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(Article begins on next page)



# UNIVERSITÀ DEGLI STUDI DI TORINO

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# Benign paroxysmal positional vertigo and orthostatic hypotension

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## Abstract

### Objective

The aim of this study was to investigate a possible correlation between post-benign paroxysmal positional vertigo (BPPV) dizziness and orthostatic hypotension (OH) using the head-up tilt test (HUTT).

### Methods

Twenty-nine patients previously affected by BPPV and successfully underwent repositioning maneuvers were tested using the HUTT.

### Results

Our data do not show a statistically significant relationship between OH and the persistence of balance disorders after recovery from BPPV; anyway the prevalence of OH in the overall sample (34%) and in subjects affected by balance disorders after recovery (40%), was higher than in the general population.

### Interpretation

it is reasonable to hypothesize that OH plays a role in the genesis of orthostatic dizziness that patients commonly experience after recovery from BPPV. To improve the sensitivity of the HUTT, it would be advisable to use non-invasive continuous blood pressure monitoring. Although we feel that additional data are needed, we believe that the present work underlines the importance of considering anomalies of the autonomic system in the differential diagnosis of dizziness and could offer the basis for further studies about the role of sympathetic reflexes in those cases of persistence of symptoms after recovery from BPPV.

### Keywords

Benign paroxysmal positional vertigo Head-up tilt test Orthostatic hypotension Dizziness Vestibulosympathetic reflex

## Introduction

Benign paroxysmal positional vertigo (BPPV) is characterized by sudden attacks of vertigo triggered by changes in head position and is the most frequent cause of vestibular vertigo. According to the epidemiological studies, approximately 18% of patients seen in dizziness clinics [11] and 16% of patients seen in primary care have BPPV, whereas in a population-based survey study the lifetime prevalence was calculated to be 2.4% with a 1-year incidence of 0.6% [24]. The same study shows that the incidence of BPPV increases with age, with a mean age of onset of

49 years, and that it is more common in women, with a ratio of 2.4. BPPV therapy is based on repositioning maneuvers (RM), with a cure rate of up to 90% in patients with posterior semicircular canal involvement [13], and 85% in those with lateral semicircular canal involvement [5].

Patients frequently experience postural instability, brief episodes of vertigo, light-headedness, and orthostatic dizziness after the resolution of positional vertigo [6], especially when stand up, even months after the RM. Similar symptoms are commonly reported by patients with orthostatic hypotension (OH), which could be associated with supine hypertension and antihypertensive therapy [14]. The head-up tilt test (HUTT) represents a useful tool for the evaluation of neurocardiogenic syncope, dysautonomia and postural orthostatic tachycardia syndrome; moreover, HUTT can provide objective measures of OH [3].

Using the HUTT, this study aimed to investigate whether a correlation between post-BPPV dizziness and orthostatic changes in blood pressure and whether symptoms were reproducible during orthostatic challenge.

## Materials and methods

The study included 29 consecutive patients (18 females and 11 males, mean age  $61 \pm 17$  years, age range 18–84), affected by idiopathic BPPV, who successfully underwent RM in our department. Twenty-seven patients (93%) had canalolithiasis of the posterior canal (21–72% had left-posterior canal involvement and 6–21% had right-posterior canal involvement), whereas two patients (7%) had canalolithiasis of the left-lateral canal. No patients experienced syncope or fall before the episodes of BPPV and OH was not reported.

In each patient, diagnosis was carried out by means of Dix-Hallpike and Semont maneuvers for posterior canal BPPV and by means of the Pagnini–McClure maneuver [5] for lateral canal BPPV. Fourteen patients (48%) were affected by hypertension treated with antihypertensive drugs (various combination of ace-inhibitors, Ca-antagonist, diuretics, and  $\beta$ -blockers), of these 12 were taking 2 or more drugs. Four patients had asymptomatic coronary artery disease, with normal left ventricular function at the time of the test (previous percutaneous coronary angioplasty).

Patients older than 85, those affected by another concomitant vestibular or central disease, severe mental impairment, diabetes or Parkinson disease were excluded from the study.

