



A comparative study of two methods for treatment of benign paroxysmal positional vertigo in the emergency department

D. Giardino ^{a, b}, M. Musazzi ^{a, b}, M. Perez Akly ^a, M. Cherchi ^{c, d, *}, D.A. Yacovino ^{a, e}

^a Department of Neurology — Dr Cesar Milstein Hospital, Buenos Aires, Argentina

^b Department of Neurology — Centro de Educación Médica e Investigaciones Clínicas “Norberto Quirno” (CEMIC), Buenos Aires, Argentina

^c Department of Neurology — Feinberg School of Medicine, Northwestern University, Chicago, IL, USA

^d Chicago Dizziness and Hearing, Chicago, IL, USA

^e Memory and Balance Clinic, Buenos Aires, Argentina

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ABSTRACT

Introduction: Posterior canal benign paroxysmal positional vertigo (PC-BPPV) is considered the most common cause of peripheral vertigo in the emergency department (ED). Although the canalith repositioning maneuver (CRM) is the standard of care, the most effective method to deliver it in the ED has been poorly studied.

Objective: To compare two protocols of the Epley maneuver for the treatment of PC-BPPV.

Patients and methods: We prospectively recruited 101 patients with unilateral PC-BPPV on physical examination, randomizing them to either a single Epley maneuver (EM) (n = 46) or multiple maneuvers (n = 55) on the same visit. Measured outcomes included presence/absence of positional nystagmus, resolution of vertigo, and score on the dizziness handicap inventory (DHI) at follow-up evaluations. The DHI was stratified into mild (≤ 30) and moderate-severe (> 30).

Results: Normalization of the Dix-Hallpike maneuver at day 5 was observed in 38% of the single EM group and 44.4% in the multiple EM group (p = 0.62). The DHI showed reduction from 42.2 (SD 18.4) to 31.9 (SD 23.7) in the single EM group and from 43.7 (SD 22.9) to 33.5 (SD 21.5) in the multiple EM group (p = 0.06). A higher number of patients improved from moderate-severe to mild DHI (p = 0.03) in the single EM group compared to the multi-EM group (p = 0.23).

Conclusion: There was no statistically significant difference between performing a single EM versus multiple EMs for treatment of PC-BPPV in the emergency department. The single EM approach is associated with shorter physical contact between patients and examiner, which is logically safer in a pandemic context.

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1. Introduction

Posterior canal benign paroxysmal positional vertigo (PC-BPPV) is considered the most common cause of vertigo of peripheral origin, and one of the main reasons for consultation in an emergency department (Edlow, 2016).

* Corresponding author. Department of Neurology, Feinberg School of Medicine, Northwestern University, Abbott Hall, 11th Floor, 710 N. Lake Shore Dr., Chicago, IL, 60611-3078, USA.

E-mail address: m-cherchi2@fsm.northwestern.edu (M. Cherchi).

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The pathophysiological mechanism of BPPV is the presence of free moving debris of calcium carbonate (otoliths) detached from the utricular macula that have migrated into the semicircular canal, a state referred to as canalolithiasis. Depending on the movement and orientation of the head, gravity intermittently causes the free moving otoliths within the semicircular canals to descend, producing aberrant stimulation of the vestibular afferents of the affected canal. Typically, the clinical findings include brief episodes of vertigo (lasting less than 1 minute) provoked by positional changes of the head (e.g., lying down, sitting up or rolling over in bed), combined with a nystagmus whose direction is in the plane of the affected canal following Ewald's Law (Bhattacharyya et al., 2017).

Although all semicircular canals are vulnerable to canalolithiasis, the posterior semicircular canal is involved in approximately 80% of the cases (Helminski et al., 2010). The Dix–Hallpike (DH) maneuver is considered the gold standard test to diagnose PC-BPPV and a “positive” DH test is defined by the occurrence of the symptom of vertigo in combination with the oculomotor finding of a brief up beat nystagmus and torsional nystagmus (with the upper pole of the eyes beating towards the affected ear) (von Brevern et al., 2015; von Brevern et al., 2017).

