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Original Article

Comparison of the Efficacy of Appiani and Zuma Maneuvers in Patients with Apogeotropic Horizontal Canal Benign Paroxysmal Positional Vertigo

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BACKGROUND: Apogeotropic horizontal canal benign paroxysmal positional vertigo (HC-BPPV) is a challenging variant of BPPV with lower treatment success rates compared to the geotropic form. The Appiani maneuver (ApM) and the Zuma maneuver (ZmM) represent 2 repositioning strategies targeting this condition, but head-to-head comparative data remain limited.

METHODS: A prospective randomized comparative study was conducted between December 2024 and November 2025. Patients with unilateral apogeotropic HC-BPPV confirmed by videonystagmography (VNG)-assisted supine roll testing were assigned to either the ApM (n = 38) or the ZmM (n = 39). The primary outcome was resolution of positional nystagmus; the secondary outcome was the number of maneuver sessions required (maximum 4). Patients who developed canal conversion to another semicircular canal during follow-up were excluded from efficacy analysis.

RESULTS: Among 77 patients (63.6% female; 59.7% aged ≥ 60 years), the overall single-session resolution rate was 63.6%. Resolution after 1 session was achieved in 68.4% (ApM) and 59.0% (ZmM) of patients, with no significant between-group difference ($P = .389$). Older age (≥60 years) was the only factor significantly associated with requiring ≥2 sessions (82.1% vs. 46.9%; $P = .002$).

CONCLUSION: Both the ApM and ZmM are effective and comparable treatments for apogeotropic HC-BPPV. Advanced age (≥60 years) was identified as an exploratory factor associated with requiring multiple treatment sessions.

KEYWORDS: Apogeotropic, Appiani maneuver, benign paroxysmal positional vertigo, horizontal canal, videonystagmography, Zuma maneuver

INTRODUCTION

Benign paroxysmal positional vertigo (BPPV) is the most common peripheral vestibular disorder, caused by dislodgment of otoconia from the utricular macula into 1 of the semicircular canals, producing abnormal endolymphatic stimulation. It is characterized by recurrent brief episodes of vertigo triggered by changes in head position and is diagnosed by the nystagmus pattern elicited during provocative maneuvers. Treatment consists of canal-specific repositioning maneuvers.[1-4]

Although the posterior semicircular canal is most frequently affected, horizontal canal (HC-BPPV) accounts for approximately 10%-30% of all BPPV cases.[5] Horizontal canal benign paroxysmal positional vertigo exhibits greater pathophysiologic heterogeneity than the posterior canal variant, making it more challenging to diagnose and treat.[6] Diagnosis relies on the supine roll test (Pagnini–McClure test), in which the head is rotated 90° to each side while the patient is supine. This maneuver elicits 2 principal nystagmus patterns: geotropic nystagmus (beating toward the ground), which results from canalithiasis in the posterior (long) arm of the horizontal canal; and apogeotropic nystagmus (beating away from the ground), which may arise from canalithiasis in the anterior (short) arm or from cupulolithiasis on either the canalicular (C-Cup) or utricular (U-Cup) side of the horizontal canal cupula.[2,7]

When apogeotropic direction-changing positional nystagmus (Apo-DCPN) is transient (duration < 1 minute) and without latency, anterior arm canalithiasis is favored; a sustained pattern (duration > 1 minute) with latency suggests cupulolithiasis.[8,9] However,

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these criteria have limited discriminatory precision in routine clinical practice, and considerable overlap exists between subtypes. These distinctions are clinically important because they inform maneuver selection and interpretation of treatment response during follow-up.[10]