All patients affected by posterior canal BPPV were treated with Semont RM [22]; two patients with horizontal canal involvement underwent Lempert's barbecue maneuver, an RM consisting in body rotation of  $270^\circ$ ; this rotation was performed in the supine position toward the healthy side in steps of  $90^\circ$  [5].

All patients were re-examined 1 week after the RM, which in some cases was repeated until the disappearance of the acute positional vertigo. Following the complete resolution of BPPV, all patients were tested with HUTT and a bithermal binaural caloric test using the Fitzgerald–Hallpike technique. This control was scheduled 2–4 weeks after BPPV resolution.

The HUTT was carried out in a quiet, dark environment, with a room temperature between  $20^\circ$  and  $24^\circ$ , at least 2 h after a light meal. The intake of current therapy was not interrupted. A continuous 12 leads ECG was monitored and printed on paper every minute. Manual blood pressure reading was obtained from the left arm, with a mercury column sphygmomanometer, while heart rate was recorded on an electrocardiographic monitor. Patients were previously examined by a cardiologist. Measurements of blood pressure were taken during the 1st, 5th, and 10th minute, while the patient was in the supine position with safety belts fastened. The tilt table was then gently tilted head-up until an angle of  $70^\circ$  in 10 s. Blood pressure measurements were obtained as soon as the patient was in the orthostatic position and every minute during the first 5 min of tilt, then at the 8th, 10th, 12th, 15th, and 20th minute. The duration of the tilt was 20 min in order to detect cases of delayed OH [15]. All clinical data, including the history of hypertension and antihypertensive therapy, other cardiac diseases, previous episodes of syncope and ECG abnormalities were recorded. Hypotensive reactions on tilt were considered when, at any time during the HUTT, the systolic blood pressure

(SBP) decreased by  $\geq 20$  mmHg or the diastolic blood pressure (DBP) decreased by  $\geq 10$  mmHg relative to the last supine measurement. Supine hypertension was defined as SBP of 140 mmHg or more and/or DBP of 90 mmHg or more during the 10-min supine phase prior to the test [17].

The statistical analysis was carried out by means of the Fisher exact test and Student's t test. The significance level was set at  $P < 0.05$ .

## Results

Ten patients (34%) reported dizziness during the diagnostic maneuvers when they were moved from supine to sitting position; 19 (66%) did not report symptoms after RM. In no case did we find a vestibular dysfunction on the caloric test.

In 10 patients affected by balance disorders during the diagnostic maneuvers, symptoms such as slight unsteadiness in the upright position or after the rapid elevation movements persisted in the subsequent days. Among these patients, 7 (70%) were affected by BPPV of the left-posterior canal, 1 (10%) by BPPV of the left-lateral canal and 2 (20%) by BPPV of the right-posterior canal (Table 1). The persistence of balance disorder was significantly correlated with sex ( $P < 0.05$ ) and it was reported in 70% of males and in 30% of females (Table 1). Differences in age, time between RM and HUTT and hypertension were not significant between subjects affected or free from balance disorders after the resolution of BPPV (Table 1).

Table 1

Distribution of clinical parameters in relationship to the presence of balance disorders after RM and their statistical relationship

Persistence of symptoms after recovery	N	Age (SD)	Sex		Symptoms during HUTT	Canalolithiasis			Weeks (SD) from RM	Hypertension	
			Male	Female		Lat L	Post R	Post L		Yes	No
Yes	10	66 (16)	7 (70%)	3 (30%)	8 (80%)	1 (10%)	2 (20%)	7 (70%)	3 (2)	6 (60%)	4 (40%)
No	19	59 (18)	4 (21%)	15 (79%)	3 (16%)	1 (5%)	4 (21%)	14 (74%)	4 (1)	8 (42%)	11 (58%)
P		>0.05	<0.05		>0.05	>0.05			>0.05	>0.05	

Post L left-posterior canal, post R right-posterior canal, Lat L left-lateral canal, SD standard deviation, RM repositioning maneuver

