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Canalith Jam as a Novel Complication of Stapes Surgery: A Case Report

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ABSTRACT

Background: Postoperative vertigo is a complication of stapes surgery, sometimes associated with benign paroxysmal positional vertigo (BPPV). Among its variants, a canalith jam is a rare entity characterized by mechanical obstruction of endolymphatic flow by otoconia with subsequent canal-specific hypofunction. Case Presentation: We present the case of a 37-year-old male who developed disabling persistent vertigo and imbalance with positional exacerbation following right-sided stapedotomy with canalplasty. Clinical evaluation revealed subtle positional nystagmus, isolated right posterior semicircular canal hypofunction on the video head impulse test (vHIT), and preserved cervical vestibular-evoked myogenic potentials. Based on these findings, posterior canalith jam was hypothesized. Symptom remission was achieved acutely after performing the Bascule maneuver, which produced an abrupt and sustained improvement in symptoms and vHIT trace. There was an improvement in gain and saccade pattern on the affected canal, noted immediately after symptom resolution. The patient returned to full daily and sporting activities with long-term resolution of vertigo. Conclusion: This case highlights posterior canalith jam as a possible complication of stapedotomy. The selective canal dysfunction documented by vHIT was essential for diagnosis and monitoring. Recognition of this mechanism is clinically relevant, as it expands the spectrum of postoperative vestibular complications and underscores the role of targeted rehabilitation in ensuring recovery.

KEYWORDS

Benign Paroxysmal Positional Vertigo, Stapes Surgery, Semicircular Canals, Video Head Impulse Test, Postoperative Complications.

1 Introduction

Stapes surgery is a common otological procedure, which involves the placement of a prosthesis on the incus to bypass a fixed stapes footplate in otosclerosis. One of the main complications of this surgery is postoperative dizziness, which can be partly attributed to Benign Paroxysmal Positional Vertigo (BPPV) (Atacan et al., 2001; Magliulo et al., 2005; Antonelli, 2018; Necula et al., 2023).

The underlying mechanisms of BPPV following a stapedotomy could be linked to trauma inflicted on the otolith organs with subsequent particle dislodgement, with the posterior semicircular canal being the most frequently affected due to gravitational physics (Atacan et al., 2001).

Recent reports have expanded our understanding of BPPV variants, namely those of the posterior semicircular canal (PSC) (Castellucci et al., 2021a; Garaycochea and Pérez-Fernández, 2024). It is understood that, similarly to the horizontal canal, the posterior semicircular canal is also affected by both canalolithiasis and cupulolithiasis, as well as a less frequent variant of canalith jam (Castellucci et al., 2021b).

Unlike canalolithiasis, in which otoconia debris are free-floating and mobile within a semicircular canal, otoconia in cupulolithiasis are attached to the cupula and are displaced according to the gravitational vector during positional testing. PSC cupulolithiasis is best diagnosed using the Half-Hallpike maneuver, in which the head is only extended to 60º (and not to 120º, as in the Dix-Hallpike maneuver), revealing a vertical upbeating and torsional geotropic nystagmus (Garaycochea and Pérez-Fernández, 2024).

Canalith jam, first described by Epley (1997, 2001), is a condition in which the otoconia particles become trapped in the canal or cupula, causing a mechanical jamming of the canal which is unaffected by gravity. Epley further classifies canalith jam as partial (incomplete) or complete: the partial form impacts the displacement of fluid in the semicircular canal, reducing the effectiveness of the vestibulo-ocular reflex (VOR) within its plane, while the complete form sustains the movement of endolymphatic fluid around the canal, leading to persistent deflection of the cupula

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with spontaneous nystagmus (Epley, 2001). Furthermore, some occurrences of canalith jam are thought to be reversible, presenting with an apogeotropic direction-changing positional nystagmus, while others are classified as fixed (Kalmanson and Foster, 2023).

The Video Head Impulse Test (vHIT) has been considered to be of diagnostic value in some variants of BPPV, especially regarding atypical variants, allowing the correct identification of the affected side and subsequent adequate choice of canalith repositioning maneuver (CRM) (Castellucci et al., 2020; Califano et al., 2021). Previous reports have highlighted the possibility of canalith jam occurring in all of the semicircular canals, presenting with isolated semicircular canal hypofunction that is reversible along with symptoms with successful CRM (Luis et al., 2013; Ko et al., 2014; Castellucci et al., 2021b, 2022).