Treatment success rates for apogeotropic HC-BPPV are generally lower than those for the geotropic variant, partly because the otolithic debris is located closer to the ampulla and because multiple pathophysiologic subtypes may coexist.[11,12] Several repositioning maneuvers have been proposed, including the modified Semont maneuver, therapeutic head-shaking, forced prolonged positioning, and the Gufoni maneuver.[13] In 2005, Appiani modified the Gufoni maneuver specifically for the apogeotropic form by reversing the head rotation direction, thereby facilitating debris displacement aided by inertia and gravity.[14] In 2016, Zuma e Maia introduced a new maneuver designed to address all 3 apogeotropic subtypes (anterior arm canalithiasis, C-Cup, and U-Cup cupulolithiasis) within a single sequence of movements**,** exploiting both inertial forces during rapid position changes and gravitational forces during maintained positions.[15]

Despite the clinical relevance of these 2 maneuvers, published comparative data remain limited. The aim of this study was to prospectively compare the therapeutic efficacy of the Appiani and Zuma maneuvers (ApM and ZmM) in patients with apogeotropic HC-BPPV by evaluating nystagmus resolution rates and the number of sessions required for cure, and to identify clinical or demographic factors that predict treatment response.

METHODS

Ethics and Consent

Ethical approval was obtained from the Ethics Committee of University of Katip Celebi (Approval No: 0258; Date: 19.12.2024). Written informed consent was obtained from all participants prior to enrollment. The study was conducted in accordance with the Declaration of Helsinki.

Study Design and Participants

This was a prospective, randomized comparative study conducted at the vertigo outpatient clinic between December 2024 and November 2025. Patients were eligible if they were adults with a diagnosis of unilateral apogeotropic HC-BPPV established according to the 2017 American Academy of Otolaryngology–Head and Neck Surgery (AAO-HNS) Clinical Practice Guideline.[16]

Inclusion criteria required the identification of direction-changing apogeotropic nystagmus on videonystagmography (VNG)-assisted supine roll testing in the absence of any other vestibular, neurological, or otological pathology, history of head trauma, or substance use disorder. Patients with posterior or anterior canal involvement on the roll test, or with physical limitations precluding safe maneuver performance (cervical, lumbar, or other musculoskeletal conditions), were excluded. The affected ear was identified using Ewald's second law: in apogeotropic HC-BPPV, nystagmus is strongest when the affected ear is uppermost.[6] When lateralization was ambiguous, the bow-and-lean test was used as an adjunct.[17]

Intervention

After diagnosis, patients were randomly assigned to 1 of 2 treatment groups. The ApM was performed as follows: with the patient seated upright, the examiner rapidly tilted the patient onto the affected side; after a 2-minute pause, the head was briskly rotated 45° upward (nose-up); this position was maintained for a further 2 minutes before the patient was returned to the upright position (Figure 1).[14]

The ZmM was performed as follows: from the seated position, the patient was rapidly laid onto the affected side; the head was then rotated 90° upward (nose-up); followed by a further 90° rotation toward the healthy side; the head was gently tilted forward (chin-tuck); and the patient returned to the upright position with the head slightly flexed. Each step was maintained for 3 minutes (Figure 2).[15]

Outcome Assessment

Patients were re-evaluated 48 hours after each maneuver session using VNG-assisted diagnostic testing (Dix-Hallpike and supine roll tests). Treatment success was defined as complete resolution of positional nystagmus on both tests. If nystagmus persisted in the original canal and direction, the same maneuver was repeated. Patients who developed canal conversion to another semicircular canal during follow-up—confirmed by a newly positive Dix-Hallpike test at reassessment—were excluded from the efficacy analysis, as the clinical course in such cases reflects a distinct pathological process. A maximum of 4 maneuver sessions was permitted. The total number of sessions required to achieve resolution was recorded for each patient.

Statistical Analysis

An a priori power analysis was conducted in G*Power (version 3.1) using a 2-tailed z-test for the difference between 2 independent proportions. With a significance level of $\alpha = 0.05$, a target power of $1-\beta = 0.80$, and equal group allocation (N2/N1 = 1), the analysis indicated that a minimum total sample size of 70 participants was required (critical z = 1.96; achieved power = 0.804). The enrolled sample of 77 patients exceeded this requirement.

