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CLINICAL STUDY

THE EVALUATION OF THE EFFECTS OF GENERAL ANESTHESIA ON VESTIBULAR SYSTEM WITH CVEMP

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SUMMARY

Objectives: To evaluate the effects of general anesthesia on the vestibular system using cervical vestibular evoked myogenic potentials (cVEMP).

Methods: This study included 29 patients who underwent septoplasty, rhinoplasty, under general anesthesia with ASA I/II. All patients underwent ear, nose, throat, hearing and vestibular system examination before surgery. Cervical VEMP was performed on all patients preoperatively which were taken basal values and repeated at 24th hour postoperative. Preoperative measurements and postoperative 24th hour measurements were compared.

Results: There were no statistically significant differences between preoperative and postoperative the cVEMP parameters including the mean latencies of p1 and n1, amplitudes of p1 and n1 wave, peak-to-peak amplitude and amplitude asymmetry ratio values.

Conclusion: We indicated that there were no effects of anesthetics on the vestibular system. Our findings suggest that postoperative nausea and vomiting may be related to central effects of anesthetics.

Keywords: VEMP, general anesthesia, vestibular system, vomiting, nausea

GENEL ANESTEZİNİN VESTİBÜLER SİSTEM ÜZERİNE ETKİLERİNİN CVEMP İLE DEĞERLENDİRİLMESİ

ÖZET

Amaç: Bu çalışmada genel anestezinin vestibüler sistem üzerine etkilerinin servikal VEMP (cVEMP) kullanılarak değerlendirilmesi amaçlanmıştır.

Yöntem: Bu çalışmaya genel anestezi altında septoplasti ve rinoplasti ameliyatı yapılacak olan, ASA I/II, 29 sağlıklı erişkin hasta dahil edildi. Tüm hastalara ameliyattan önce kulak burun boğaz, işitme ve vestibüler sistem muayenesi yapıldı. Ameliyattan önceki gün ve ameliyattan 24 saat sonra yapılan cVEMP sonuçları karşılaştırıldı.

Bulgular: Ameliyat öncesi ve ameliyattan 24 saat sonraki p1 ve n1 amplitüdleri, p1 ve n1 latansları, peak-to-peak amplitüdleri ve amplitüd asimetri oranları arasında istatistiksel olarak anlamlı bir fark bulunmadı.

Sonuç: Bu çalışmada genel anestezinin vestibüler sistem üzerine etkisinin olmadığı görülmüştür. Bizim sonuçlarımız, ameliyat sonrası görülen bulantı ve kusmanın genel anestezinin vestibüler sistem üzerine etkilerine bağlı olmadığını, anesteziklerin santral etkileri ile ilişkili olabileceğini düşündürmektedir.

Anahtar Sözcükler: VEMP, genel anestezi, vestibüler sistem, bulantı, kusma

INTRODUCTION

The vestibular system plays an important role of balance control in people. Damage of vestibular system may lead to symptoms such as loss of balance, vertigo, nausea and vomiting[1]. Vestibular system is affected by many drugs and chemicals including antibiotics, antimalarial drugs, certain diuretics, chemotherapy and heavy metals[1,2].

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To best of our knowledge, there were no specific studies about the effects of anesthesia on the vestibular system by VEMP. In fact, the applications of general anesthesia are known to produce intense effects in many systems and organs all over the body in a short time. It leads to many changes in the hematological and immune system by the effects on the cellular level[3].

Nausea and vomiting after general anesthesia is observed in the majority of patients. However, this mechanism has not been explained adequately. Could be these symptoms of nausea and vomiting due to the effects of general anesthesia on the vestibular system?

The vestibular evoked myogenic potentials (VEMP) is a clinical test used for the diagnosis of vestibular diseases and is performed by recording and evaluating the muscle potentials resulting from the stimulation of the vestibular system with different stimuli. VEMP is the only test that examined the function of saccule and inferior vestibular nerve[4,5]. It is a electrophysiological method which is measured alerts triggered via stimulation of peripheral vestibular organs in the muscles by electromyography (EMG)[4]. The VEMP is generated by activation of the saccular afferents and moving to the neurons of Scarpa's ganglion, through the inferior vestibular nerve, lateral or inferior vestibular nucleus, and medial or lateral vestibulospinal tract, and finally to the motor neurons of the sternocleidomastoid muscle[6]. Damage or lesions such as multiple sclerosis, vestibular neuritis, brainstem lesion (Wallenberg's syndrome) and stroke on any part of this synaptic way can cause impairment of the VEMP recording[7].

In our study; we aimed to evaluate the damage of the general anesthesia on the vestibular system by cervical vestibular evoked myogenic potentials (cVEMP).

