New treatment strategy for apogeotropic horizontal canal benign paroxysmal positional vertigo

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Abstract

The apogeotropic variant of horizontal semicircular canal benign paroxysmal positional vertigo (HC-BPPV) is attributed to canalithiasis of the anterior arm or cupulolithiasis. Despite some therapeutic maneuvers, I propose a new treatment strategy for apogeotropic HC-BPPV that is designed to detach both the otoconial debris from the anterior arm of the semicircular canal and the debris that is attached to the utricular side of the cupula using inertia and gravity and based on simulations with a 3D biomechanical model.

Introduction

Benign paroxysmal positional vertigo (BPPV) is one of the most common disorders causing dizziness.[1] It is characterized by recurrent brief episodes of vertigo that are triggered by changes in head position and caused by free-floating otoliths (canalithiasis) or otoliths that have adhered to the cupula (cupulolithiasis) within any of the three semicircular canals.[2]

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BBPV develops mostly in the posterior (90% of cases) and horizontal (5-30% of cases) semicircular canals.[3,4] However, horizontal canal BPPV (HC-BPPV) may be more prevalent than previously thought.[5] The cause of BPPV is unknown (idiopathic) in all variants of this syndrome. BPPV is highly prevalent in middle-aged women, and hormonal factors may therefore play a role in the development of BPPV.[6]

HC-BPPV is diagnosed by the supine roll test, in which the patient's head is turned about 90° to each side while supine. This maneuver can induce horizontal nystagmus that may beat toward the ground (geotropic form) or toward the ceiling (apogeotropic form). Apogeotropic HC-BPPV is attributed to either cupulolithiasis or canalithiasis within the anterior arm of the horizontal canal. Cupulolithiasis itself may be canal sided or utricular sided.[7] It is characterized by horizontal, direction-changing nystagmus toward the uppermost ear on both sides. One study attempted to evaluate how to differentiate cupulolithiasis on either side of the cupula, but based on clinical follow-up to positions and maneuvers.[8] The therapeutic goal should be to detach the otolithic debris from the cupula or shift the debris from the anterior into the posterior arm of the horizontal canal. In the case of adhesion at the canal side of the cupula or free-floating particles in the anterior arm, detachment and shifting of the otolithic debris into the posterior arm would lead to a transition into geotropic HC-BPPV.[2]

Some treatment regimens have been proposed for the management of apogeotropic HC-BPPV, such as head-shaking in the horizontal plane, modified Semont maneuver, Asprella maneuver, Gufoni maneuver, and, recently, head-tilt hopping exercises.[9] A double-blind randomized trial[10] showed that the Gufoni maneuver was highly effective, as compared to a sham maneuver, in both geotropic and apogeotropic forms, changing the recommendation of treatment from level B to level A for the apogeotropic variant of HC-BPPV. However, in other studies, the efficacy of the Gufoni maneuver was considerably lower and varied widely, ranging from 22.2% to 81.3% possibly because of difficulties in detaching the otoconia from the cupula.[11-13]

The Gufoni maneuver was designed to remove the otolithic debris from the anterior arm of the semicircular canal near the cupula by means of the *inertial* detachment of otoliths caused by the brisk deceleration of the head and their migration toward the utricle or the canal. The original Gufoni maneuver described in 1999[14] was performed with the examiner standing in front of the patient, who was seated in the center of the examination couch. First, the patient was *briskly* brought down on one side (the healthy side in geotropic forms and the affected side in apogeotropic forms). Then, the head was quickly inclined *downward* by 45° and held in this position for 2 to 3 minutes. Finally, the patient was returned to the starting position. The maneuver was performed twice consecutively in the same session and patients did not receive any post-treatment restrictive instructions. However, several authors[15-17] have performed the Gufoni maneuver for apogeotropic HC-BPPV as proposed and described by Appiani,[18] that is, in the second step of the maneuver, instead of inclining the head downward by 45°, the patient's head is turned 45° *upward.*

Therefore, I propose a new treatment strategy for apogeotropic HC-

BPPV that is designed to detach both the otoconial debris from the anterior arm of the semicircular canal and the debris that is attached to the utricular side of the cupula using inertia and gravity.