All analyses were performed using IBM Statistical Package for the Social Sciences Statistics version 30.0 (IBM Corp., Armonk, NY, USA). Categorical variables are expressed as frequency and percentage; continuous non-normally distributed variables as median and interquartile range (IQR). Group differences for categorical variables were assessed with the Pearson chi-square test; Fisher's exact test (2-sided) was applied when expected cell counts were <5. All tests were 2-tailed and statistical significance was set at $P < .05$. The primary analysis was limited to univariate comparisons; the number of outcome events relative to candidate covariates precluded stable multivariate logistic regression modeling in the current sample

MAIN POINTS

- The Appiani and Zuma maneuvers show comparable effectiveness in the treatment of apogeotropic horizontal canal benign paroxysmal positional vertigo (HC-BPPV).
- Advanced age (≥60 years) is an exploratory factor associated with requiring multiple repositioning maneuvers.
- Clinicians should anticipate a longer treatment course in elderly patients with apogeotropic HC-BPPV, regardless of the maneuver performed.

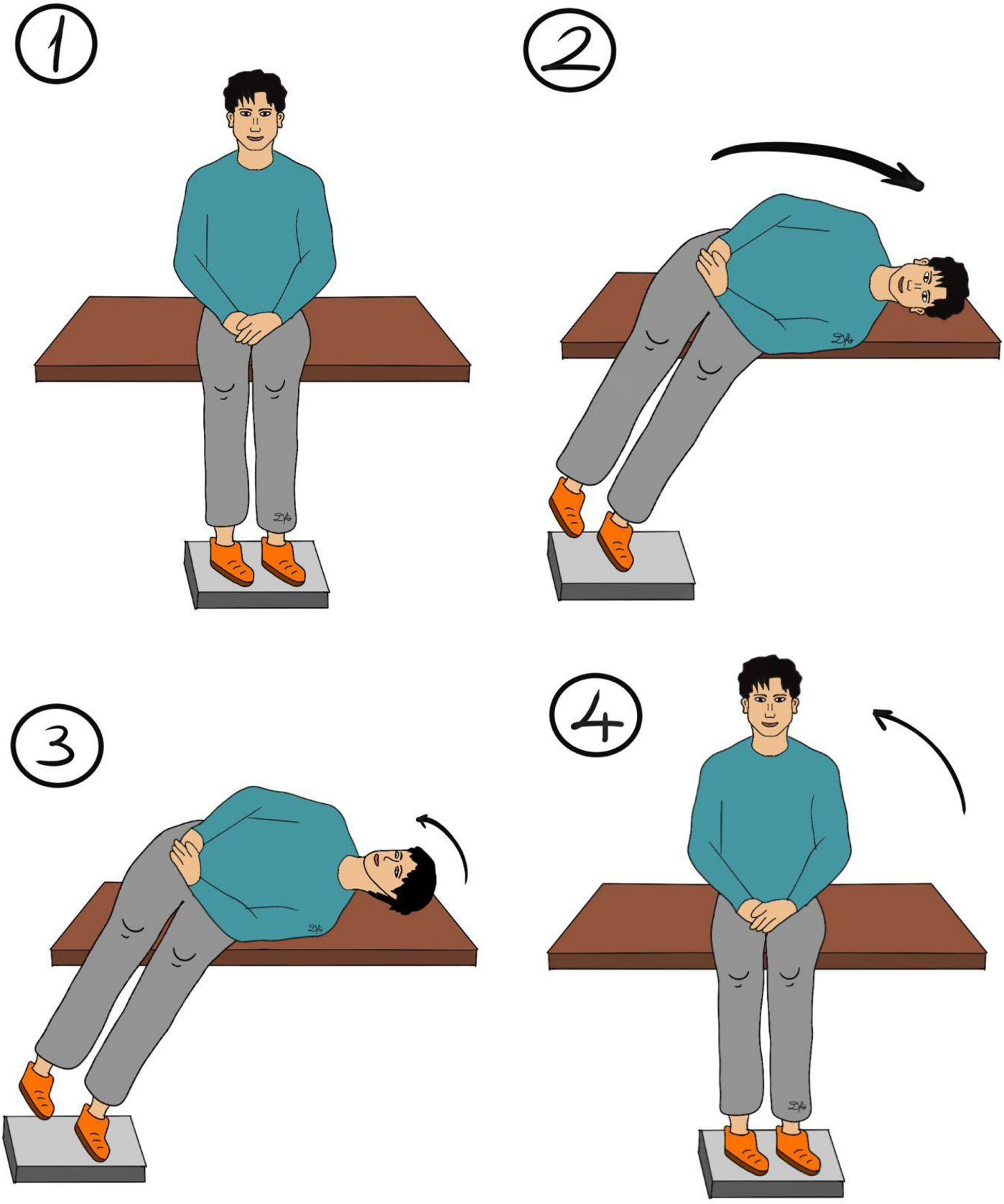


Figure 1. Appiani Maneuver.

