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ARTICLE

The minimal caloric test asymmetric response in vertigo-free migraine patients

A resposta assimétrica ao teste calórico mínimo nos pacientes com enxaqueca sem vertigem

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ABSTRACT

Vertigo symptoms and subclinical vestibular dysfunctions may occur in migraine. The Minimal Caloric Test (MCT), an easy-to-perform, convenient and yet informative procedure was used to test the vestibular function in 30 vertigo-free migraine patients outside attacks and 30 paired controls. Although not statistically significant, a right-to-left nystagmus duration asymmetry greater than 25% was present in both groups. This difference was greater in the patients group, suggesting the presence of subclinical vestibular imbalance in migraine.

Keywords: migraine, vestibular system, minimal caloric test.

RESUMO

Vertigem e alterações vestibulares subclínicas têm sido identificadas na enxaqueca. O teste calórico mínimo é simples de realizar, informativo e conveniente. Ele foi realizado em 30 pacientes com enxaqueca sem queixa de vertigem e 30 controles pareados. Embora não estatisticamente significativo, ocorreu assimetria direita-esquerda superior a 25% na duração do nistagmo em ambos os grupos, maior nos pacientes, o que sugere a presença de desequilíbrio vestibular subclínico na enxaqueca.

Palavras-chave: enxaqueca, sistema vestibular, teste calórico mínimo.

In 1860, Brown Séquard[1] described vertigo and disequilibrium after cold water injection into the ear. One year later Prosper Ménière[2] localized the vertigo sensation in the inner ear. In 1906, Robert Bárány[3] popularized the procedure of irrigating the ears with 10 to 20 cc of cold water to produce a marked nystagmus. Kobrak, in 1920 and 1923[4] attempted to use less amount of water to minimize the associated discomfort and side effects of the caloric testing. In 1942, Fitzgerald and Hallpike[5] described their caloric method in which the ears were irrigated for forty seconds with water 7°C above and below body temperature. In 1968, Linthicum[6] described The Minimal Caloric Test (MCT) consisting of only 0.2 cc ice water instillation in the external ear canal. With the purpose to confirm Linthicum results, Nelson[7] reviewed the MCT and proved its efficacy. Along the same minimalist line, Weinberg J. et al.[8] suggested that the MCT can be done with an eardrum stimulus by a simple wet cotton wood. In the last decades, few vestibular studies have used the MCT[9].

Migraine is one of the most common primary headaches[10,11]. Vertigo symptoms are well known in migraine[12,13] and vestibular dysfunctions have been found in migraineurs[14]. To further investigate vestibular dysfunction in migraine, in this study – a byproduct of a larger bedside tests study[15] – 30 vertigo-free migraine patients and 30 paired controls were evaluated to test the hypothesis that vertigo-free migraine patients present vestibular dysfunctions as detected by the MCT.

METHOD

Thirty (25 females) vertigo-free migraine patients according to the ICHD 2nd edition[16], 19 to 62 y-o (median 39.3 years) and 30 gender and age paired controls participated in the study. Patients were sequentially selected amongst the outpatient headache clinic from the Hospital Universitário Clementino Fraga Filho - UFRJ, from March 2012 until

