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Age predicts the absence of caloric-induced vertigo

Gary P. Jacobson [a], Erin G. Piker [b,*], Sarah L. Grantham [a], Lauren N. English [a]

[a] Department of Hearing and Speech Sciences, Divisions of Audiology and Vestibular Sciences, Vanderbilt University Medical Center, Nashville, TN, USA
[b] Department of Communication Sciences and Disorders, James Madison University, Harrisonburg, VA, USA

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Abstract

Introduction: The absence of vertigo during the caloric test, despite a robust response, has been suggested to represent a central vestibular system phenomenon. The purpose of this investigation was to determine the prevalence of absent caloric-induced vertigo perception in an unselected group of patients and to assess possible predicting variables.
Methods: Prospective investigation of 92 unselected patients who underwent caloric testing. Inclusion criteria were that each patient generate a maximum slow phase velocity (maxSPV) $\geq$ 15 deg/sec and a caloric asymmetry of $\leq$10%. Following the caloric, patients were asked, "Did you have any sensation of motion?"
Results: Results showed 75% of patients reported motion with a mean age of 56.51 years compared to a mean age of 66.55 in the 25% of patients reporting an absence of motion. A logistic regression was performed and the overall model was statistically significant accounting for 29% of the variance in caloric perception. The significant predictor variables were patient age and maxSPV of the caloric response. The effect size for both variables was small with an odds ratio of .9 for maxSPV and 1.06 for age.
Conclusions: The current investigation showed that both age and maxSPV of the caloric response were significant predictors of vertigo perception during the caloric exam. However, the association between age and caloric perception is not conclusive. Although there is evidence to suggest that these findings represent age-related changes in the central processing of vestibular system stimulation, there are additional unmeasured factors that influence the perception of caloric-induced vertigo.

keywords: Vestibular; Vertigo; Central processing; Caloric test; Aging

1. Introduction

Clinicians who evaluate vestibular function may be presented with a patient that perceives the cutaneous aspects of the caloric stimulus (i.e. the hot or cold water rushing in their ear), but reports having no sensation of motion or vertigo during the caloric exam. They may comment that they feel "nothing" or a mild sensation of "floating". These cases are most perplexing in patients whose peripheral vestibular system generates a robust response measured through the vestibulo-ocular reflex (VOR). Anecdotal evidence suggests that these patients usually are elderly. The underlying mechanism and clinical significance of the absent post-caloric self-motion perception in the presence of a clinically normal peripheral vestibular response is unknown. However, there is evidence to suggest this phenomenon may implicate the central vestibular system pathways and may produce postural instability.

Takeda et al., 1995, first reported this phenomenon in patients with known lesions involving the parieto-temporal lobe (i.e. analogous to the "vestibular cortex" in nonhuman mammals). The investigators described the patients as experiencing

Abbreviations: SPV, slow phase velocity; VNG, videonystagmography.

* Corresponding author. James Madison University, 235 Martin Luther King Jr. Way, MSC 4304, Harrisonburg, VA 22807, USA.
E-mail address: pikereg@jmu.edu (E.G. Piker).

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"nystagmus-sensation dissociation", defined as "brisk caloric nystagmus without simultaneous sensation of vertigo" (Takeda et al., 1995). Takeda and colleagues later described this phenomenon in a small subset of healthy participants and reported that the degree of self-motion perception during the caloric test was correlated with the magnitude of cerebral blood flow in the parietal lobe, further implicating the central vestibular structures in the perception of caloric-induced vertigo (Takeda et al., 1996).

