.–max.	0.78–1.20	0.85–1.20	0.83–1.10	0.83–1.11	0.70–1.16	0.819
Mean±SD	0.97±0.12	0.99±0.12	0.99±0.09	0.97±0.09	0.94±0.12	
Median	0.99	1.0	1.02	0.97	0.96	
RP						
Min.–max.	0.87–1.40	0.80–1.19	0.89–1.16	0.81–1.20	0.77–1.08	0.133
Mean±SD	1.05±0.15	0.96±0.11	1.01±0.08	0.97±0.10	0.93±0.09	
Median	1.02	0.93	1.0	0.95	0.93	

LA, left anterior; max., maximum; min., minimum; RP, right posterior. *P* value for ANOVA test.

Table 3 Comparison between the five studied groups according to right anterior left posterior

Right anterior left posterior	Age groups					*P*
	10–25 (*n*=10)	25–35 (*n*=10)	34–45 (*n*=10)	45–55 (*n*=10)	>55 (*n*=10)	
LP						
Min.–max.	0.90–1.20	0.90–1.14	0.89–1.19	0.93–1.12	0.91–1.15	0.983
Mean±SD	0.98±0.09	1.0±0.08	1.0±0.10	0.99±0.07	0.99±0.07	
Median	0.95	0.98	0.97	0.97	1.0	
RA						
Min.–max.	0.81–1.20	0.80–1.17	0.82–1.20	0.83–1.08	0.78–1.20	0.987
Mean±SD	0.98±0.13	0.96±0.11	0.97±0.13	0.97±0.09	0.95±0.13	
Median	0.97	0.93	0.96	0.97	0.92	

LP, left posterior; max., maximum; min., minimum; RA, right anterior. *P* value for ANOVA test.

on the VOR has indicated the importance of the cerebellum for facing 'challenges' and 'repairing' the VOR; these challenges are magnified vision or probably age [14–16].

Previously, many studies have reported that dynamic visual acuity (DVA) actually declines with the aging process, but we should note that DVA is an indirect measure of vestibular function. DVA definition is the threshold for recognizing a briefly flashed optotype during a head movement. Poor DVA has been translated as poor semicircular canal function, in light of the contention that an inadequate VOR will give rise to smearing of the flashed letter across the moving retina and so the recognition of that letter will decline. Although an inadequate VOR gain will without a doubt result in smearing of the image (depending on head velocity, stimulus duration, and so on) and thus degrade visual acuity, there are other nonvestibular age-dependent factors, for example, luminance, that can, and probably do, influence letter recognition in this paradigm. Senior patient testing, if done without their optical correction, would also affect their DVA performance [17,18].

The above-mentioned studies may explain the result of the current study.

The findings of this study are supported by those of the study by McGarvie *et al.* [19], who reported that age was not a statistically significant factor into the 80s of 91 healthy patients they examined.

A recent study by Rambold [20] stated that the aging effect was not explained by the VOR gain decrease.

Yang *et al.* [21] also noted an unvarying gain value from 20s to 60s.

Mossman *et al.* [22], who studied horizontal VOR gain, concluded that although horizontal VOR gain decreases a little with age there is no need to adjust the VOR gain into 80s, taking into consideration that the normal 2 SD lower border, over a wide age range, is generally robust.

Another study found an aging effect of the VOR gain of the horizontal canal-vHIT in patients over 70–80 years of age depending on the stimulus head velocity, but the ages of the current study participants are not more than 66 years [23].

Conclusion

VOR gain seems to be stable with respect to age, and thus these values may be helpful in the diagnosis of peripheral vestibular deficiencies across a wide age range.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1 Aw ST, Haslwanter T, Halmagyi GM, Curthoys IS, Yavor RA, Todd MJ. Three dimensional vector analysis of the human vestibulo-ocular reflex in response to high-acceleration head rotations. I. Responses in normal subjects. J Neurophysiol 1996; 76:4009–4020.

2 Roy FD, Tomlinson RD. Characterization of the vestibulo-ocular reflex evoked by high-velocity movements. Laryngoscope 2004; 114:1190–1193.