This report aims to present a unique case of posterior canalith jam with coexistent cupulolithiasis as a complication of stapes surgery, describing both the relevant diagnostic approach as well as the therapeutic and rehabilitation process. Several published reports describe the occurrence of BPPV following stapes surgery. However, to our knowledge, no case of canalith jam as a postoperative complication has been described.

2 Case Report

2.1 Patient Information

A 37-year-old male was admitted to the ENT department to undergo stapes surgery and canalplasty on the right ear. Relevant past medical history included bilateral otosclerosis and grade 2 exostosis (33-66% occlusion), with no prior symptoms of vertigo or imbalance. four years before, he had undergone stapedotomy on the left ear, with a good clinical and audiometric outcome.

2.2 Clinical Findings

The transcanal microscopic stapedotomy with a 0.4 × 4.5 mm *Causse* teflon prosthesis placement on the incus after a perforator platinotomy, performed in association with a canalplasty, ensued as planned with no intra-operative complications.

In the immediate post-operative period, the patient complained of nausea and acute vertigo, and a spontaneous downbeat nystagmus was observed. The patient was discharged and was subsequently referred to an outpatient neurotology consultation for the presented complaints.

On the first evaluation, approximately one month after surgery, the patient was moderately incapacitated, and main complaints were related to gaze stabilization in the vertical plane as well as positional vertigo on the recumbent position and while sitting up. The relevant physical examination findings included an absence of spontaneous nystagmus, a corrective saccade in the head impulse test towards the right PSC, and a subtle persistent upbeat counterclockwise torsional nystagmus on the right Half-Hallpike maneuver, with sitting-up vertigo. Mastoid vibration on the right elicited a similar upbeat right torsional nystagmus. Bedside testing excluded oculomotor abnormalities or other central signs.

2.3 Diagnostic Assessment

A vHIT was performed, revealing a selective right posterior semicircular canal impairment with a gain of 0.46 and scattered overt saccades (Figure 1). A Cervical Vestibular Evoked Myogenic Potential (cVEMP) was also performed, with normal amplitude and latencies, and absent asymmetry (0.15) (Figure 2).

A diagnosis of right PSC complete canalith jam with coexistent cupulolithiasis was hypothesized, and the patient underwent a vestibular rehabilitation therapy program with canalith repositioning maneuvers as well as gaze stabilization exercises and balance control training.

2.4 Therapeutic Intervention

The program consisted of biweekly CRM, in which the Bascule maneuver (Castellucci et al., 2025; Asprella-Libonati et al., 2026) was performed. To execute the Bascule maneuver, the patient was directed to sit and rotate their head 45° to the left, positioning right PSC in line with the Semont maneuver plane. The patient is swiftly swung into the nose down position, similar to a demi-Semont maneuver, followed by a reverse Semont maneuver, and then a regular Semont maneuver, all performed in quick succession with each position being held for 15 seconds. Further background, rationale and applications of the Bascule maneuver can be found in (Vats et al., 2025, 2026). Gaze stabilization and balance control training were performed throughout 8 sessions, both in the gym and on a dynamic platform.

2.5 Follow-Up and Outcomes

The sequential vHIT findings and their respective timepoints are depicted in Figure 3, and were all performed by the same operator in the same setting.

Figure 3A represents the first visit (baseline, Figure 1). The patient was subsequently evaluated within 10 days (Figure 3B) and CRM were repeated, unsuccessfully. The patient remained symptomatic and vHIT trace still revealing low gain and scattered overt saccades in the right PSC.

One month after the first visit (Figure 3C), the still symptomatic patient underwent a vHIT evaluation before undergoing CRM, in which the trace was similar to the previous evaluation. The patient was then submitted to the Bascule maneuver, which led to an acute sudden resolution of symptoms and marked subjective improvement. A subsequent vHIT was undertaken immediately after the successful CRM, revealing an enhanced gain and a marked improvement in the saccade pattern, with lower latency and organization in a covert pattern (Figure 3D).

Further evaluation was undertaken 2 weeks after successful CRM, and the patient reported to remain symptom-free and back to regular daily activities, which included surfing and gymnastics. Although the vHIT trace in this evaluation still showed an abnormal right PSC function (Figure 3E), a complete subjective resolution of symptoms was achieved, with no residual imbalance, dizziness or positional vertigo.

The last evaluation took place 2 years after surgery (Figure 3F), and the vertigo and imbalance symptoms did not recur.

