The Follow-Up Role of the Vestibular Evoked Myogenic Potential Test in Meniere's Disease

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Received: 10 Nov. 2017; Accepted: 26 Dec. 2017

Abstract- Despite some proposed roles for the diagnostic impact of the cervical vestibular evoked myogenic potential test in the patients with Meniere's disease, the role of this test as an objective instrument in following up the patients with Meniere's disease who underwent. Intratympanic steroid injection is not cleared. In a prospective study, thirty-one adult patients with definite one-sided Meniere's disease with vertigo as main complaint refractory to medical treatments for three months, were selected. Patients underwent three times of intratympanic dexamethasone injection with one-week intervals. We performed cervical vestibular evoked myogenic potential test at first and four weeks after the last injection for all participants. We followed the patients for one year. The study results were analyzed with the chi-square test. Cervical vestibular evoked myogenic potential test could not be recorded in 26 patients (83.9%), and the test results were abnormal in the remaining 5 patients. The results were abnormal in the healthy ear of 32.3% of the patients. Despite the clinical improvement of the symptoms after intratympanic injection, the test results were not changed. Cervical vestibular evoked myogenic potential test could not be recorded in the majority of the patients with Meniere's disease; while it is usually recorded in normal ears. On the other hand, results of the cervical vestibular evoked myogenic potential test do not change during the early phase after treatment and could not be a good option for follow up and evaluating the response in this situation.

Acta Med Iran 2018;56(1):43-48.

Keywords: Meniere's disease; cVEMP test; Intratympanic injection; Dexamethasone; Follow up

Introduction

Meniere's disease is a chronic disorder of inner ear that affects hearing and balance and presents with episodes of vertigo, tinnitus, and hearing loss. This disease was first described by Prosper Meniere in 1861 (1). The possible pathogenesis of the disease is endolymphatic hydrops (2). Causes of endolymphatic hydrops are excessive production of endolymph, decreased absorption of endolymph by endolymphatic sac, genetic predisposition, viral infections, nutrition, autoimmune reactions, and vascular and allergic disorders. The hydrops usually occurs at the inferior part of the labyrinth (saccule and cochlea).

Meniere's disease usually presents with one symptom and gradually progresses. There is no need for all symptoms to make the diagnosis, but having multiple symptoms at the same time is more diagnostic than having several symptoms at different times. The criteria proposed by the American Academy of Otolaryngology-Head and Neck Surgery in 1995 for the diagnosis of Meniere's disease consists of vertigo, hearing loss, and tinnitus/aural fullness (3,4).

The cervical vestibular evoked myogenic potential (cVEMP) test is an important clinical option to evaluate the function of the vestibule. It's the measurement of sternocleidomastoid muscle's relaxation in response to a vocal stimulus and evaluates the function of the saccule, inferior vestibular nerve, and vestibular pathways. The afferent and efferent pathways consist of sensory cells in

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saccule that react to voice acts and medial vestibulospinal tract in cervical motor neurons, respectively. The endolymphatic hydrops is related to the changes of the cVEMP test in patients with Meniere's disease. It causes more changes in vestibular than cochlear function; so, the cVEMP test could be a good option for evaluating the saccular function. In Meniere's disease, there are some changes in cVEMP test results because of the saccule enlargement. In normal people, the test is recorded at the frequency of 500Hz, but a response in Meniere's disease is acquired by higher thresholds. According to different studies, the cVEMP test is recorded in 98% of the normal population, while it is absented in the 51-54% of the patients with Meniere's disease and the response in the healthy ear is identical to the affected one (5,6). The cVEMP test is not only capable of determining the site of the disease, but also evaluates the severity and even predicts the hydrops formation in saccule, before patients getting symptomatic (5).

Meniere's disease does not have a definite cure. Prevention of vertigo episodes has been the outcome in management planning. There is no significant recovery through more conservative approaches in most of the patients (7). Low salt diet (1.5 g/d) and using diuretics like hydrochlorothiazide, triamterene and acetazolamide are conventional approaches for controlling symptoms (8,9). Nowadays, treatment with steroids is recommended because of the important possible role of allergic and autoimmune factors in the pathogenesis of Meniere's disease and application of steroids in the treatment of sudden neurosensory hearing loss (10,11). Despite the significant proposed role of cVEMP test for diagnosis of Meniere's disease, its usage for following response to treatment is unclear. The main item for planning the patients as unresponsive to the treatment is the symptom control which is subjective. We conducted this study to evaluate the use of the cVEMP test in the follow up of patients with definite Meniere's disease who underwent intratympanic dexamethasone injection.