In parenthesis rate or standard deviation

Statistical test applied were  $\chi^2$  and Student's t test

Ten patients (34%) had a hypotensive reaction to HUTT (Table 2). The presence of hypotensive reaction was not related to age, sex, and hypertension ( $P > 0.05$ ). All hypotensive reactions occurred during the first 5 min of tilt: in 6 out of these patients (60%) it occurred in the first minute and no cases of delayed OH were found. In all the patients, OH was transient and in no cases was the test interrupted. Eleven patients experienced dizziness during tilting maneuver or in the first 3 min of orthostatic position, however, only four patients had OH, while these symptoms were being experienced (Table 2). Out of 11 patients who had symptoms during HUTT, 8 had persistence of symptoms after recovery from BPPV and 3 did not report symptoms after the resolution of BPPV. The correlation between the induction of symptoms during HUTT and persistence of symptoms was significant ( $P < 0.05$ ) (Table 1). As regards, the relationship between persistence of dizziness after RM and OH to HUTT, we found that among subjects affected by balance disorders 4 (40%) were positive for hypotension to HUTT and 6 (60%) negative; otherwise among subjects free from balance disorders 6 (32%) were positive to HUTT and 13 (68%) negative (Fig. 1). Differences on the Student's t test are not significant ( $P > 0.05$ ).

Table 2

Distribution of clinical parameters in relationship to the outcome of HUTT

Orthostatic hypotension at HUTT	No. of patients	Symptoms during HUTT	Age	Sex		Hypertension	
				Males	Females	Yes	No
Yes	10	4 (40%)	64 (15)	7 (70%)	3 (30%)	5 (50%)	5 (50%)
No	19	7 (37%)	55 (21)	11 (58%)	8 (42%)	9 (47%)	10 (53%)
P		>0.05	>0.05	>0.05		>0.05	

In parenthesis rate or standard deviation

Differences of parameters considered are not significant at the statistical analysis ( $P > 0.05$ )

Statistical tests applied were  $\chi^2$  and Student's t test

HUTT head-up tilt test

Fig. 1

Relationship between the presence or absence of balance disorder after RM in relation to the outcome of HUTT. White bars rate of subjects positive at HUTT, black bars subjects negative at HUTT. Differences are not significant at the  $\chi^2$  test. HUTT head-up tilt test

## Discussion

According to the canalolithiasis hypothesis, BPPV is caused by the presence of calcium debris in the semicircular canals. This debris, which probably originates from the otoconia of the utricular sac [16], disturbs endolymph flow and causes an inappropriate stimulation of the hair-cell receptors whenever the head is rotated in the plane of the canal. The classic form of BPPV is caused by canalolithiasis of the posterior semicircular canal, whereas the lateral semicircular canal has been identified as the affected structure in about 10–15% of cases [4]. A superior semicircular canal variant is reported, although its incidence appears to be very low [13]. Classic posterior canal BPPV is idiopathic in the majority of cases. Secondary BPPV can follow prior to head trauma in approximately 15% of cases [18] or can be a residual effect of a variety of vestibular pathologies, most commonly Meniere's disease (30%), but also vestibular neuronitis, ear surgery, and inner ear ischemia [18].

Since the first description of BPPV, in 1921 [1], much progress has been made in understanding and treating it, but there are some aspects that still remain unclear. RM are the most effective treatment for the disease [5, 13], but even after successful treatment, it is common for there to be brief episodes of dizziness during the Dix–Hallpike diagnostic maneuver in which the patient is moved from the supine to the seated position, as happens in patients with symptoms due to OH.

The influence of the vestibular system on autonomic responses is well known: in fact pallor, nausea, and sweating are commonly observed during acute vestibular vertigo attacks. These findings support the concept that otolith organs contribute to sympathetic regulation in humans; in particular, stimulation of the otolithic organ during change in the head position seems to contribute to activating, via the vestibulosympathetic reflex (VSR), adjustments in circulation and respiration that are necessary for maintaining homeostasis. Blood pressure and heart rate increase even before other cardiovascular mechanisms, such as the baroreceptor reflex, occur [19]. There is evidence from studies conducted on animals and humans that vestibular lesions result in a diminished VSR and consequently in an increased intolerance to the orthostatic position [8, 28]. This seems to happen not only in cases of acute vestibular lesions, but also in elderly [10].