Figure 4 shows the audiological results before and after surgery, which highlight a partial improvement in the air-bone gap with a slight reduction in low-frequency bone conduction thresholds, especially at 250 and 500 Hz, and high-frequency air conduction thresholds at 4-8 kHz, suggesting the possibility of labyrinthine damage.

3 Discussion

The present case report proposes the complete canalith jam phenomenon as a possible mechanism for the persistent gaze instability and VOR deficit, associated with a coexisting cupulolithiasis, which explains the positional vertigo experienced by the patient.

The underlying mechanisms of BPPV following a stapedotomy

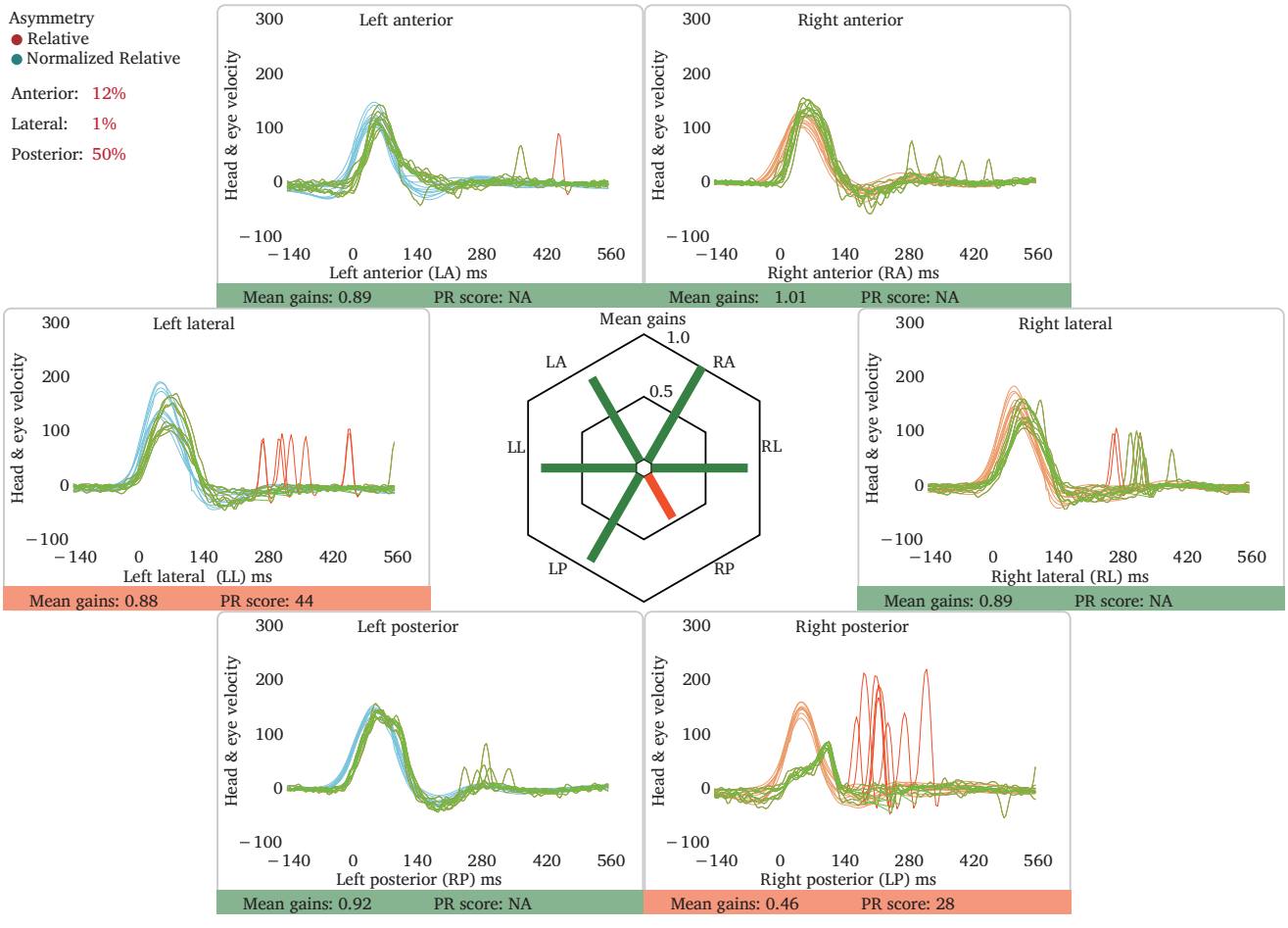


Figure 1 vHIT at baseline. Evident isolated right posterior canal hypofunction (gain = 0.46) with scattered overt saccades.