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September 2013. Subjects were first examined to rule out the presence of spontaneous nystagmus and the external ear canal (EEC) were inspected to both dispel any earwax obstruction and to evince the canal shape trough the tympanic membrane. Other excluding criteria included spontaneous nystagmus, Ménière disease, vestibular neuritis, benign positional paroxysmal vertigo; use of anxiolytic, antidepressant and antivertiginous drugs for the last two days, or pain killers more than twice a day. A paper cup was half filled with water and three ice cubes to keep the temperature between 1° to 3°C throughout the test. A 1 mL syringe was filled with 0.2 mL ice water for instillation into the EEC. A stopwatch was used to time the duration of nystagmus. A Frenzel goggle (Micromedical Infrared Googles RealEyes x DVR 2.2 C), was fitted for better detection of the small nystagmus beats throughout the test. Subjects were positioned in the supine position with the head bended 30° forward (Figure 1). The head was then rotated to the side so that the ice water was instilled in a single plunge and trickled by gravity to the eardrum. The subjects were left in this position for ten seconds and then turned straight ahead. Due to it's great variability[7], we did not consider the time elapsed between the EEC plunge and the nystagmus onset. While observing for nystagmus, continuous questioning – simple mental arithmetic or other tasks – kept the person alert. If no nystagmus was observed after instillation, the procedure was repeated five minutes later with 0.4 mL (applied in only two control individuals). After the end of nystagmus, a five minutes' interval was allowed before the same procedure was performed on the other side. The Student *t* test were used for statistical analyses, p-values < 0.05 were considered significant. A difference between the ears response greater than 25% was considered as a canal paresis. The local Ethics Committee approved this study (protocol # 159-11). All images were used in accordance with legally authorized.

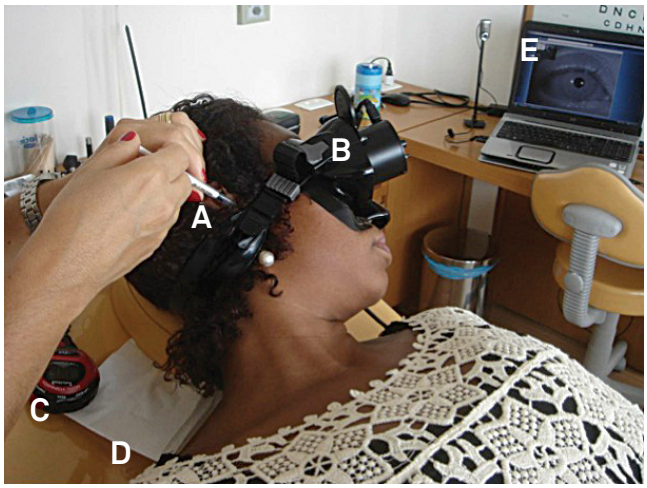

Figure 1. MCT. Tuberculin syringe of 0.2 cc ice water (A), Frenzel goggle (B), chronometer (C), absorbent paper (D), amplified eye in the computer screen (E).

RESULTS

From 60 individuals (120 ears), all but two presented nystagmus in response to 0.2 mL MCT. Two responded with 0.4 mL bilaterally. Eleven patients (36.7%) showed a difference greater than 25% in the nystagmus duration between the ears. The nystagmus duration ranged from 16 to 218 seconds – right ear: 16 to 158 seconds (mean: 106.2 ± 39.4 seconds); left ear: 17 to 218 seconds (mean: 121.2 ± 45.8 seconds). The average right-to-left difference in the patients group was 20.97 ± 15.9%.

In the control group nine individuals (30%) had the nystagmus duration difference greater than 25% between the ears. In this group the nystagmus duration ranged less extensively, from 55 to 165 seconds. Right ear: 55 to 156 seconds (mean: 108.5 ± 26.3 seconds); Left ear: 75 to 165 seconds (mean: 119.7 ± 27.8 seconds). The average right-to-left difference in the control group was 18 ± 11.5% (Figure 2). The differences between patients and controls were not statistically significant.

DISCUSSION

This study points to a greater right-to-left MCT asymmetry and greater response variability in vertigo-free migraineurs as compared with controls. The result may indicate a greater instability of the vestibular response in migraine, which is in line with previous vestibular tests in this condition[17,18].