Materials and Methods

In this prospective interventional study, we selected 31 consecutive patients in the referral medical center with definite one-sided Meniere's disease. Their chief complaint was vertigo refractory to treatments such as low salt diet, diuretics and betahistine for three months. The exclusion criteria were neuromuscular system disorders, central nervous system and spinal cord defects, middle ear diseases and serous otitis media, history of middle ear surgery or any manipulation in the inner ear, perforation of the tympanic membrane, bilateral Meniere's disease, and systemic steroid use during last month. Because of the ethical issues, there was no control group in this study. For accepting the unilateral involvement of the ear, patients should have all the three diagnostic symptoms on one side, and the other side did not meet all the criteria for definite Meniere's disease. According to the mentioned setup for this study and universal acceptance of intratympanic steroid injection for intractable Meniere's disease, all these patients were the candidate for this modality of treatment and after their acceptance for participation, written informed consent was taken for participating in the study. Patients' information was gathered including age, sex, duration of the disease, family history of Meniere's disease, the mean number for episodes of vertigo for one month, associated symptoms and the results of the audiometric tests including the degree and severity of hearing loss. Magnetic resonance imaging and fluorescent treponemal antibody absorption test was done to rule out other main causes of the hydrops. The cVEMP test was performed for all participants.

Cervical VEMP test was carried out by two channels EP25 Interacoustic EP system (Eclipse). The cVEMPs were recorded on the sternocleidomastoid (SCM) muscle ipsilateral to stimulated ear. The stimuli were presented through a headphone. The non-inverting electrode was placed on the upper third of the SCM muscle belly, while an inverting electrode was positioned on the edge of the sternum, and a ground electrode was set on the forehead. The responses from the next ear were elicited in the same manner. To record cVEMPs, 200 responses to air conducted 500 Hz tone burst at an intensity of 95 dB peSPL, presented monaurally with rarefaction polarity via an inset phone, averaged with a stimulation rate of 7.1Hz/s. Two tracks from each side were obtained to assess reproducibility. Also, the stimulus was characterized with a rise-and-fall time of 2 ms and a plateau time of 0 ms. The response was also bandpass filtered (20-2000Hz) and amplified (5000x). Recorded data about amplitude and latency of the P13N23 waves were evaluated.

The patients underwent three times intratympanic microscopic guided dexamethasone injection that was done in anterior part of tympanic membrane after local anesthesia with 10% lidocaine. Four weeks after the last injection, we repeated the cVEMP test to find any changes in recording, amplitude, and latency of the P13N23 waves. The test result was considered as abnormal when the waves were absent (negative) or had

abnormal morphology including changes in amplitude or latency compared to the normal standard results or to the other side. All patients were followed for one year (in 4-6 week intervals) to find whether they have changed in frequency and severity of episodes of vertigo, tinnitus, and hearing loss. For evaluation of the effects of episodic vertigo on daily activities, functional level scale form was applied which has 6-point level scale (3). All the data collected in this study were analyzed with the chi-square test.

Results

From the total of 31 patients, 16 were female. Seven patients had the age of 30 years or younger, 17 patients were between 30 and 50 years old, and 7 were older than 50 years. Four patients had a family history of Meniere's disease. Duration of the Meniere's disease was as the following: 5 patients had less than 2 year's history, 16 had 2 to 5 years, 8 had 5 to 10 years, and 2 patients had more than 10 years history of the symptoms. Twenty patients had mild hearing loss, 10 patients had moderate, and 1 patient had severe hearing loss. Out of 31 participants, hearing loss occurred in low frequencies in 20 patients, 10 patients had the hearing loss in all frequencies, and 1 patient had hearing loss in high frequencies.

The cVEMPs were absent in 26 patients (83.9%) before intratympanic dexamethasone injection, and the test results were abnormal in the remaining 5 patients (16.1%). Hearing status of the patients with absent cVEMPs was as the following: 65% of patients had mild, 31% had moderate, and 4% had severe hearing loss. Admittedly, in the abnormal cVEMP test result group, 3 patients had mild hearing loss, and 2 patients were with the moderate hearing loss. There was no statistically significant relationship between the severity of hearing loss and the absent or abnormal cVEMP test result (P=0.788). In addition, the analysis of the relation between absent or abnormal cVEMP test result and duration of the disease did not show a significant relation.