Canalith repositioning maneuvers (CRMs) move the loose otoliths into the utricle, which promotes their eventual resorption, and comprises the basis for the treatment of BPPV. Two CRMs have been reported to be effective: the Epley maneuver (or more precisely the modified Epley maneuver) and the Semont maneuver (Bhattacharyya et al., 2017). The Epley maneuver (EM) is the most widely used maneuver, consisting of a sequence of four movements of the head and body, from sitting to the DH position, a 90-degree rotation from the affected to the healthy side, and ends when the patient sits back up (Gaur et al., 2015). At each change of position, gravity sequentially pulls the otoliths to the non-ampullary exit of the posterior canal, through the common crus, and ultimately into the utricular cavity. The cure rate of the EM approaches 95% depending on the series (Smouha, 1997). A common complication of performing EM is canal switch (also called a canal conversion), which is the unintentional migration of otoliths from one canal to another. A canal switch can result from a repositioning maneuver itself or from a subsequent diagnostic positional test. The reported rates of canal conversion following treatment of PC-BPPV with the EM range from 2.4% (Lee et al., 2019) to 16% (Foster et al., 2012). Re-entrance of the otoliths during a diagnostic maneuver (such as the Dix–Hallpike) is also possible, when the otoliths drop back into the same (previously cleared) canal (Dispenza et al., 2015; Foster et al., 2012). The former complications are usually poorly tolerated by the patient and the risk logically increases in proportion to the number of EMs performed (Lee et al., 2019).

Although there is a satisfactory level of evidence to treat PC-BPPV with the Epley maneuver, discrepancies remain about which protocol is considered the most effective. The most widely used guidelines for management of the PC-BPPV fail to clarify quantitative aspects of the Epley maneuver procedure (Reinink et al., 2014); in particular, the optimal number of Epley maneuvers to perform remains debatable; there are diverse recommendations and insufficient evidence (Korn et al., 2007).

With this in mind, the aim of the present study is to elucidate which treatment procedure is more effective for managing the PC-BPPV, comparing a single EM versus multiple EMs in the same session in an environment that is always demanding, the emergency department (ED).

2. Materials and methods

We conducted a single-center, prospective, randomized, open experimental study with blind evaluation of the results. All the patients who, in a 12-month period (2016), presented to the emergency department at a single medical center where neurology was consulted, with a diagnosis of BPPV canalolithiasis of the posterior canal according to the diagnostic criteria established in the Bárány Society consensus document (von Brevern et al., 2015), were eligible for this study. Patients with a history of brief episodes of vertigo provoked by changes in head position and associated with nystagmus during the Dix–Hallpike maneuver on physical examination were included in this study. The involvement of the posterior canal was confirmed during Dix–Hallpike test by the presence of up beat, geotropic, torsional nystagmus with its characteristic latency and duration (<1 min), and associated with the

subjective perception of vertigo. The DH test was performed bilaterally. The affected side was determined as that on which there was more pronounced nystagmus and perception of vertigo (von Brevern et al., 2015; von Brevern et al., 2017).

Patients whose pattern of nystagmus suggested BPPV involving something other than a single unilateral posterior canal were excluded. Other clinically obvious concomitant causes of peripheral vestibular pathology (labyrinthitis, Ménière’s syndrome, vestibular neuronitis, vestibular schwannoma, perilymphatic fistula) were excluded. A comprehensive neurological examination by a junior neurologist was conducted, which included assessment of oculomotor function, bilateral vestibulo-ocular reflex, axial balance and gait. Once BPPV involving unilateral posterior canal canalolithiasis was diagnosed, the patients were randomized into two treatment groups (A and B) to compare the efficacy between them.

The study was carried out under existing ethical and legal standards pertaining to research involving human subjects and protection of personal data. It was approved by the local ethics committee and Institutional Review Board (IRB) of Dr. César Milstein Hospital. Participants were given verbal and written information about the study and were included after signing informed consent. All clinical assessments and EMs were performed by the same four neurology residents trained in diagnostic and canalith repositioning maneuvers. Being a study in the setting of an emergency department, the DH and Epley maneuvers were performed while observing the patients with the naked eye, unaided by oculomotor instrumentation (such as infrared video Frenzel goggles).