Fifty-five years ago, the labyrinthine function was wrongly considered less important in humans: "the phylogenetically ancient and vital organ of balance has suffered debasement in the more evolved animals, and diminishes in importance as we ascend the phylogenetic scale"[19]. However, a breakthrough in neurophysiological and clinical knowledge on the previously unknown labyrinth took place in the last decades, paralleling the recognition of the relationship between dizziness and headache[20,21,22]. The bithermal caloric test (BCT) procedures represent the gold standard in respect of the analysed parameters of vestibular evoked nystagmus[23,24]. Nevertheless, the established BCT procedures require that a large quantity of water (50-100 mL) be maintained at an exact temperature (30°C and 44°C), and also involve the use of cumbersome equipment for air heating. These conditions are difficult to fulfill outside the vestibular laboratory, particularly when a consultant outside the department of otorhinolaryngology performs the examination[9]. Lintchicum et al.[6] tested 67 cases of acoustic neuroma using MCT and showed that 83% of the patients presented a reduced vestibular response. They highlighted that, provided there is no spontaneous nystagmus, the MCT can be employed for diagnosis purposes since it requires little time and equipment to be performed and causes less discomfort to the patient. Nelson[7] used Linthicum's method in normal

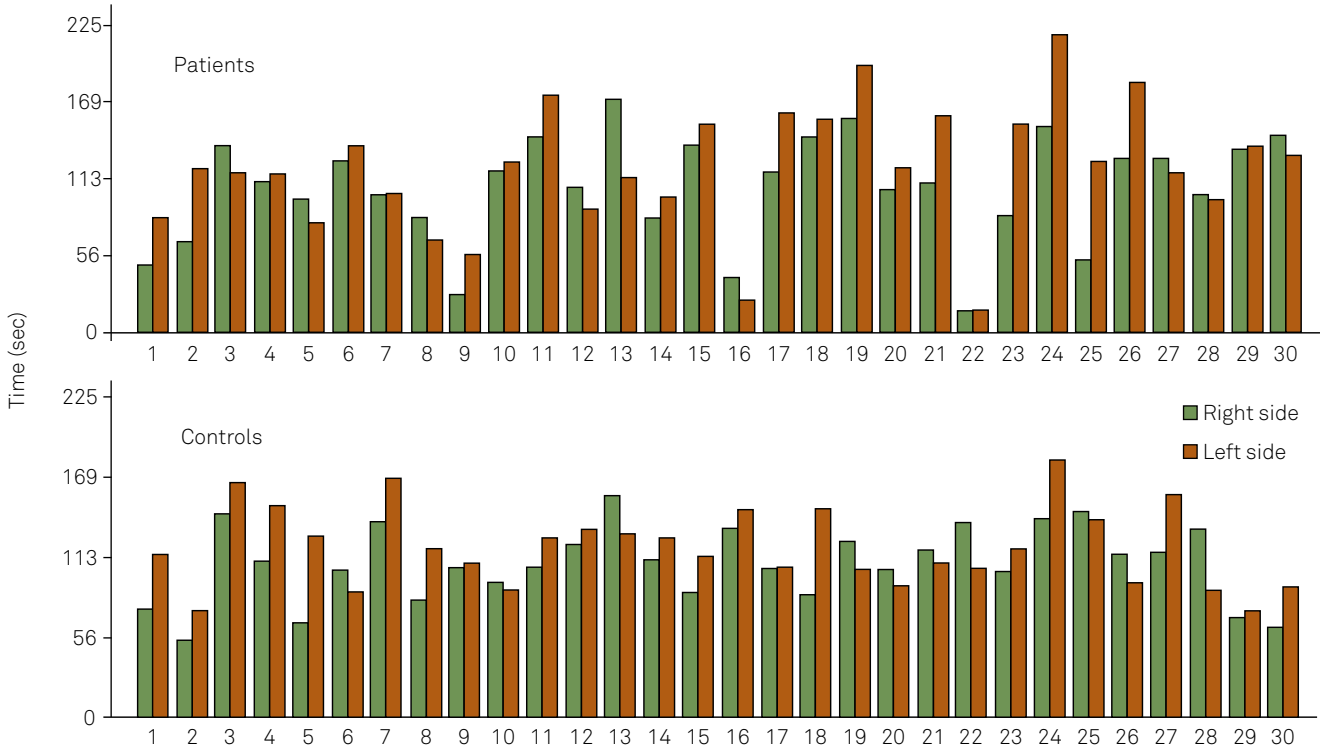

Figure 2. Minimal Caloric Test responses (seconds) in 30 patients (upper panel) and controls (lower panel). Each pair of blue and green bars, representing respectively the right and the left sides, correspond to one subject, as indicated in the x axis. The Right-to-left asymmetry tends to be greater amongst patients. Samples 1 and 2 of control group used 0.4 cc.

subjects and vertiginous patients searching for the amount of ice water necessary to initiate the nystagmus, its duration, and intensity as well. They stressed that although the standard 30°C Hallpike stimulus[5] was about four times as intense as the 0.2 cc ice water, the latter could be used as screening test to all physicians.