In all patients, the cVEMPs were recorded in the healthy ear before the intervention. The test result was abnormal in the healthy ear of 10 patients, while 21 patients had normal cVEMPs response. In abnormal cVEMPs group, two patients had mild hearing loss, 7 had moderate hearing loss, and 1 patient had severe hearing loss. We identified a significant relationship between an abnormally recorded cVEMP test in the healthy ear of the patients and the severity of hearing loss (P=0.001). However, there was not a significant relationship between an abnormally recorded cVEMP test in the healthy ear and the duration of the disease (P=0.101).

The total number of negative cVEMPs responses did not change after intratympanic injections, and 26 patients were consistently cVEMPs negative. In other patients, the recorded waves were abnormal after intratympanic dexamethasone injections.

After treatment with intratympanic dexamethasone injection, 29 patients out of 31 had fewer episodes of vertigo, and 2 patients didn't show any response to treatment and were selected for surgical treatment. There was no significant relationship between severity of hearing loss and response to treatment (P=0.823). Moreover, the significant relationship between the duration of the disease and medical response to treatment was not seen (P=0.428). Duration of Meniere's disease in the patients who did not respond to intratympanic injections was 2 to 5 years.

From the total of 31 patients, 17 patients had no episodes of vertigo during the first 4 months of follow up after treatment, 8 patients remained in this level in the second 4 months, and 1 patient was vertigo free during third 4 months of follow up. When one episode of vertigo or less was considered as an outcome, a number of patients in first, second, and third 4 months were 24, 18, and 11 patients, respectively. In addition, hearing level of all patients remained unchanged (no change or less than 10 dB in pure tone average). On the other hand, tinnitus in 28 patients did not show any response to treatment, and in 3 patients its severity has been decreased. These three patients all had mild hearing loss, and the duration of their disease was less than two years.

The functional status of the patients before intratympanic dexamethasone injections and after that are depicted in figure 1. None of the patients were in group 6 (the most severe disability). Two patients were categorized as group 5 and had severe dysfunction due to vertigo attacks and did not have a response to intratympanic dexamethasone injections. They were considered for surgical intervention.

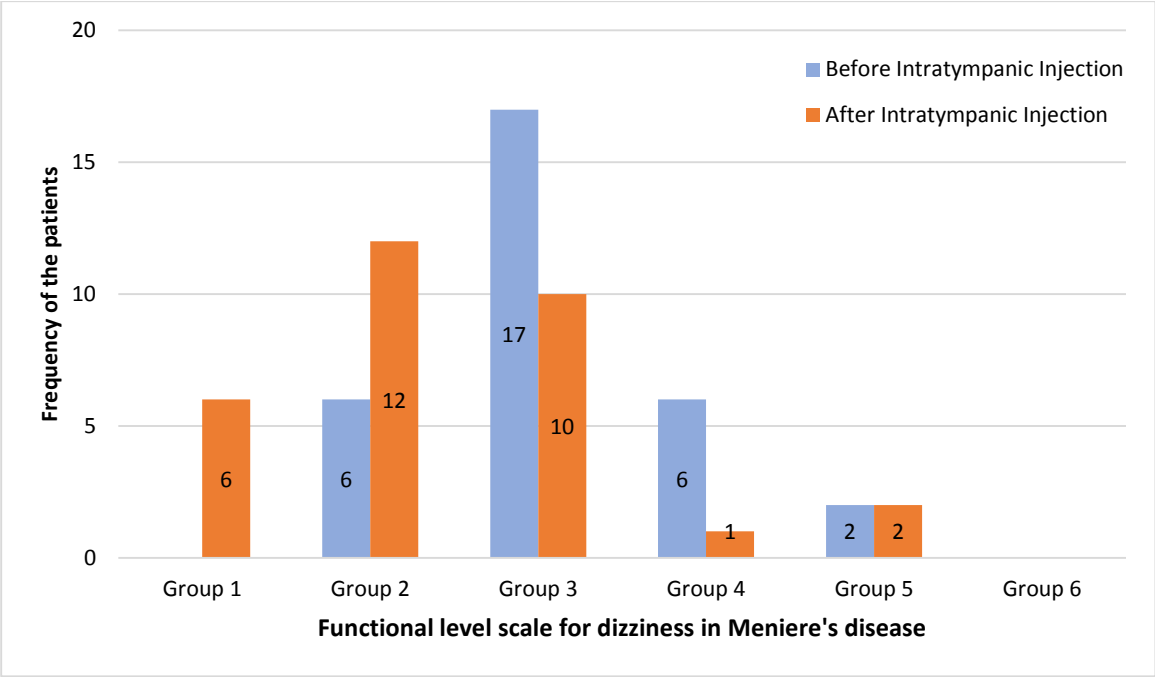

Figure 1. Functional level scale of the patients with Meniere's disease before and after intratympanic dexamethasone injections