Patients were randomly assigned to one of two groups (A or B) using free randomization software (Urbaniak and Plous, 2013).

2.1. Study groups

In both groups the Epley maneuver was performed immediately after neurological evaluation and once unilateral PC-BPPV was diagnosed. Afterwards, the patients were divided into 2 groups by randomization.

Group A: This group of participants underwent multiple sequentially performed Epley maneuvers up to a maximum of 10 (one after the other at 5-min intervals) or until the subsequent DH maneuver was negative (nystagmus was no longer observed).

Group B: In this group of patients, a single Epley maneuver was performed without immediate monitoring after the maneuver.

Neither sedation nor mastoid vibration (Hunt et al., 2012) was used during the EM. Basic postural restrictions and safety advice were prescribed in all patients, including limiting cervical flexion-extension, sleeping with 2 pillows (elevating the head 30–45° from the bed), and avoiding sleeping on the affected ear for the next 48 hours. No cervical collar was prescribed.

2.2. Methods of efficacy measures

The patients were monitored on at least two occasions after the initial EMs. At the follow-up visit, the evaluator was blinded regarding the treatment group in which the patient had been enrolled. According to the protocol, the first monitoring was performed 5 days after the initial EM. A DH maneuver was performed, and if it was positive, a single EM was performed (regardless of the original group). The last monitoring visit of protocol finalization was established a month after the first negative DH.

The primary outcome was evidence of “cure,” defined as the negativization (conversion from positive to negative) of nystagmus on DH maneuvers during follow-up monitoring. The secondary outcome was to measure the subjective efficacy of the therapeutic intervention using the local version of the Dizziness Handicap Inventory (DHI) (Caldara et al., 2012). The DHI was administered at

the time of diagnosis and in subsequent monitoring visits. Briefly, the DHI consists of 25 multiple-choice questions. Each question is scored from 0 to 4, with a composite score ranging from 0 to 100 points. Higher values in the DHI reflect greater impairment.

The results from the DHI can be analyzed in two ways; first, the higher the score, the greater the negative impact of vertigo on daily activities (Caldara et al., 2012); second, the values can be stratified into mild (0–30) versus moderate-to-severe handicap (31–100) (Whitney et al., 2004). For the analysis, we also included general medical history and possible causes of BPPV, as well as the affected side.

2.3. Statistical analysis

Categorical variables were expressed as percentages, and continuous variables with means and standard deviations. The comparison of categorical variables was performed using the chi square test. The student t-test was used to compare means between groups. The statistical analysis was performed using SPSS version 22.0 for MacOS.

3. Results

One-hundred and one patients were included in the study, 55 patients in group A and 46 in group B. The mean age was 72.2 years (SD 8.8), 88% were women and the right ear was slightly more frequently affected. Twenty-two patients had a prior history of BPPV, 11 in each group. There were no statistical differences at baseline with respect to age, sociodemographic data, comorbidities, history of BPPV, and affected sides between groups (see Table 1). The mean number of maneuver repetition in group A was 2.7 (SD:2.4). Only 3 patients reached 10 (upper limit) CRMs, and most of them required only one (18 of 55).

A high percentage of patients (19 of 101 patients) self-reported brain injury within a month of the first visit; this high proportion surprised us, as it is unusual for the population of BPPV patients as a whole; we suspect that this may be a sampling bias arising from a possible tendency of patients with recent brain injury to seek care in an emergency department out of concern for more ominous causes of symptoms.

There was a significant drop out rate of patients (Fig. 1), involving 11 in group A and 7 in group B at 5 days visit. At one month, an additional 25 patients dropped out of each group (Fig. 1).

Table 1
Baseline clinical characteristics of each group and comparative analysis.