MATERIAL and METHODS

The study was conducted with approval of local ethics committee (date: 05.08.2015 and desicion number: 2015-13).

The study comprised 29 patients who underwent septoplasty, rhinoplasty, under general anesthesia with ASA I/II. All study participants provided informed written consent prior to study enrollment. A detailed history was taken to exclude the presence of otologic diseases, hearing loss, vertigo and patients with steroids, diuretics and other anti-edema therapy. Otoscopic examination was performed for all subjects and they were also evaluated with pure tone audiometry, tympanometry and stapedial reflexes on the first visit to document the possible otologic pathologies. Cervical VEMP was performed on all patients preoperatively and it was recorded as a baseline value. In the operation day, standard general anesthesia induction was applied and intubation was performed. Routine maintenance of general anesthesia (6-8% desflurane and remifentanil 0,25 mg/kg/minute into 50% oxygen, 50% medical air mixture, remifentanil 0.25 mg/kg/minute) were performed. Cervical VEMP was repeated 24 hours after the operation. Preoperative measurements were compared postoperative 24 hours measurements.

Cervical Vestibular Evoked Myogenic Potential Performing

The surface electromyographic activity was recorded with Epic-Plus evoked acoustic potentials system (Labat S.r.l. Mestre, Italy) from the upper half of each sternocleidomastoid muscle with a reference disk electrode on the upper sternum. The recording electrode was placed on the middle of the ipsilateral clavicle, the reference electrode was placed on the middle third of the ipsilateral sternocleidomastoid muscle, and ground electrode was placed on the center of sternal manubrium. Attention was paid to place bilateral electrodes on symmetrical sites. During the recording, the patient was in a lying position and was instructed to rotate his/ her head to the opposite side of the stimulated ear. Logon type stimulus with a 500 Hz frequency was delivered at an intensity of 120 dB HL with a 4/s stimulation rate. Recordings were obtained averaging 200 stimuli and two traces from each test were obtained to assess reproducibility. The averaged latency in two runs was regarded as the latency of p1 and n1. Using normative data obtained by one of the authors in the laboratory.

Statistical Analysis

The SPSS 19.0 for Windows program was used for statistical analysis (IBM SPSS Statistics, IBM Corporation; Chicago, IL, USA). Descriptive data are given as mean, standard deviation, minimum, maximum, frequency and percentage values. For related samples, Wilcoxon signed ranks test was used to compare preoperative and postoperative 24th hour cVEMP values. P values less than 0.05 were considered to be statistically significant.

RESULTS

Twenty nine (2 female, 27 male) patients's 58 ears were included in the study. The mean ages of the patients were 27.24±7.10 (21-45 years). The average rate nausea and vomiting was 31.03%.

Preoperative cVEMPs measurements were taken basal values and were compared postoperative measurements. The mean latencies of p1 and n1, amplitudes of p1 and n1 wave and amplitude asymmetry ratio (AR) values in preoperative and postoperative are presented in Table 1.

VEMP response couldn't have been gotten from two patients preoperatively and from two patient postoperatively. The response rate of p1n1 wave was 93.1% for both preoperative and postoperative.

Preoperative test values, the means latencies of p1 and n1 were 11.95±1.84 ms and 17.64±2.40 ms, the means amplitude of p1 and n1 wave were 48.58±43.73 µV and 52.73±54.72 µV and peak-to-peak amplitude 101.31±85.74 and AR was 5.38±7.15. Postoperative the means latencies of p1 and n1 were 12.77±2.17 ms, 18.94±3.51 ms and the means amplitude of p1 and n1 were 44.75±49.16 µV and 43.82±37.55 µV and peak-to-peak amplitude 88.57±77.92 and AR was 5.76±10.85, respectively. There were no statistically significant differences between preoperative and postoperative the cVEMPs parameters including the mean latencies of p1 and n1, amplitudes of p1 and n1 wave, peak-to-peak amplitude and amplitude asymmetry ratio values p= 0.138, p= 0.096, p= 0.548, p= 0.278, p= 0.195, p=0.091, respectively).

Table 1: The means of cVEMP parameters of subjects

	Preoperative Mean±SD	Postoperative Mean±SD	p value
p1 latency (ms)	11,95±1,84	12,77±2,17	0,138
p1 amplitude	48,58±43,73	44,75±49,16	0,548
n1 latency (ms)	17,64±2,40	18,94±3,51	0,096
n1 amplitude	52,73±54,72	43,82±37,55	0,278
Peak-to-peak amplitude (n1-p1)	101,31±85,74	88,57±77,92	0,195
AR	5,38±7,15	5,76±10,85	0,091

VEMP: vestibular evoked myogenic potentials, SD: standart deviation, AR: amplitude asymmetry ratio, p1: the first positive wave, n1: the first negative wave, ms: millisecond.

