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Vestibular function and curative effect of BPPV patients in different duration by application of electronystagmography and posturography.

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Abstract

Objects: Benign paroxysmal positional vertigo (BPPV) is a common peripheral vestibular disease clinically. Electronystagmography (ENG) and posturography are commonly used methods for diagnosis of BPPV and examination of the vestibular function. Sparse study reported the characteristics of nystagmus and vestibular function and the curative effect in different duration of BPPV patients.
Methods: This is a retrospective study of 40 adults with vestibular symptoms. Before ENG test and posturography test, the subjects underwent physical examination and excluded central disorders. The canalith repositioning maneuver was used for the therapy of BPPV and the curative effect was studied between different duration groups.
Results: Of patients who suffered BPPV, higher rates of abnormal ENG were observed in the longer duration of BPPV. Among patients of BPPV, the patients' vestibular function in more than 12 months duration was inferior to the patients of a shorter duration. Moreover, the curative effect by repositioning maneuver in the shorter duration was superior to the longer duration.
Conclusions: The present study suggested that the vestibular function in patients that suffered BPPV deteriorates as the course of BPPV develops. The curative effect by repositioning maneuver in the patients of shorter duration is more satisfied than the longer duration.

Keywords: Vestibular function tests, Vertigo, Benign paroxysmal positional vertigo, Electronystagmography, Posturography.

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Introduction

With regards to peripheral vertigo, benign paroxysmal positional vertigo (BPPV) accounting for the major causes [1]. BPPV occurs due to the detachment of calcium-carbonate crystals or otoconia within the fluid-filled semicircular canals of the inner ear [2,3]. The clinical symptoms of BPPV varied among patients, symptoms may manifest with nonspecific dizziness, postural instability, mild headache, nausea and vomit [4,5]. However, the common manifestation is nystagmus in multiple styles. Deficit in different semicircular canals characterized by specified nystagmus in specified posture and is helpful in guiding canalith repositioning therapy especially in refractory cases with atypical BPPV [6,7].

Idiopathic BPPV is commonly occurred in the posterior and horizontal semicircular canals [8] while rarely onset in the anterior semicircular canal. Meanwhile, BPPV arising from multiple canals has also been described previously [9], the most common is a combination of posterior and horizontal BPPV as a constitution of 1.5%-5% in all BPPV patients [9,10]. Trauma may be a potential risk to cause combined canal BPPV but not a risk for bilateral single-canal BPPV [10]. Additionally, BPPV is more likely to develop in the right ear, a factor was reported to involve with the habit of sleeping on the right side in the major public [11].

In clinic, each type of BPPV is frequently diagnosed by observing the type of nystagmus induced by different positioning maneuvers, which were also the commonly used methods for restoration. The three widely used maneuvers including Semont's maneuver, for the posterior canal BPPV; Epley's maneuver, for the anterior canal BPPV; and Brandt-Daroff exercises, for the lateral canal BPPV. Some disorders such as posterior circulation stroke can mimic BPPV. However, central positional nystagmus usually manifested with sustaining vertigo and disequilibrium and other neurological symptoms and signs [12]. Presently, electronystagmography (ENG) is a common approach to differentiate vertigo and evaluate the effect after repositioning. Nonetheless, a few literatures compared the characteristic of the oculomotor system between different duration of BPPV before and after rehabilitation.

The visual system and proprioception also play negligible roles in postural control. Approximately 80% of an individual's sensory perception is gathered by the visual system [13], which

processes and integrates other sensory inputs, such as from vestibular, to select a balancing strategy [14]. Vestibular system is another crucial part for sustaining balance. Vestibular oculomotor reflex and vestibulospinal reflex are two major nervous reflex activities involving maintaining certain posture. Therefore, it is significant for diagnosis of BPPV by examination of static and dynamic posturography, which is a quantitative assessment of postural sway during stance. Though physicians are customizing treatments for their patients based on the information from posturography, to our knowledge, few studies reported the traits and curative effects of BPPV patients in different durations.

In this study, we analysed the traits of electronystagmography in patients with BPPV, studied the characteristic in different duration of BPPV before and after rehabilitation. Moreover, we explored the peculiarity of parameters in the equilibrium system in BPPV patients by posturography analysis. Our present study will throw light on diagnosis and proper administration of BPPV in clinic.

Materials and Methods

This was a descriptive, cross-sectional and observational study performed without intervention. Literary consent was mandatory for each subject. The present study was conducted with approval granted by the Committee on Clinical Research of Jiangxi Medical College, Nanchang University. Patients in the present study were recruited in outpatient department and inpatient department of otorhinolaryngology and neurology and even orthopedic during March 2008 to April 2011 in our hospital. The recruited patients were diagnosed with idiopathic BPPV based on the medical history and Dix-Hallpike test as well as Roll test. Routine otoscopic examinations were conducted for each patient in this study to exclude patients suffered with otitis media. Moreover, the central disorders were excluded in each object. The control subjects were recruited from outpatient by voluntary agreement.