Variable	Group A (n = 55), multiple CRMs	Group B (n = 46), single CRM	p value
Age	73.1 (SD 9.2)	71.1 (SD 8.2)	
History of BPPV: n (%)	11 (20%)	11 (23.9%)	0.45
Mild traumatic brain injury: n (%)	11 (20%)	8 (17.3%)	0.53
Hypertension: n (%)	36 (65.4%)	29 (63%)	0.28
Diabetes: n (%)	9 (16.3%)	6 (13%)	0.5
Current smoker: n (%)	15 (27.2%)	10 (21.7%)	0.39
Previous Medication: n (%)	2 (3.6%)	4 (8.7%)	0.17
- Betahistine	6 (10.9%)	1 (2.2%)	
- Dimenhydrinate			
Affected Side: n (%)	30 (54.5%)	25 (54.3%)	0.54
- Right	25 (45.4%)	21 (45.6%)	
- Left			
Negative DH at 5 days: n (%)	21 (47%)	18 (51.2%)	0.83
Mean DHI (SD) at baseline	43.54 (19.5)	45.2 (22.01)	0.76
Mean DHI (SD) at 5-day monitoring visit	31.9 (23.7)	33.5 (21.5)	0.62
Negative DH at 4 weeks n (%)	16/19 (84%)	11/14 (78.5%)	0.68
Mean DHI (SD) at 4-week monitoring visit	21.6 (20.8)	28.86 (24.8)	0.29

Abbreviations: BPPV = benign paroxysmal positional vertigo, CRM = canalith repositioning maneuver, DH = Dix-Hallpike maneuver, DHI = Dizziness Handicap Inventory, SD = standard deviation.

When patients who failed to appear for a follow-up examination were contacted, the most common reasons cited for failure to follow-up were symptom resolution, and reluctance to return to the emergency department.

Results are shown in Table 1. Related to the main outcome, at the first monitoring visit (5th day), the cure rate based on observation of a negative Dix-Hallpike maneuver was 47% in group A and 51% in group B. A statistically significant difference was observed in both group A and B when comparing the mean of the DHI at the initial consultation and at the 5-day follow-up examination. However, the difference was larger in group B ($p = 0.006$ vs $p < 0.0001$). At the 30-day analysis there were also differences in both groups from the baseline DHI ($p = 0.001$) without differences between the groups.

Comparing the performance of multiple EMs (group A) and a single maneuver (group B), by considering the mean DHI at 5 days and 30 days, and the transformation of a Dix-Hallpike maneuver from positive to negative, both showed a significant reduction, and there were no statistically significant differences between them ($p = 0.62$). When the DHI in the mild category was compared to that of the moderate-to-severe category, group B achieved a statistically significant reduction, with a higher number of patients improving from moderate to mild DHI ($p = 0.03$) in comparison with group A ($p = 0.23$).

We note that no canal conversions were observed at any point in the patients of this study.

4. Discussion

There is strong evidence that the Epley maneuver is effective and safe in the treatment of PC-BPPV (Hilton and Pinder, 2014). Varying results from different studies have raised questions about which is the best EM protocol (Dorigueto et al., 2005; Korn et al., 2007; Perez-Guillen et al., 2020). Our goal in this study was to examine more closely the short-term therapeutic effect of two EM protocols in the demanding environment of the emergency department.

Although the EM is proven to be effective in managing PC-BPPV, it is commonly associated with either discomfort (nausea and vomiting) or complications (e.g., canal conversion). In this study, we compared an abbreviated versus a longer treatment strategy by using a single EM without immediate monitoring versus multiple EMs, and we subsequently monitored for resolution of both positional nystagmus and self-perceived disability. No sham maneuver