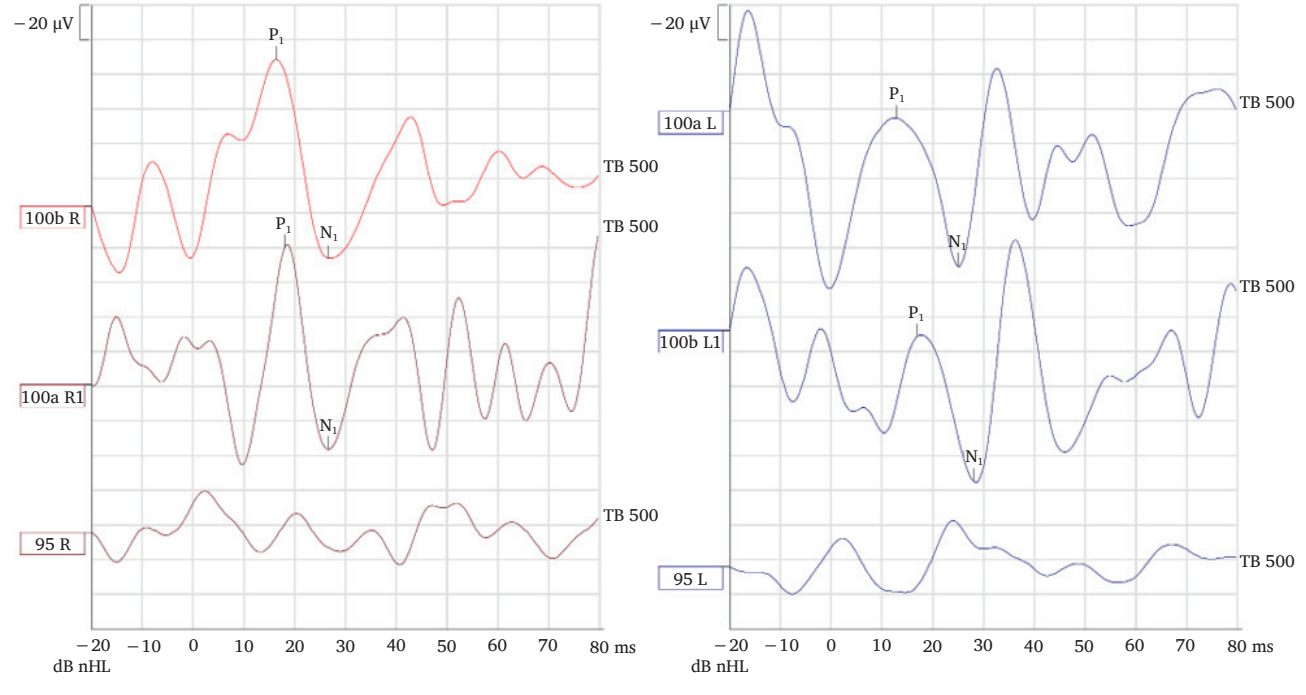


Figure 2 500 Hz bone conducted cVEMP trace at baseline, displaying normal P1 and N1 latency, amplitude and low asymmetry (0.15).