Materials and Methods

I describe a new treatment strategy for apogeotropic HC-BPPV based on the 3D biomechanical model that was applied by Richard Rabbitt[19,20] in order to predict the location of particle debris within the labyrinth and cupula volume displacements during the apogeotropic HC-BPPV canalith repositioning procedure (CRP) (Figure 1) (Video). The particles in this simulation are large and they allow a faster CRP - small particles may require a 3-minute wait time. This study was approved by the Ethics Committee of the Brazilian Lutheran University (ULBRA RS), Canoas, Brazil (protocol number CAEE 06137012.3.2002.5349).

This maneuver is performed with patients in the sitting position. First, the patient is asked to quickly lie down on the affected side (step I) and is held in this position for 3 minutes. Then, the patient's head is rotated *90° toward the ceiling* (step II) and held in this position for another 3 minutes. After 3 minutes, the patient moves the body into dorsal decubitus and the head is *turned 90° toward the unaffected side* (step III) and held in this position for another 3 minutes. Finally, the patient's head is tilted slightly forward (step IV), followed by a slow return of the patient to the sitting position (step V) (Figure 2).[21]

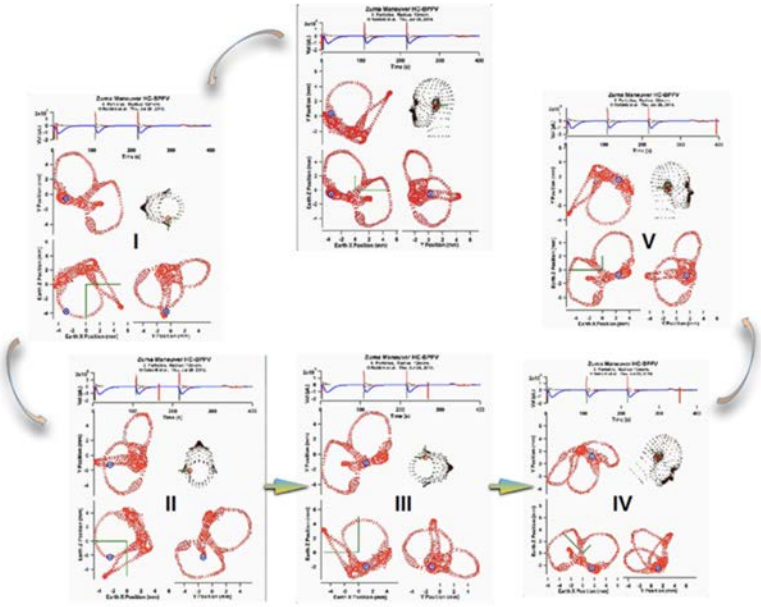

Figure 1. Simulation of the new apogeotropic horizontal semicircular canal benign paroxysmal positional vertigo canalith repositioning procedure based on the 3D biomechanical model applied and previously modified by Richard Rabbitt.[19,20]

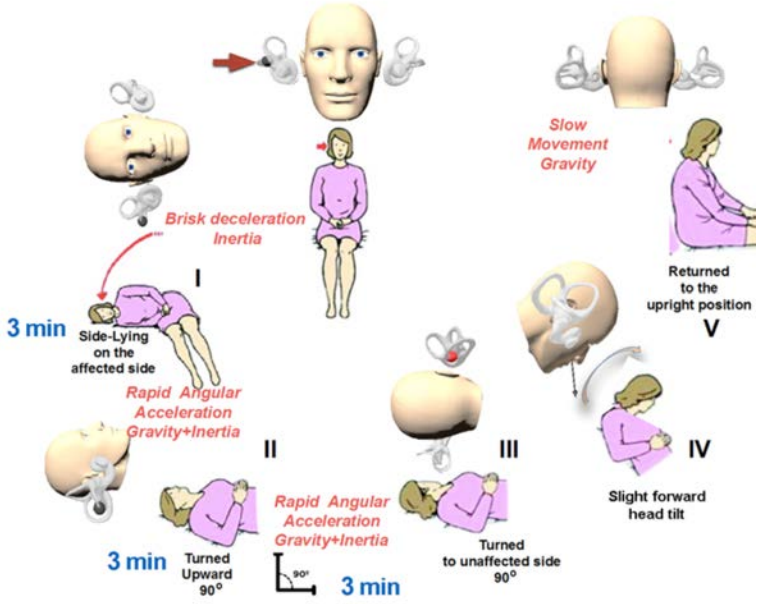

Figure 2. New treatment strategy for apogeotropic horizontal semicircular canal benign paroxysmal positional vertigo.21

Eight patients using Frenzel goggles without fixation were diagnosed with nystagmus by maneuver for HC-BPPV in the supine head roll test or McClure–Pagnini test. This is performed by turning the head 180° to either side while supine. Since it is performed on the yaw plane, it should be more correct to call it the head yaw test (HYT) while supine.