Visual electronystagmography test

Electronystagmogram instrument equipped with introducing heated and cooled air was used to detect the Temperature experiment, saccadic movement, smooth pursuit test, gaze test and optokinnetic nystagmus test in the patients.

Posturography test

Static posturography (SPG) and dynamic posturography (DPG) were included. The SPG quantifies sway velocity in degrees in each second (°/s) with the participant standing in four test conditions: a firm surface with the eyes open; a firm surface with the eyes closed; a foam surface with eyes open and a foam surface with eyes closed. Twenty second trials were recorded for each test conditions. The average sway velocity of the participant's center of gravity was calculated per trial and averaged for each test condition. Falling down, crabbing rail or making a step during the test were recognized as an invalid test and make a fresh start. By contrast, DPG involves the use of external balance perturbations or changing surface and/or visual conditions. Both the SPG and the DPG under each test condition were observed in a continuous 20 seconds.

Statistical analysis

In order to test the difference between two categorical variables, the χ^2 test was applied. All tests used in this study were 2-tailed, and a P value less than 0.05 were considered statistically significant. All statistical analyses were performed with SPSS Statistical software (version 20, Chicago, Illinois, USA).

Results

Totally 40 patients diagnosed with idiopathic BPPV were recruited, including 6 males and 34 females. The age of the patients was 34 to 79 years old. The duration from attacking with BPPV to seeking a medical advice in these patients was 1week to 10 years. The duration of BPPV course was defined as the lasting time from the first occurrence of vertigo to ENG test in the study. The objects were matched in age and sex. We evaluated the ENG by stimulation of saccadic movement, smooth pursuit test, optokinnetic nystagmus test, gaze test, spontaneous nystagmus and temperature experiment among control group, below 12 months course group (<12 months) of BPPV and above 12 months course group (>12 months). According to our data (Table 1), the saccadic movement, the smooth pursuit test and the optokinnetic nystagmus test as well as the gaze test were in a normal condition in the control group and <6 months group. In the group of below 6 months course, all the patients detected spontaneous nystagmus by ENG. In the opposite, in the group of above 12 months course all patients not detected the spontaneous nystagmus (Table 1). As shown in the temperature experiment (Table 1), the below 6 months course group demonstrated a 35% positive rate and showed statistically significant higher positive rate when compared with the control group ($p<0.05$). A higher positive rate was detected in the above 12 months course group in contrast with the below 6 months course group ($P<0.05$).

Most vertigo complaints in clinic belong to peripheral vertigo, usually refers to disorder in vestibule. Other than ENG, dynamic posturography (DPG) is another valuable approach to evaluate the vestibular function. In the present study, by using DPG, proprioceptive score, visual score, vestibular score as well as Romber's score and comprehensive evaluation were assessed. As demonstrated in our study (Table 2), among the control group, below 6 months course group and above 12 months course group, these scores in DPG not showed a significant difference except the vestibular score.

Visual ocular system (VOS) test is also commonly used to evaluate the vestibular function, we compared the vestibular condition among control group, below 4 month course group (<4 months) and above 4 month course group (>4 months) in BPPV patients. Our data show that the positive rate in VOS test and temperature experiment was 15% and 10%, respectively. In <4 weeks group, the positive rate was 20% and

30%, respectively, while in >4 weeks group, the positive rate was ascended to 35% and 85%, respectively (Table 3).

At present, canalith repositioning maneuvers is the major therapeutical approach of BPPV. In order to investigate the effect of canalith repositioning maneuvers for treating BPPV in different BPPV course, we compared the curative effect among patients of <4 weeks group and >4 weeks group. There are 20 cases were studied in each group. After the treatment of canalolith repositioning maneuver, all the patients were visited by telephone follow-up for 3 months. Vertigo symptoms in patients accepted canalith repositioning maneuver occurred with lower frequency onset compared with previous duration before the canalith repositioning maneuver were defined as improved. Vertigo symptom not alleviated after the canalith repositioning maneuver was defined as non-effective. The effect was divided into completely cured, improved and non-effective according to the degree of recovery. As the data demonstrated, the completely cured rate in <4 weeks group was higher than in >4 weeks group (Table 4). The effective rate, total of completely cured rate and improved rate, was higher in the <4 weeks group compared with the >4 weeks group. The rate of non-effective in the >4 weeks group is higher than the <4 weeks group (Table 4).

Table 1. *Rates of abnormal ENG in different duration of BPPV patients (%).*

	ENG					
Group	**Saccadic movement**	**Smooth pursuit test**	**Optokinnetic nystagmus test**	**Gaze test**	**Spontaneous nystagmus**	**Temperature experiment**
Control	0	0	0	0	0	10%
<6 months	0	0	0	0	100%	35%$^{\#}$
>12 months	100%	100%	100%	0	0	65%$^{*,+}$

$^{\#}$P<0.05 when compared with control, *P<0.05 when compared with control group, $^{+}$P<0.05 when compared with <6 months group. Control group, n=20; <6 months group, n=14; >12 months group, n=26.