Schmäl et al.[9], compared the MCT (1 ml and 2 ml) with the established vestibular caloric test procedures. They found a strong nystagmus correlation between cold water (30°C) and bithermal water (30°C and 44°C) with MCT, and also concluded that using a small amount of ice water, Frenzel glasses and a tuberculin syringe, MCT can be performed with minimum technical and financial effort. More recently, Leigh and Zee[24] compared the caloric tests and reinforced the importance and feasibility of MCT. Our study confirms that MCT is a clean and quickly monothermal bedside test that can be applied by professionals working outside vestibular laboratory, e.g. in a hospital ward or offices. Being essentially a low-frequency stimulus, caloric testing can detect vestibular impairment that may not be apparent during higher-frequency head rotation[22].

As part of a larger work in which we evaluate the vestibular system of migraine patients without vertigo complains with vestibular bedside tests[15], we compared herein the MCT-induced nystagmus duration in our study population. In only two control subjects (3.3%) 0.4 mL was required to induce the response. None of the individuals presented spontaneous nystagmus. Although not statistically significant, eleven migraine patients (36.7%) showed unilateral vestibular weakness average with asymmetric responses – greater than 25% – to a larger extent when compared with nine (30%) healthy controls. To the best of our knowledge this is the first report on the results of MCT in vertigo-free migraine patients. Migraine is generally a nervous system hyperexcitability disorder[25]. Vestibular hyperexcitability could lead to greater, longer and perhaps more unstable MCT responses in migraine. We did not verify whether the headache side would interfere with the results, although it is known that in migraine unilateral headaches are usually not side-locked[26]. Further studies – with larger samples and considering headache frequency, intensity, location, treatment effects and disease duration – are necessary to verify whether our results really point to a migrainous subclinical vestibular dysfunction or are indicative of another epiphenomenon.