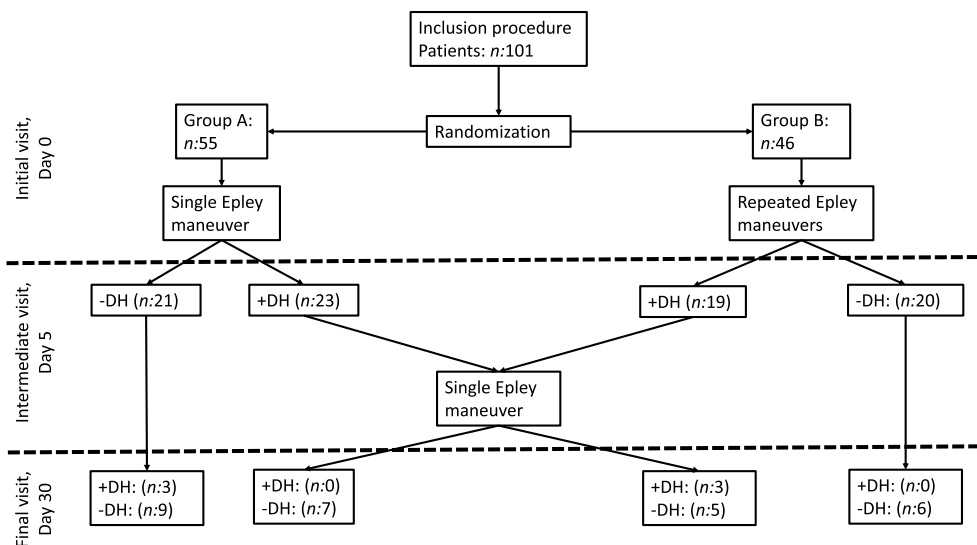


Fig. 1. Flow diagram. Description of the results in each group in the visit at day 5 and 30. +DH = positive Dix-Hallpike maneuver, -DH = negative Dix-Hallpike maneuver. The percentages were calculated on the total number of patients attending each visit in each group.

was included in the design of the study since the EM has already been proven as effective in managing PC-BPPV.

In one arm of the study (group A), the Epley maneuver was sequentially performed in the first treatment session until the nystagmus could no longer be provoked — and it should be noted that even then, the absence of nystagmus does not distinguish between cure (removal of the otoliths provoking the inappropriate stimulus of the canal) and fatigue (temporary vestibular habituation). Previous studies considered the immediate post-CRM negative results on the DH test as a sign of BPPV resolution (Imai et al., 2019; Korn et al., 2007), however, distinguishing fatigue, short-term adaptation or resolution is not always feasible at the bedside, especially on face-to-face examination in the emergency department (i.e., without instrumentation with infrared video Frenzel goggles). In other words, finding a negative DH result immediately after the very first repositioning maneuver cannot be considered as a successful procedure (Amor-Dorado et al., 2012; Imai et al., 2019). Immediate post-EM monitoring would be unable to distinguish a truly effective maneuver from mere habituation; in contrast, monitoring at 5 days should no longer be influenced by habituation and thus would be a better indicator of whether the initial maneuver was truly effective; thus, we chose to collect and analyze the data from monitoring at 5 days.

Studies regarding the optimal number of EM iterations to treat PC-BPPV are scarce. Three studies comparing a single EM versus multiple EMs in the same session reported a higher rate of therapeutic success in the latter (Gordon and Gadoth, 2004; Hughes et al., 2015; Korn et al., 2007), though it should be noted that these studies were not conducted in the ED setting. Gordon and colleagues (Gordon and Gadoth, 2004) reported 92% efficacy with three maneuvers compared to 80% with a single maneuver as treatment. Similarly, Korn and colleagues (Korn et al., 2007) found 88% efficacy with multiple maneuvers compared to 68% efficacy with a single maneuver. Hughes and colleagues (Hughes et al., 2015) reported 84% efficacy with three EMs compared to 47% with one EM. In contrast, the present study found that performing a single EM in the same session in which PC-BPPV is diagnosed is just as effective in the short term as performing several maneuvers. In

terms of efficacy, in both groups we found an initial resolution or cure rate (at 5 days) of the Epley maneuver to be lower than expected (~50%), which is below the range reported (68–90%) in other studies (Reinink et al., 2014). Potential causes include (1) the fact that older age is associated with worse outcomes (Babac et al., 2014; Teggi et al., 2011), and in our study the mean age of patients was high (72 ± 8.8 years); (2) the fact that the emergency room is a suboptimal environment for performing EM; (3) the skill level of junior physicians could be associated with the lower early results. All of these factors are common limitations in the real-world ED setting. Nevertheless, the results at one month were similar to those reported by other authors (Bhattacharyya et al., 2017). These results are somewhat similar to those of Balve and colleagues (Ballve et al., 2019), although the latter study was conducted in a primary care setting.