As therapeutic maneuver should be performed toward the healthy side, diagnosing the affected side is critical for successful treatment. The first described clinical sign in order to identify the impaired side in HC-BPPV, is the intensity of the nystagmus evoked by performing HYT while supine: Head Yaw Nystagmus.

The Head Yaw Nystagmus beats with more intensity towards the impaired ear, according to Ewald's second law, which postulates that the response to an excitatory stimulus is always more intense than the one following an inhibitory stimulus. In the apogeotropic variant the affected side is the one on which the nystagmus is less intense in HYT.

The new treatment maneuver was performed and its immediate therapeutic efficacy was determined by the same experienced neurotologist.

The primary outcome with respect to efficacy was the proportion of patients achieving immediate resolution of vertigo and positional nystagmus as measured 1 hour after a single application of the maneuver. Patients received no post-treatment restrictive instructions.

Results

All 8 patients achieved immediate resolution of vertigo and positional nystagmus as measured 1 hour after the application of the new maneuver.

Discussion

The success rates reported for the Gufoni maneuver in the geotropic variant of HC-BPPV after 1 or 2 applications are quite high (78.1–86% and 93–100%, respectively).[13] However, when applied to the apogeotropic variant, the efficacy of the Gufoni maneuver falls considerably (22.2–81.3%),[13] perhaps because of difficulties in detaching the otoconia from the cupula. Also, a clinical distinction between canalithiasis and cupulolithiasis (canal or utricular sided) seems complicated, and so far no suggestions have been made on a potential algorithm for their differential diagnosis. Another issue concerns the fact that some authors report the efficacy rates of the Gufoni maneuver for apogeotropic HC-BPPV when they are, in fact, referring to the variant maneuver proposed by Appiani.[15-18]

The first step of the new treatment strategy proposed in the present study is pretty much the same of Gufoni/Appiani – brisk deceleration. Through this brisk deceleration, inertia can detach the otoconia from the cupula (canal side). Some authors also report the use of the first step of the Gufoni/Appiani maneuver as a method of transforming the apogeotropic into the geotropic variant.[22] The horizontal canal is placed on the earth-vertical plane. Thus, the otoconia from the canal side of the cupula gravitate in the ampulla and the otoconia from the anterior arm gravitate in the canal inducing an ampullofugal endolymph flow and horizontal nystagmus beating toward the unaffected side.

The second step involves rapid angular acceleration (gravity + inertia). The 90-degree upward turning of the head aims to facilitate the movement of the detached otoconia either toward the utricle or toward the canal depending on their location in the ampulla. In cases of otoconia in the anterior arm, a horizontal nystagmus beating toward the unaffected side is expected.

The third step also involves rapid angular acceleration (gravity + inertia), but with a 90-degree turning of the head toward the unaffected side. This third step theoretically places the otoconia nearer the utricle. There is no need for another Gufoni maneuver in the case of geotropic transformation (this time on the healthy side) to achieve cure, and this movement may remove the otoconial debris that is attached to the utricular side of the cupula.

In the fourth step, the patient's head is tilted slightly forward in order to encourage the particles to move toward the utricle, where they are likely to become stuck. Otherwise, the particles could move back toward the lumen of the horizontal canal.

In the fifth step, the patient resumes the original sitting position slowly (gravity), allowing the otoconia to fall into the utricle.

While maintaining the simplicity of the Gufoni/Appiani maneuver, the new treatment strategy proposed for apogeotropic HC-BPPV may have some advantages in practice. First, similarly to the Gufoni/Appiani maneuver, the patient is positioned on the side that induces fewer vertiginous symptoms (affected side), which seems not only detach otoconia from the cupula but also to move them out of the horizontal canal, second, this maneuver is easier to perform in patients with obesity, advanced age, cervical spondylosis, or musculoskeletal deficiencies than the so-called *barbecue* maneuvers.

Conclusions

Despite the small sample of patients, the new strategy for apogeotropic HC-BPPV was effective after a single application. However, further studies are needed to evaluate the efficacy of this maneuver.

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