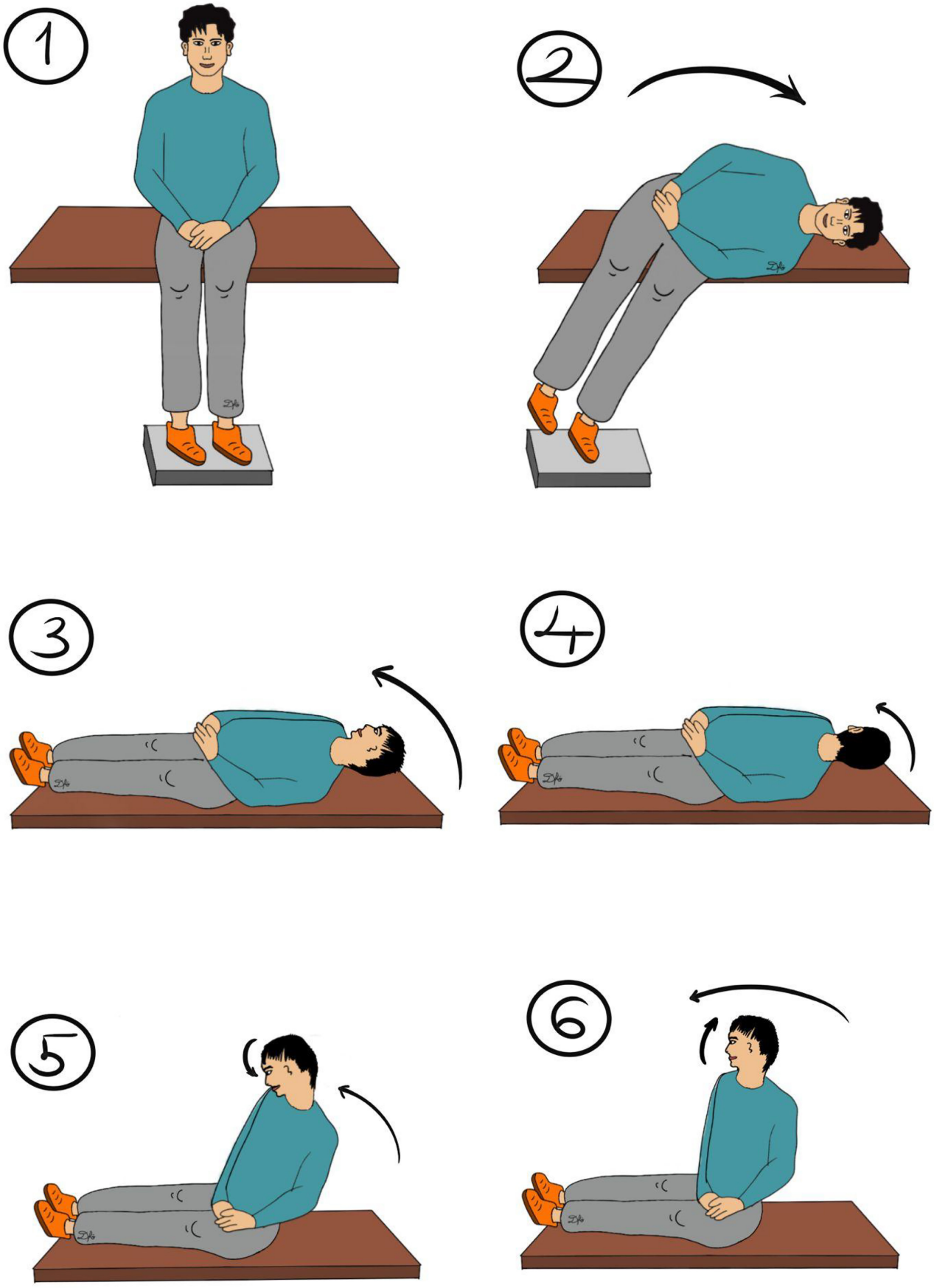


Figure 2. Zuma Maneuver.

(events-per-variable ratio < 10), and such analyses are recommended for future confirmatory studies.

RESULTS

Patient Characteristics

A total of 77 patients were enrolled (Table 1). The cohort was predominantly female (63.6%) and older, with nearly 60% aged ≥ 60 years. Cardiometabolic comorbidities were common: hypertension was present in 54.5% and diabetes mellitus (DM) in 29.9%. Migraine was relatively infrequent (11.7%). Most participants had no thyroid disorder (72.7%). Left lateral canal involvement was slightly more frequent (54.5%). The 2 maneuvers were assigned in nearly equal proportions (Appiani 49.4% vs. Zuma 50.6%).

Treatment Outcomes

Overall, the median number of maneuver sessions was 1 (IQR 1-2), and 63.6% of patients achieved resolution after a single session. The distribution of sessions by treatment group is shown in Table 2. In the ApM group, 68.4% of patients resolved after 1 session and 21.1% required 2 sessions; in the ZmM group, 59.0% resolved after 1 session and 30.8% required 2. The proportions requiring 3 or 4 sessions were similarly low in both groups, and the difference in overall maneuver requirements was not statistically significant ($P = .389$).

Table 1. Baseline Demographic and Clinical Characteristics of the Study Participants (n = 77)

Variable	Category	n (%)
Sex	Female	49 (63.6)