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References

1. Brown-Séquard CE. Physiology and pathology of the central nervous system. Philadelphia; Collins; 1860.
2. Baloh R. Prosper Ménière and his disease. Arch Neurol. 2001;58(7):1151-6. doi:10.1001/archneur.58.7.1151
3. Baloh R. Robert Bárány and the controversy surrounding his discovery of the caloric reaction. Neurology. 2002;58(7):1094-9. doi:10.1212/WNL.58.7.1094
4. Linthicum Jr FH, Waldorf R, Luxford WM, Caltogirone S. Infrared/ video ENG recording of eye movements to evaluate the inferior vestibular nerve using the minimal caloric test. Otolaryngol Head Neck Surg. 1988;98(3):207-10.
5. Fitzgerald G., Hallpike CS. Studies in human vestibular function: I. Observations on the diretional preponderance ("Nystagmubereitschaft") of caloric nystagmus resulting from cerebral lesions. Brain. 1942;65(2):115-37. doi:10.1093/brain/65.2.115
6. Linthicum Jr. FH., Churchill D. Vestibular test results in acoustic tumor cases, Arch Otolaryngol. 1968;88(6):604-7. doi:10.1001/archotol.1968.00770010606007
7. Nelson JR. The minimal ice water caloric test. Neurology. 1969;19(6);577-85. doi:10.1212/WNL.19.6.577
8. Weinberg J, Sadé J. A simple and time saving cold mini caloric test. J Laryngol Otol. 1984;98(7):701-5. doi:10.1017/S0022215100147310
9. Schmäl F, Lübben B, Weinberg K, Stoll W. The minimal ice water caloric test compared with established vestibular caloric test procedures. J Vestib Res. 2005;15(4):215-24.
10. Wang SJ, Chen PK, Fuh JL. Comorbidities of migraine. Front Neurol. 2010;1:16. doi:10.3389/fneur.2010.00016
11. Manzoni GC, Stovner LJ. Epidemiology of headache. In: Nappi G; Moskowitz MA, editors. Handbook of clinical neurology. Amsterdam: Elsevier B.V., 2011. p. 3-22.
12. Lempert T, Neuhauser H. Epidemiology of vertigo, migraine and vestibular migraine. J Neurol. 2009;256(3):333-8. doi:10.1007/s00415-009-0149-2
13. Brevern M, Neuhauser H. Epidemiological evidence for a link between vertigo and migraine. J Vestib Res. 2011;21(6):299-304. doi:10.3233/VES-2011-0423
14. Brant T, Dieterich M, Strupp M. Vertigo and dizziness: common complains. London: Springer; 2009.
15. Maranhão ET, Maranhão-Filho P, Luiz RR, Vincent MB. Vestibular bedside tets in migranious patients without vertigo complain. Arq Neuropsiq. 2015 Forthcoming.
16. The international classification of headache disorders 2nd edition. Cephalalgia. 2004;24 Supp 1:1-151.
17. Çelebisoy N, Gokcay F, Sirin H, Biçak N. Migrainous vertigo: clinical, oculographic and posturographic findings. Cephalalgia. 2008;28(1):72–7. doi:10.1111/j.1468-2982.2007.01474.x
18. Teggi R, Colombo B, Bernasconi L, Bellini C, Comi G, Bussi M. Migrainous vertigo: results of caloric testing and stabilometric findings. Headache. 2009;49(3):435-44. doi:10.1111/j.1526-4610.2009.01338.x
19. Smith BH. Vestibular disturbances in epilepsy. Neurology. 1960;10(5):465-9. doi:10.1212/WNL.10.5.465
20. Neuhauser H, Leopold M, von Brevern M, Arnold G, Lempert T. The interrelations of migraine, vertigo, and migrainous vertigo. Neurology. 2001;56(4):436-41. doi:10.1212/WNL.56.4.436
21. Neuhauser H, Lempert T. Vertigo and dizziness related to migraine: a diagnostic challenge. Cephalalgia. 2004;24(2):83-91.
22. Brevern M, Zeise D, Neuhauser H, Clarke AH, Lempert T. Acute migrainous vertigo: clinical and oculographic findings. Brain. 2005;128(2):365-74. doi:10.1093/brain/awh351
23. Haim T. Caloric test. Available from: http://www.tchain.com/ otoneurology/practice/caloric_test.htm [Last access: June 26, 2015].
24. Leigh RJ, Zee SD. The neurology of eye movements. 4th ed. New York: Oxford Univesity Press; 2006.
25. Brighina F, Bolognini N, Cosentino G, Maccora S, Paladino P, Baschi R et al. Visual cortex hyperexcitability in migraine in response to sound-induced flash illusions. Neurology. 2015;84(20):2057-61. doi:10.1212/WNL.0000000000001584
26. Silberstein S, Saper J, Freitag FG. Migraine: diagnosis and treatment. In: Silberstein S, Lipton R, Daleso DJ, editors. Wolff's headache and other head pain. 7th ed. New York: Oxford University Press; 2001. p. 121-237.