3 Tabak S, Collewijn H, Boumans LJ, van der Steen J. Gain and delay of human vestibulo-ocular reflexes to oscillation and steps of the head by a reactive torque helmet. I. Normal subjects. Acta Otolaryngol 1997; 117:785–795.

4 Robinson DA. A method of measuring eye movement using a scleral search coil in a magnetic field. IEEETrans Biomed Eng 1963; 10:137–145.

5 Imai T, Sekine K, Hattori K, Takeda N, Koizuka I, Nakamae K, *et al.* Comparing the accuracy of video-oculography and the scleral search coil system in human eye movement analysis. Auris Nasus Larynx 2005; 32:3–9.

6 MacDougall HG, Weber KP, McGarvie LA, Halmagyi GM, Curthoys IS. The video head impulse test: diagnostic accuracy in peripheral vestibulopathy. Neurology 2009; 73:1134–1141.

7 Bartl K, Lehnen N, Kohlbecher S, Schneider E. Head impulse testing using video-oculography. Ann N Y Acad Sci 2009; 1164:331–333.

8 Agrawal Y, Schubert MC, Migliaccio AA, Zee DS, Schneider E, Lehnen N, *et al.* Evaluation of quantitative head impulse testing using search coils versus video-oculography in older individuals. Otol Neurotol 2014; 35:283–288.

9 Weber KP, MacDougall HG, Halmagyi GM, Curthoys IS. Impulsive testing of semicircular-canal function using video-oculography. Ann N Y Acad Sci 2009; 1164:486–491.

10 Schneider E, Villgrattner T, Vockeroth J, Bartl K, Kohlbecher S, Bardins S, *et al.* EyeSeeCam: an eye movement-driven head camera for the examination of natural visual exploration. Ann N Y Acad Sci 2009; 1164:461–467.

11 MacDougall HG, McGarvie LA, Halmagyi GM, Curthoys IS, Weber KP. Application of the video head impulse test to detect vertical semicircular canal dysfunction. Otol Neurotol 2013; 34:974–979.

12 MacDougall HG, McGarvie LA, Halmagyi GM, Curthoys IS, Weber KP. The video head impulse test (vHIT) detects vertical semicircular canal dysfunction. PLoS One 2013; 8:e61488.

13 McGarvie LA, Halmagyi M, Curthoys I, MacDougall H. Video head impulse testing – age dependent normative values in healthy subjects. J Vestib Res 2014; 24:77.

14 Engstrom H, Bergstrom B, Rosenhall U. Vestibular sensory epithelia. Arch Otolaryngol 1974; 100:411–418.

15 Robinson DA. Editorial: how the oculomotor system repairs itself. Invest Ophthalmol 1975; 14:413–415.

16 Robinson DA. Adaptive gain control of vestibuloocular reflex by the cerebellum. J Neurophysiol 1976; 39:954–969.

17 Burg A. Visual acuity as measured by dynamic and static tests: a comparative evaluation. J Appl Psychol 1966; 50:460–466.

18 Long GM, Crambert RF. The nature and basis of age-related changes in dynamic visual acuity. Psychol Aging 1990; 5:138–143.

19 McGarvie LA, MacDougall HG, Halmagyi GM, Burgess AM, Weber KP, Curthoys IS. The video head impulse test (vHIT) of semicircular canal function-age dependent normative values of VOR gain in healthy subjects. Front Neurol. 2015; 6:154.

20 Rambold HA. Age-related refixating saccades in the three-dimensional video-head-impulse test: source and dissociation from unilateral vestibular failure. Otol Neurotol 2016; 37:171–178.

21 Yang CJ, Lee JY, Kang BC, Lee HS, Yoo MH, Park HJ. Quantitative analysis of gains and catch-up saccades of video-head-impulse testing by age in normal subjects. Clin Otolaryngol 2016; 41:532–538.

22 Mossman B, Mossman S, Purdie G, Schneider E. Age dependent normal horizontal VOR gain of head impulse test as measured with video-oculography. J Otolaryngol Head Neck Surg 2015; 44:29.

23 Matiño-Soler E, Esteller-More E, Martin-Sanchez JC, Martinez-Sanchez JM, Perez-Fernandez N. Normative data on angular vestibulo-ocular responses in the yaw axis measured using the video head impulse test. Otol Neurotol 2015; 36:466–471.