Critical Review:
Does the evidence support the use of audiological tests to define characteristics specific to EVA?

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This review critically evaluates the existing literature examining two possible characteristics of EVA, an audiometric air-bone gap and a low resonant frequency of the middle ear. Study designs include a cohort study and case-control studies. Overall, the evidence gathered provides consistent support that EVA should be suspected whenever there is a low frequency air-bone gap and low resonant frequency in combination with normal middle ear function. The findings support the inclusion of bone conduction testing, conventional tympanometry, and multi-frequency tympanometry in the assessment of patients with undiagnosed hearing loss.

Introduction

The development of imaging techniques such as computed tomography (CT) and magnetic resonance

Objectives

The primary objective of this review is to critically evaluate the existing literature examining two possible characteristics of EVA, an air-bone gap and low resonant frequency. The secondary objective is to determine if the results of this review have clinical implications for the assessment of patients with undiagnosed hearing loss.

Methods

Search Strategy
Computerized databases including Pubmed, Scopus and CINAHL were searched using the following search strategy: [(EVA) OR (enlarged vestibular aqueduct) OR (large vestibular aqueduct)] AND [(air bone gap) OR (conductive) OR (bone conduction)] AND [(tympanometry) OR (multi-frequency tympanometry) OR (resonant frequency)]. The search was limited to the English language and humans.

Selection Criteria
Studies included in this review were required to specifically examine both an air-bone gap and the resonant frequency of the middle ear in EVA patients.

Data Collection
Results of this literature search yielded four studies: one cohort study design, and three case-control study designs.

Results

Cohort Study Design:

Bilgen, Kirkim, and Kirazli (2009) used a prospective cohort study design with an evidence level of 2b, to assess the effect of inner ear pressure on the impedance of the middle ear in EVA patients. They recruited eight patients (n=16 ears) who had been diagnosed with EVA by a high resolution CT scan. The patients were matched according to age to one of three normal-hearing control groups. There were 25 subjects in each control group, who were selected according to the age decades of the cases in the study group. Subjects were excluded from the control group if they had any history of physical or laboratory findings of otology disease. Investigations of all subjects included air and bone audiometry to assess the presence of an air-bone gap, and multi-frequency tympanometry to assess the resonant frequency of the middle ear. Conventional tympanometry was also used to determine the status of the middle ear. All of the study patients were deemed to have normal middle ear function, as indicated by normal middle ear pressure in the range of +/- 50mm H_20. In respect to the air-bone gap and resonant frequency, the authors did not apply a statistical analysis to the data due to the small number of cases. Instead the data was compared between the EVA patients and the control groups with regard to the mean values +/- 2 standard deviations (SD) and presented in graph form. Results showed that five EVA subjects had an air bone gap at the lower frequencies. For those remaining, bone conduction could not be completed due to the severity of the loss and the limits of the bone oscillator. The resonant frequency values of six EVA patients were lower than the mean values +/- 2 SD of the control group. Of the remaining two EVA patients, one of them was on the lower limit of +/- 2 SD, however the other one was lower than the mean value +/- 2 SD. Interestingly, the authors noticed that these two patients were the only ones that experienced hearing loss fluctuations at the time of the study. The authors suggested that these patients also had endolymphatic hydrops, which explains some of the vestibular symptoms that EVA patients experience, as well as fluctuations in hearing.

Case-Control Study Design:

Mimura, Sato, Sugiura, et al. (2005) used a prospective case-control study with an evidence level of 2b, to evaluate EVA patients to determine whether the audiometric Bing test is assocl(in)7(g)6( )-eth twh tw[illegible] whetr g98ure

provides evidence that an air-bone gap is present in EVA patients, but also raises the question as to its etiology. The authors suggest that the “third window” theory is a plausible explanation to explain why the EVA patients in their study typically presented with an air-bone gap and a low resonant frequency. This suggestion is reasonable given that the literature also refers to the “third window” theory; however, no explanation was proposed for the results of the Bing test and overall this study is vague in its descriptions and methodology.

Nakashima, Ueda, Furuhashi, et al. (2000) used a retrospective case-control study with an evidence level of 2b, to investigate the cause of the air-bone gap seen

Clinical Implications

EVA should be suspected when a patient has an air-bone gap in the presence of normal tympanometry and a low resonant frequency. This should also warn clinicians that the air-bone gap is not due to middle ear pathology. The awareness of these clinical features should aid in differentiating EVA from middle ear pathology, thus preventing unnecessary and sometimes devastating middle ear surgery in an attempt to close the air-bone gap. Awareness of the presence of these characteristics will help clinicians make a confident referral for further assessment by an otolaryngologist, who can use this information for a prompt referral for a CT scan or MRI. An early and accurate diagnosis can prevent the progression of hearing loss due to head injury or increases in inner ear pressure through appropriate counseling and precautions. For example, patients with EVA may avoid participating in contact sports and avoid barometric pressure changes such as in scuba diving or flying in an airplane. The conclusion made from this review should provide enough support to implement bone conduction testing, conventional tympanometry and multi-frequency tympanometry in the assessment of patients with undiagnosed hearing loss. When these assessments are made in combination with each other