	Male	28 (36.4)
Age group (years)	≤45	4 (5.2)
	45-60	27 (35.1)
	≥60	46 (59.7)
Diabetes mellitus (DM)	No	54 (70.1)
	Yes	23 (29.9)
Hypertension	No	35 (45.5)
	Yes	42 (54.5)
Thyroid status	None	56 (72.7)
	Euthyroid	16 (20.8)
	Hypothyroid	3 (3.9)
	Hashimoto thyroiditis	2 (2.6)
Additional comorbidity	No	37 (48.1)
	Yes	40 (51.9)
Migraine	No	68 (88.3)
	Yes	9 (11.7)
Lateral canal side	Left	42 (54.5)
	Right	35 (45.5)
Maneuver type	Appiani	38 (49.4)
	Zuma	39 (50.6)
Number of maneuvers	Median (IQR)	1 (1-2)
	1	49 (63.6)
	2	20 (26.0)
	3	7 (9.1)
	4	1 (1.3)

IQR, interquartile range.

Table 2. Number of Maneuver Sessions Required by Treatment Group (N = 77)

Sessions, n	Appiani (n = 38) n (%)	Zuma (n = 39) n (%)	Total (N = 77) n (%)
1	26 (68.4)	23 (59.0)	49 (63.6)
2	8 (21.1)	12 (30.8)	20 (26.0)
3	3 (7.9)	4 (10.3)	7 (9.1)
4	1 (2.6)	0 (0.0)	1 (1.3)

Factors Associated with Multiple Sessions

Factors associated with requiring ≥2 maneuver sessions are presented in Table 3. In univariate analysis**,** older age (≥60 years) was the only variable significantly associated with the need for multiple sessions: patients aged ≥ 60 years comprised 82.1% of the ≥2-session group compared with 46.9% of those who resolved with 1 session ($P = .002$). Sex, hypertension, DM, migraine, the presence of any comorbidity, lateral canal side, and maneuver type were not significantly associated with requiring multiple sessions.