Discussion

The cervical VEMP test is a vestibular test for saccular function and seems to be a good choice for supporting the diagnosis of Meniere's disease (12). In this study, participants had similar characteristics to the reported points of Meniere's disease, like their age, sex ratio, and prevalence of a positive family history of Meniere's disease was similar to the literature (13-14). De Waele and the colleagues in one of the earliest clinical studies on the evaluation of saccular function in patients with Meniere's disease have shown that the VEMP test was absent in 54% of the patients (15). The current research showed that in about 84% of patients, no cVEMPs waves were recorded. This difference might be secondary to the severity of the disease in patients of the two studies, as more than 74% of the participants were in the functional disability level of 3 or 4 (Figure 1). It seems that more severe forms of the Meniere's disease (severe hearing loss or high level of functional disability by vertigo attacks) are accompanied by abnormalities in the cVEMP test results including the absence of the waves (5,12,16).

Saccular dysfunction is one of the main pathological dysfunctions of Meniere's disease. The VEMP test abnormalities support this point. However, despite the overall improvement in the clinical status of the patients who received medical treatment with intratympanic dexamethasone injection, the test results did not get a significant change. This may be due to the controlling effect of the intratympanic injection of steroids on some aspects of the pathophysiological basis of the disease presentation, but not treating its pathology. So, despite symptom-relieving effects of our intervention, saccular pathology is not changed. Furthermore, early time of testing (just one month after the last injection) may cause no changes in post-injection results compared to pre-injection results. Indeed, performing the cVEMP test in a few months later may lead to more positive results. More research with specific focus on this point could be reasonable.

Abnormalities in the test results in the healthy ear were recorded in nearly one-third of the patients. Other than the false positive justification, prediction of the involvement of the other side be the cVEMP test could be assumed as an explanation. Katayama and the colleagues also have concluded that the VEMP test can predict the involvement of the other ear in patients with unilateral Meniere's disease (5).

In more than 90% of the patients, a decrease in episodes of vertigo occurred. Other studies have shown a response rate of 43% to 91% with intratympanic steroid injections (10,17,18). About 55% of the patients had no vertigo, and 77% experienced the maximum of one episode during the first 4 months after intervention. An improvement in hearing sensation occurred in 22.4% of the patients which are compatible with acquired results in other studies (17,19). A decrease in episodes

of tinnitus was occurred in about 10% of the patients as Graduno-anaya *et al*., also showed the similar results with the improvement in 18% of the patients (19). On the other hand, Sennaroglu and the colleagues have shown that the tinnitus was resolved in 42% of the participants (17). This difference may be due to method and duration of dexamethasone application. In the last study, topical dexamethasone was used for longer terms through the ventilation tube.

Quality of life and functional disability as the main outcome was assessed in this research. Nearly one-fifth of the patients had no disturbances in daily activities due to vertigo after intratympanic injection (Figure 1). Intratympanic dexamethasone injection could improve patients' quality of life, and this is compatible with the results of Kyrodimos et al. (20). Regarding this research, intratympanic dexamethasone injection could be effective in controlling vertigo and preventing invasive methods of treatment in patients with definite one-sided Meniere's disease.

This study could not show the effectiveness of the cVEMP test for following the response rate of the patients with Meniere's disease. The short time between the intervention and the test might be a limitation of this study.

The VEMP test was not recorded in most of the patients while it is usually recorded in normal people. However, the test results cannot evaluate the response to intratympanic dexamethasone injection in the early phase. Further studies with more injections of intratympanic dexamethasone injections, longer follow up period, performing cVEMP test in 1 and 6 months after treatment, and even with higher stimulating sound frequencies (such as 1000 Hz instead of 500 Hz), and using other electrophysiologic tests which might be more sensitive in follow up, can provide more accurate information in evaluating saccular function and analysing the objective efficacy of the treatment in patients with Meniere’s disease.

Acknowledgments

This research conducted as a postgraduate medical graduation thesis in the specialty of otorhinolaryngology-head and neck surgery in Amir Alam Hospital affiliated with Tehran University of Medical Sciences, Tehran, Iran.

Our special thanks go to the patients who always help us for improving science with their patience and cooperation freely and without reproach.

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