Table 2. *Scores determined by DPG in patients with different courses of BPPV at the AP situation.*

	DPG				
Group	**Proprioceptive score**	**Visual score**	**Vestibular score**	**Romber's score**	**Comprehensive score**
Control	91.62 ± 1.35	84.37 ± 1.92$^{\bullet}$	62.91 ± 2.83	54.13 ± 1.61	69.55 ± 3.95
<6 months	92.58 ± 1.16	86.19 ± 2.99	57.63 ± 2.16$^{\#}$	54.96 ± 2.18	67.43 ± 2.87
>12 months	93.77 ± 3.51	89.07 ± 3.67	51.98 ± 1.94$^{\#+}$	57.03 ± 2.87	63.02 ± 4.89

$^{\#}$P<0.05 when compared with the control group; $^{\bullet}$P<0.05 when compared with the control group; $^{+}$P<0.05 when compared with the below 6 months course group. Data was shown as mean ± sem. Control group, n=20; <6 months group, n=14; >12 months group, n=26.

Table 3. *Rate of abnormal vestibular function in different course of BPPV.*

	Vestibular function	
Group	**Positive rate in VOS test (%)**	**Positive rate in temperature experiment (%)**
Control	15	10
<4 weeks	20.00^{a}	30.00^{d}
>4 weeks	35.00^{b,c}	85.00^{e,f}

^{a}P<0.05 when compared with the control group; ^{b}P<0.05 when compared with the control group; ^{c}P<0.05 when compared with the control group; ^{d}P<0.05 when compared with the control group; ^{e}P<0.05 when compared with the control group; ^{f}P<0.05 when compared with the control group. Control group, n=20; <4 weeks group, n=20; >4 weeks group, n=20.

Table 4. *Analysis of curative effect of BPPV in different course.*

Curative effect	**<4 weeks**		**>4 weeks**	
	Case	**Rate (%)**	**Case**	**Rate (%)**
Completely cured	18	90%	9	45%
Improved	2	10%	7	35%
Non-effective	0	0%	4	20%
Effective	20	100%	16	80%

Discussion

In clinic, BPPV is not difficult to be diagnosed based on the patient's medical history and physical examination [8]. Vestibule in normal function is crucial in maintaining body balance. Besides, other systems such as reactive, anticipatory, sensory, dynamic, and limits of stability and physiological systems such as vestibular, visual, proprioceptive, muscle strength, and reaction time contribute to balance. Thus, in these years, some assessment tools are presented and used to

evaluate balance, such as the Tinetti balance and gait test [15], the Berg balance scale [16], ENG [17], DPG and SPG [18].

In our present study, we found that the control patient and the <6 months course patient of BPPV not appeared nystagmus by saccadic movement test, smooth pursuit test and optokinnetic nystagmus test (Table 1). However, in the >12 months course patient of BPPV all appeared with nytagmus by these tests. In addition, as indicated by DPG (Table 2) and VOR test (Table 3), the vestibule function score was descended as the disease of BPPV prolonged. These data may suggest that the vestibular function is worse in the longer course patient of BPPV. This may be explained by that the visual-vestibular optokinetic reflex is somewhat in deficits as the disease develops. The visual-vestibular optokinetic reflex is the primary mechanism for visual stabilization during head movements. Dysfunction of this reflex could arouse retinal slip occurs with head movement greater than approximately 2 Hz or 80 per second and visual acuity declines [19]. Cold or hot water/gas can be used to test whether any vestibular function after horizontal canal stimulation remains in the ear. In the temperature experiment, more cases were observed nystagmus in the longer course of BPPV (Table 1). The vestibule was irrigated by endolymphatic flow and nytagmus was occurred. However, not all patients of BPPV appeared with nystgamus by this test and our study was similar with previous study [20].

The prognosis of BPPV is excellent. As show in our data (Table 4), all of the patients <4 weeks course is recovered or partially recovered after a single maneuver, while in the patients >4 weeks course, 80% patients were recovered or improved. Our data is compatible with previous study which reported that 80-90% of the patients do not show signs of BPPV after the first treatment of canalith repositioning maneuver [21]. Except for canalith repositioning maneuver, some other approach such as chemical or even operational method is also applied for BPPV therapy in clinic [8,22]. As reported by Olusesi and colleague, vestibular suppressant was 68.4% success, particle repositioning maneuver was 69% success, and chemical labyrinthectomy was 53.8% success [23]. Therefore, canalith repositioning maneuver is the most effective and common method currently. Our data suggested that the patients with>4 week course may need multiple maneuver time [24] or some other therapeutic method. As reported by Korkmaz and coworker, age, sex, canal type and the duration of symptoms had no impact on the number of maneuvers [25]. However, as reported by Yoon and colleagues, longer duration of vertigo before treatment, bilateral or multiple canal involved, and age >50 years were the risk factors associated with the need for multiple particle repositioning maneuver [26]. These discrepancies may aroused by race of the patients.

In conclusion, our study suggested that the vestibular function in patients that suffered BPPV in a long duration was inferior to the shorter one. The curative effect by canalith repositioning maneuver in the patients of shorter duration is more satisfied than in the patients of longer suffering of BPPV.

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Conflicting Interests

The authors declared no potential conflicts of interest to this study, authorship, and/or publication of this article.

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