Baseline Comparability of Treatment Groups

Baseline characteristics of the ApM and ZmM groups are compared in Table 4. Diabetes mellitus was significantly more prevalent in the ZmM group (43.6% vs. 15.8%; $P = .008$), and the overall prevalence of any comorbidity was higher in the ZmM group (69.2% vs. 34.2%; $P = .002$), reflecting random imbalance rather than systematic selection. Other characteristics, including age distribution, sex, hypertension, migraine, and lateral canal side, were comparable between groups.

Table 3. Factors Associated with Requiring ≥2 Maneuver Sessions (N = 77)

Variable	Category	1 session (n = 49) n (%)	≥2 sessions (n=28) n (%)	*P*
Sex	Female	30 (61.2)	19 (67.9)	.561
	Male	19 (38.8)	9 (32.1)	
Age group	<60 years	26 (53.1)	5 (17.9)	.002†
	≥60 years	23 (46.9)	23 (82.1)	
Hypertension	No	24 (49.0)	11 (39.3)	.411
	Yes	25 (51.0)	17 (60.7)	
Diabetes mellitus	No	37 (75.5)	17 (60.7)	.172
	Yes	12 (24.5)	11 (39.3)	
Any comorbidity	No	24 (49.0)	13 (46.4)	.829
	Yes	25 (51.0)	15 (53.6)	
Migraine	No	44 (89.8)	24 (85.7)	.716*
	Yes	5 (10.2)	4 (14.3)	
Lateral canal side	Left	24 (49.0)	18 (64.3)	.194
	Right	25 (51.0)	10 (35.7)	
Maneuver type	Appiani	26 (53.1)	12 (42.9)	.389
	Zuma	23 (46.9)	16 (57.1)	

Pearson's chi-square test was used unless otherwise specified.
*Fisher's exact test applied when expected cell counts were <5.
†Statistically significant (p<0.05).

Table 4. Comparison of Baseline Characteristics Between Treatment Groups (N = 77)

Variable	Category	Appiani (n = 38) n (%)	Zuma (n = 39) n (%)	*P*
Sex	Female	24 (63.2)	25 (64.1)	.931
	Male	14 (36.8)	14 (35.9)	
Age group	<60 years	16 (42.1)	15 (38.5)	.744
	≥60 years	22 (57.9)	24 (61.5)	
Diabetes mellitus	No	32 (84.2)	22 (56.4)	.008†
	Yes	6 (15.8)	17 (43.6)	
Hypertension	No	20 (52.6)	15 (38.5)	.212
	Yes	18 (47.4)	24 (61.5)	
Any comorbidity	No	25 (65.8)	12 (30.8)	.002†
	Yes	13 (34.2)	27 (69.2)	
Migraine	No	33 (86.8)	35 (89.7)	.737*
	Yes	5 (13.2)	4 (10.3)	
Lateral canal side	Left	17 (44.7)	25 (64.1)	.088
	Right	21 (55.3)	14 (35.9)	

Pearson's chi-square test was used unless otherwise specified.
*Fisher's exact test applied when expected cell counts were <5.
†Statistically significant (p<0.05).

DISCUSSION

In this prospective comparative study, both the ApM and ZmM demonstrated comparable efficacy for the treatment of apogeotropic HC-BPPV. Overall, 63.6% of patients achieved resolution after a single session, consistent with published single-session success rates of 60%-75% reported for horizontal canal variants.[1,2] The single-session resolution rates of 68.4% (ApM) and 59.0% (ZmM) were not significantly different, supporting the conclusion that both maneuvers represent valid and clinically equivalent first-line treatment options for an unselected apogeotropic HC-BPPV population.