DISCUSSION

Postoperative nausea and vomiting is a major problem in patients undergoing general anesthesia. The incidence of postoperative nausea and vomiting after general anesthesia is up to 30% when inhalational anesthetics are used with no prophylaxis[8]. In our study, the means of nausea and vomiting were 31.03% after general anesthesia.

The incidence of nausea and vomiting in several studies the frequency with different general anesthetic 10-87%[9]. We found compatible data of the nausea and vomiting with literature in this study. We aimed to reveal whether the possible detrimental effects of general anesthesia on vestibular system are caused to postoperative nausea and vomiting.

In recent years, the study of the otolithic function has been remarkably benefited by the introduction of the VEMPs. These potentials are able to identify deficit of both saccular and utricular partition of the otolithic compartment. There is a general agreement that cVEMPs reflect saccular macula and nerve function[10]. It has been reported that cVEMP responses may be affected in various diseases such as vestibular neuritis, BPPV, Meniere's disease, acoustic trauma, superior semicircular canal dehiscence, bilateral vestibulopathy, central vestibular pathology[5,11-15].

VEMP responses are biphasic (positive-negative) waves which are identified ‘‘p" (for positive) and ‘‘n" (for negative) for each peaks. The first biphasic complex is named as p1-n1 or p13-n23, and the second one is named as n2-p2 or p34-n44. It has been indicated that the response rate of p1n1 was between 70% and 100% in healthy subjects depending on the stimulus pattern, stimulus intensity and test positions[13]. We found that the response rate of p1n1 was 93.1%.

We found that there were no significant difference between preoperative and postoperative

values in respect to p1 latency, n1 latency, p1 amplitude, n1 amplitude, peak-to-peak amplitude and AR. There was no study in the literature to conclude VEMP parameters in patients with general anesthesia. Our preliminary report shows that there were no changes in VEMP responses in patients with general anesthesia.

The general anesthesia may be effect vestibular system involvement of two mechanisms. Firstly, the oxygen radicals which were formed during general anesthesia could damage the vestibular system. Studies about the mechanism of cell damage has been focused on the formation of oxygen radicals and cochlear hair cell damage[2,14]. Various toxic substances lead to apoptosis and necrosis in these cells. Oxidative stress is thought to play a major role in triggering apoptosis[14]. Reactive oxygen radicals directly influence the cell membrane of isolated vestibular hair cells and cause to swell of the cell body. Morphological changes come in view 30 minute after loading with H2O2, and a considerable increase in the number of dead cells is observed after 3 hours[15]. The use of high oxygen concentrations before induction of anesthesia and in the perioperative period to continue the high oxygen applications may lead to the formation of oxygen radicals[16]. Oxygen radicals are likely to cause damages to the vestibular system. However, our study showed that; routine general anesthesia does not lead to injury on the vestibular system.

The second mechanism is a direct toxic effect of anesthetics on vestibular system. Vestibular system is affected by many drugs and chemicals such as antibiotics, antimalarial drugs, certain diuretics, chemotherapy and heavy metals[1,2]. Best known anesthetic which effects the vestibular system is nitrous oxide. The animal experiments have shown adverse effects of the nitrous oxide on the vestibular system up to 4 weeks[17]. Hamilton et al. reported that 30% of nitrous oxide has the effect of distorting ocular regulatory mechanisms on the vestibulo-ocular reflex (VOR)[18]. Lehnen et al. has also been shown that remifentanil reduces VOR[19]. We used propofol, fentanyl and rocuronium in the induction and sevoflurane, remifentanil in the maintenance of anesthesia. In our study, we observed that anesthetics used in general anesthesia did not cause to measurable damage on the vestibular system. It has been reported that there were effects of remifentanil on VOR[19]. But remifentanil has short half-life and its effect on VOR was temporary. The effects of other anesthetics on the vestibular system have not shown.

Nitrous oxide is the only anesthetic has constructive effect on the vestibular system. We did not use nitrous oxide in our study. Clinical trials which is used this anesthetic would be beneficial. We observed that there were no detrimental effects of general anesthesia on vestibular system and central effects of general anesthesia may cause nausea and vomiting after general anesthesia.

In conclusion, This is the first study which is evaluated the effect of general anesthesia on the vestibular system by VEMP. In the current study, there was no change after general anesthesia at 24th hour VEMP values compared to preoperative values. Further studies are needed to investigate the relationship between the vestibular system and postoperative nausea and vomiting.

Conflict of Interest: No conflict of interest was declared by the authors.

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