If, as demonstrated in other studies, patients with idiopathic BPPV have an otolith organ dysfunction, subsequent to degeneration of the utricular macula [25], we can assume that also in this case the contribution of the VSR to the maintenance of blood pressure during posture changes can be compromised. Further evidence that supports this thesis comes from the supposition that the otolith hair cell loss that occurs with aging [21] and after prolonged spaceflights [23] might increase orthostatic intolerance.

The persistence of mild unsteadiness, lightheadness, disequilibrium, and dizziness after full recovery, reported by 34% of our patients, has been described in other studies [16]. Nevertheless, as far as we know, this is the first study to investigate, by means of the HUTT, the presence of orthostatic intolerance in patients, who have recovered from BPPV and its relation to the persistence of dizziness. Other authors have investigated postural control in patients affected by BPPV after treatment by means of dynamic posturography [2] demonstrating the presence of postural imbalance after recovery, probably due to otolithic organ damage. Psychological factors that increase the perception of dizziness have also been advocated [16].

Tilt testing is useful to investigate any orthostatic symptom and evaluate the neurocardiovascular response in a controlled environment; its sensitivity to detect abnormal responses is calculated to be 70–100% [12]. In our study, the HUTT reproduced symptoms in 80% of patients with persistence of symptoms after recovery from BPPV. The symptoms were brief and occurred during the tilting maneuver or in the first minutes of orthostatic position. Only four patients had concomitant OH. The finding can be explained by a delay in measuring blood pressure while the table was tilted. However, symptoms could have a different origin, for example, subjective perception without significant change in blood pressure, due to a visual stimulus [26].

Our data do not show a statistically significant relationship between OH and the persistence of balance disorders after recovery from BPPV. However, it is not possible to exclude this correlation, since the prevalence of OH we found in the study group, 34% in the overall sample and 40% in subjects affected by balance disorders after recovery from BPPV, seems to be higher than in the general population, calculated to be 15.9% (25.8% in patients older than 60) in a recent study where blood pressure was measured at the third minute of active orthostatic stress [27]. A study comparing HUTT and standing up in normal subjects showed that blood pressure was lower only during the first minute of HUTT as compared to standing up; the two maneuvers have comparable effect on blood pressure after the first minute [15]. Because in our study 60% of the patients had OH in the first minute, the prevalence of OH may be overestimated. However, in a population of middle-aged adults investigated at 30-s intervals during standing up, the prevalence of OH within 3 min was 5% [20]. Our results are of particular interest when we consider that none of our patients suffered from diseases commonly recognized as being responsible for OH through autonomic failure, such as Parkinson's disease or diabetes, or through volume depletion. Previous studies report a correlation between antihypertensives and OH [21], but in our population treatment with hypotensive drugs does not seem to influence the HUTT results.

We can suppose that negativity in the statistical test analysis may be due to the fact that OH is present in a higher rate than in the normal population in both groups, with or without balance disorders, after RM, and that only in some cases does it determine dizziness or other symptoms.

Further studies of a larger population are required to demonstrate if a relation exists between persistence of symptoms and OH. In addition to the small sample of patients involved, our study was limited by the method used to detect pressure changes during the HUTT. The manual pressure measurements that are recommended in the current literature do not allow us to detect brief episodes of transient OH that may occur in the first seconds of tilting; vestibular influences on the cardiovascular system operate within one heartbeat after the onset of abrupt head acceleration and VSRS may operate at a latency of 0.4 s [9].

To improve the sensitivity of the tilt test, as suggested by Imholz et al. [7], it would be advisable to use non-invasive continuous blood pressure monitoring instead of the traditional manual procedure. Another limit of the study is the long length of time that passed between the last RM and the

HUTT: a non-invasive continuous blood pressure monitoring might allow the detection of hypotension directly at the time of the diagnostic maneuver. As far as reproduction of symptoms is concerned, there is a good correlation between persistence of symptoms and induction of dizziness during HUTT. In cases with correlation between OH and symptoms the diagnostic usefulness of the test is confirmed. While we feel that additional data is needed, we believe that the present work underlines the importance of considering anomalies of the autonomic system in the differential diagnosis of dizziness and could offer the basis for further studies about the role of sympathetic reflexes in those cases of persistence of symptoms after recovery from BPPV.



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