A key mechanistic insight underlying the equivalence of these maneuvers relates to their shared final step: returning the patient to the seated position. Although the ApM and ZmM differ in their sequential head movements and the physical forces they apply—with the ApM relying primarily on a rapid nose-up rotation to displace debris by inertia, and the ZmM incorporating both inertial and gravitational phases targeting multiple subtypes—both converge on an upright repositioning that facilitates re-entry of displaced otolith material into the utricle. This shared mechanism may partly explain why maneuver-specific advantages predicted by biomechanical models are attenuated in clinical practice. Treatment success rates for lateral canal BPPV across various repositioning maneuvers are generally moderate, partly due to the heterogeneity of subtypes. The Appiani (modified Gufoni), forced prolonged position, and therapeutic head-shaking maneuvers share a common mechanism: although primarily designed to displace the otolith mechanically, their final step—returning to a sitting position—may also allow the debris to re-enter the utricle.[18] A recent randomized controlled trial compared the efficacy of the cupulolith repositioning maneuver (CuRM) with therapeutic head-shaking and the modified Lempert maneuver for apogeotropic lateral canal BPPV and found no significant difference in clinical outcomes among the 3 groups on post-treatment day 2 and at 1 week, consistent with the equivalence observed in the present study.[19]

Ciniglio Appiani et al assessed the effectiveness of the repositioning procedure in apogeotropic lateral canal BPPV based on the assumption of free-floating dense particles in the endolymph of the anterior arm of the lateral canal.[14] The Gufoni maneuver is particularly suited to older, immobile, or overweight patients owing to its simple lateral decubitus positioning, a practical advantage that also applies to the Appiani modification.[13] A prospective randomized study comparing 4 repositioning maneuvers for lateral semicircular canal BPPV found that the Gufoni–Appiani maneuver was more effective than the Zuma e Maia maneuver for the apogeotropic variant.[11] Furthermore, a tertiary dizziness center study reported first-treatment resolution rates of 71% and 63% for geotropic and apogeotropic HC-BPPV with the Gufoni and Appiani maneuvers, respectively; after a second maneuver, these rates increased to 92% and 78%, underscoring the value of repeat sessions in refractory cases.[20]

The theoretical basis for the potential superiority of the ZmM rests on its multi-step design, which aims to address all 3 apogeotropic subtypes—anterior arm canalithiasis, C-Cup cupulolithiasis, and U-Cup cupulolithiasis—by exploiting both inertial and gravitational forces across sequential head movements. The second and third steps facilitate particle displacement through rapid deceleration (inertia), while the fourth and fifth steps consolidate repositioning for U-Cup and C-Cup/canalithiasis variants, respectively.[15] Despite this mechanistic rationale, the present study did not confirm a statistically significant therapeutic advantage over the ApM. These findings accord with those of Alvarez de Linera-Alperi et al. One explanation is that in an unselected apogeotropic HC-BPPV cohort, subtype heterogeneity dilutes the expected benefit of subtype-specific maneuver steps. These findings accord with those of Alvarez de Linera-Alperi et al, who reported that the ZmM did not achieve significantly superior resolution rates over the modified Gufoni (ApM) in patients without a prior BPPV history, although a benefit was noted in patients with recurrent disease, suggesting that subtype-stratified analysis in future studies may unmask differential efficacy.[21]

A noteworthy exploratory finding of this study is the association between advanced age (≥60 years) and the need for multiple treatment sessions in univariate analysis. Elderly patients constituted 82.1% of those requiring 2 or more sessions compared with 46.9% of those who resolved with a single maneuver ($P = .002$). This finding is consistent with evidence that aging adversely affects vestibular system plasticity, slows central adaptive mechanisms, and is associated with degeneration of the otoconial membrane, all of which may impair response to mechanical repositioning.[2] Welgampola et al further noted that advanced age predicts not only treatment resistance but also higher recurrence rates in BPPV.[2] Although BPPV in the elderly does not differ substantially from younger populations in terms of etiology, diagnostic criteria, or maneuver technique, it is typically characterized by a more prolonged course, less distinctive symptom presentation, lower initial treatment efficacy, and higher recurrence rates.[22,23] Although this finding did not derive from an adjusted multivariable model and should therefore be interpreted with appropriate caution, it is consistent with established evidence on age-related vestibular decline and warrants prospective evaluation in adequately powered studies. Pending such confirmation, clinicians may find it useful to anticipate a potentially more protracted treatment course in older patients and to counsel them accordingly.