The disability as measured by the DHI did not show statistically significant differences between groups. However, more patients who underwent a single Epley maneuver reached mild disability than those who underwent multiple EMs.

Among the potential implications of this study, it is worth mentioning that EMs require close contact between the examiner and the patient, and in the context of COVID-19 pandemic, this procedure increases the risk of infectious exposure for both the patient and the examiner. Logically, performing multiple EMs increases the physical contact time and the bidirectional risk of infection. Since our study observed no statistically significant differences in terms of single versus multiple EM efficacy rate and disability, performing a single EM maneuver would be more reasonable in the pandemic context.

Strengths of the present study include a reasonable sample size, consistency of material (by drawing from a single practice environment), and uniformity in follow-up monitoring (through evaluation by a single senior clinician).

4.1. Limitations of our study, and their implications for future studies (“lessons learned”)

Several limitations of our study should be considered.

First, although the inclusion, treatment and follow-up of the patients was carried out by a small group of junior neurologists trained in the treatment of peripheral vertigo, the difference between observers could be considered a limiting factor. To minimize the impact of this factor our protocol included the use of a blinded examiner at the follow-up visit.

Second, the data from the initial encounters were collected by neurology residents (rather than by emergency room physicians), and such a resource is not available in all emergency room departments. While it has been recognized that emergency room physicians face barriers in diagnosing and treating BPPV (Kerber et al., 2013, 2017; Kerber, 2015), more recent studies also suggest that appropriately focused training can overcome such barriers (Kerber et al., 2020; Meurer et al., 2018).

Third, being a hospital that specializes in the care of the elderly, our patient population had a higher average age than that reported in other studies; therefore, the results we obtained may not be generalizable to a younger population.

Finally, there was an unexpectedly high drop-out rate of patients at the 1-month follow-up visit. Although some patients were also examined beyond the 1-month limit, we elected to omit those data in order to maintain a consistent time frame for the analysis. The high drop-out rate and poor adherence were non-controllable behaviors of the patients in our study; we cannot identify with certainty the cause(s) for this, though when we contacted those patients who did not follow-up, the most commonly offered reasons were symptom resolution, and reluctance to return to the emergency department; in other words, it appears that the environment of the ER itself may, to some extent, have discouraged follow-up, particularly in patients whose symptoms had resolved. However, in view of the short-term results with a reasonable sample size, we consider the data to be sufficiently reliable; even with the high drop-out rate, the statistical tendency at the first visit and last visit were similar. On the one hand, the drop-out rate intrinsic to a study conducted in the ER setting is a weakness; on the other hand, the majority of studies of BPPV have not analyzed its treatment in the ER setting. Thus, although the ER setting (with the perhaps unavoidable high drop-out rate) may introduce this weakness, it is also a relevant feature to consider for future research when designing a BPPV study in the ER setting. We suggest that the relative weakness, and what has been gleaned from the relative novelty, are proportional.

5. Conclusion

The results of this study suggest that treating PC-BPPV by performing a single Epley maneuver in the ED without further monitoring is equally effective as performing multiple maneuvers. The data for this study were collected prior to the COVID19 pandemic, but the conclusion (that performing a single treatment maneuver is similarly efficacious to performing multiple maneuvers) is particularly relevant to practice during a pandemic; during the COVID19 pandemic it is perfectly feasible for patients and staff to deploy personal protective equipment (such as gloves and masks) during an encounter for the diagnosis and treatment of BPPV, but it would nevertheless be desirable to limit, where appropriate, the direct exposure of staff and patients without reducing the efficacy of the treatment. If verified in subsequent studies, this could become the “new normal” in the treatment of BPPV.

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