A more recent report from Chiarovano et al. (2016) described patients who demonstrated the absence of rotatory vertigo after caloric irrigation as having "vestibular neglect". They observed this finding in a small sample of older adults, and suggested that this blunted motion perception is both more pervasive in older adults and may place them at greater risk for falling (Chiarovano et al., 2016). Specifically, the investigators evaluated 20 subjects, ten of whom were older adults (≥65 years) who were selected based on self-reported postural instability and an absence of perceived vertigo after warm caloric irrigations. The second group consisted of 10 age and sex-matched control subjects who did not report postural instability and did report a sensation of vertigo following warm caloric irrigation. For both groups the mean peak slow phase nystagmus velocity (maxSPV) was ≥15 deg/sec. The patient was shown as perceiving motion if, "… there was perception of body rotation whose direction (to the right or left) could be given clearly by the patient …" (p 3). The investigators reported no group differences in caloric velocities or degree of caloric asymmetry. Not surprisingly, although postural stability on the Equitest was normal for the control group, the test was abnormal for the experimental group and especially for conditions 5 and 6 that are most dependent on normal vestibular system function. The design of this investigation had some shortcomings. First, by virtue of the subject selection criteria there were significant differences in the balance function of the two groups (i.e. those with a history of postural instability were unstable on the Equitest protocol). Additionally, caloric-induced vertigo was absent by subject selection criterion. Thus, the two subject groups demonstrated abnormal performance from the start. It remains unclear how pervasive absence of post-caloric motion perception is in a consecutive sample of clinical patients who produce robust and symmetrical caloric responses. Further, it remains unclear if this phenomenon is exclusively observed in older patients who may be at greater risk for central vestibular impairments.

The purpose of this investigation was to determine the prevalence of absent caloric-induced vertigo perception in an unselected group of patients and to assess possible predicting variables for a lack of vertigo perception. Accordingly, the current investigation was conducted in an effort to determine whether an absent post-caloric motion perception occurs only in elderly patients.

2. Methods

The subjects were 92 patients (mean age 59.18 years, sd 18.2, 41male) who were referred to the Balance Function Laboratory at the Vanderbilt University Medical Center for an assessment of their dizziness. Each patient received a quantitative vestibular assessment by a licensed and certified audiologist. The assessment included a videonystagmography (VNG) examination that culminated in a monothermal warm caloric test (Jacobson et al., 1995; Jacobson and Means, 1985; Murnane et al., 2009) or a bithermal water caloric test.

Criteria for acceptance to this investigation was that each subject had to generate a mean maxSPV ≥15 deg/sec for both left and right warm caloric irrigations. Further, the monothermal warm caloric asymmetry could not exceed 10% (Murnane et al., 2009). The only protocol for this investigation was the patient's answer to the question, *"Did you have any sensations of motion after the water was placed in your ear?"* The response was recorded as a binary answer of "yes" or "no". For this investigation we scored as positive those responses that denoted self-motion including "shifting," "rocking," "sliding," "floating and spinning," and "rolling." We chose to include descriptions other than "spinning," or "rotating" due to the difficulty some patients had in describing their experience. The study protocol was approved by the local Institutional Review Board (IRB #171520).

2.1. Statistical analysis

Patients were grouped according to whether or not they perceived a sensation of movement during the caloric exam yielding two groups, *presence of vertigo* and *absence of vertigo*. Summary statistics, means, and standard deviations were reported to describe the continuous variables (i.e. age, maxSPV), and count and percent were used to describe categorical variables (e.g. gender). Differences between ears were examined using t-tests if the variable was continuous and Chi-squared tests if the variable was categorical. Associations between continuous variables were assessed using the Pearson correlation. In addition, logistic regression was used to assess the probability of perceiving vertigo during the caloric test and odds ratios were reported as an indication of effect size. Significance of variables was examined at alpha = .05. The analysis were completed in SPSS, version 24.0 (IBM SPSS Statistics for Windows, Armonk, NY).

3. Results

The total cohort included 92 consecutive patients who underwent caloric testing and whose results were both normal and robust with maxSPV >15 deg/sec. Patient demographics are shown in Table 1. Of the total cohort, the majority, 69/92 (75%), reported a perception of vertigo during the caloric test while 23/92 (25%) reported an absence of vertigo. Of those who reported an absence of vertigo, the mean age was 66.55 years compared to a mean age of 56.51 years in the group who did report the presence of vertigo. Although the mean age was greater in the absent group, approximately half of the patients in the absent group, 11/23 (48%), were under the age of 65.

There was no significant ear effect on vertigo perception ($\chi^2(1) = .113$, $p = .737$) and no significant ear effect on

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