In contrast, sex, hypertension, DM, migraine, and lateral canal side did not significantly influence the number of sessions required. Although some reports have suggested that systemic comorbidities may affect the natural history or recurrence of BPPV, the analysis did not corroborate a significant effect on acute treatment response. This may reflect insufficient statistical power in subgroup analyses, heterogeneity in comorbidity profiles, or a genuine absence of effect in this cohort. Notably, there was a post-randomization imbalance in DM and overall comorbidity burden between the treatment groups; this may have introduced confounding and should be interpreted with caution, though it did not reach significance for the primary outcome (DM: $P = .172$; any comorbidity: $P = .829$). The absence of covariate-adjusted analysis is a limitation, and the potential for residual confounding cannot be fully excluded.

Several limitations should be acknowledged. First, the study was conducted at a single center, which may limit generalizability. Second, the sample size precluded adequately powered subgroup analyses for less frequent variables. Third, patients were not stratified by BPPV subtype (anterior arm canalithiasis vs. cupulolithiasis) prior to randomization, which may have contributed to outcome heterogeneity. Fourth, long-term follow-up data on recurrence were not collected. Larger, multicenter, randomized trials incorporating systematic subtype classification and extended follow-up are needed to refine these findings. More specifically: (1) pre-treatment subtype differentiation based on nystagmus duration lacks sufficient discriminatory precision for routine clinical use, and this heterogeneity represents a source of uncontrolled biological variability that may have attenuated between-group differences and limits the subtype-specific applicability of the results; (2) the 48-hour follow-up interval does not permit assessment of long-term recurrence or stability of treatment response, and the potential for spontaneous resolution or fluctuation—particularly in cupulolithiasis variants—cannot be fully excluded without a sham-controlled arm; (3) the events-per-variable ratio in the present sample precluded stable multivariate modeling, and a binary logistic regression incorporating age, maneuver type, and comorbidity burden as covariates is recommended for future studies; (4) the post-randomization imbalance in DM and overall comorbidity burden highlights the value of stratified randomization in future trials.

CONCLUSION

The ApM and ZmM demonstrate equivalent therapeutic efficacy in the treatment of apogeotropic horizontal canal BPPV. Their shared mechanistic final step—utricular re-entry facilitated by return to the upright position—may underlie this clinical equivalence. Advanced age (≥60 years) was identified in univariate analysis as an exploratory factor associated with requiring multiple treatment sessions; this association requires confirmation through multivariable modeling in larger studies. Clinicians should incorporate this information into treatment planning and patient counseling, particularly for elderly patients in whom a more resistant clinical course may be anticipated. Future studies with prospective subtype stratification and multivariate analysis are needed to determine whether mechanistically targeted maneuver selection offers advantages in specific subpopulations.

Data Availability Statement: The data that support the findings of this study are available on request from the corresponding author.

Ethics Committee Approval: Ethical committee approval was received from the Ethics Committee of University of Katip Celebi (Approval No: 0258, Date: 19.12.2024).

Informed Consent: Written informed consent was obtained from all participants prior to enrollment.

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Author Contributions: Conceptualization – A.F.B.; Data curation – A.F.B., D.F.Ö., B.Ç.; Formal analysis – A.F.B., D.F.Ö.; Funding acquisition – A.F.B.; Investigation – A.F.B., D.F.Ö.; Methodology – A.F.B.; Project administration – A.F.B.; Resources – A.F.B., B.Ç.; Software – D.F.Ö., B.Ç.; Supervision – A.F.B.; Validation – A.F.B.; Visualization – D.F.Ö.; Writing – original draft – A.F.B., D.F.Ö., B.Ç.; Writing – review & editing – A.F.B.

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