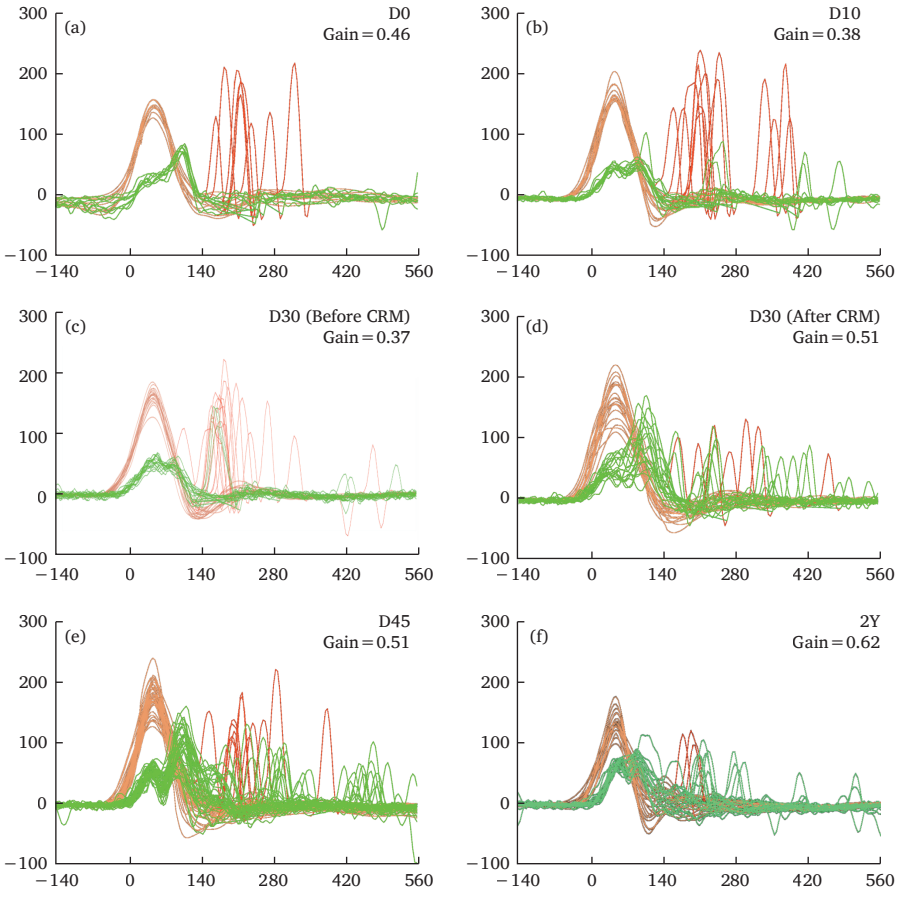


Figure 3 Temporal evolution of the right posterior canal vHIT trace: A. Initial vHIT evaluation (D0), showing a gain of 0.46 and scattered overt saccades; B. vHIT trace following the first unsuccessful canalith repositioning maneuvers (CRM) session (D10); C. vHIT evaluation at the subsequent visit (D30), before CRM were performed; D. vHIT measurement in the same day (D30), immediately after successful CRM with symptom resolution, in which gathering of covert saccades can be seen; E. vHIT trace two weeks after successful CRM (D45); F. vHIT trace after two years; although a residual posterior canal hypofunction persisted, the patient remained symptom-free;

Note: D0 relates to the first day of outpatient evaluation, corresponding to approximately 1 month postoperatively.

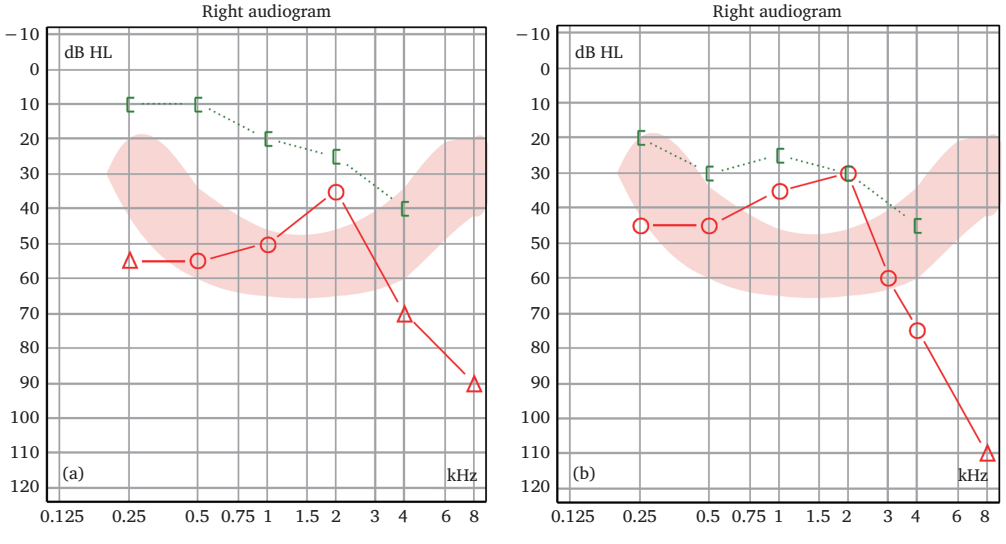


Figure 4 Pure tone audiogram, pre (A) and postoperatively (B); incomplete air-bone gap reduction was achieved with stapedotomy and there was a slight decrease in the bone conduction hearing threshold.

could be linked to trauma inflicted on the otolith organs. Positioned adjacent to the utricle and saccule, a significant proximity exists between the stapes footplate and the membranous structures within the vestibule. Should the utricle be situated near the footplate, and the piston's tip protrude excessively into the vestibule, it is possible that the utricle may suffer trauma. This could then result in the disruption of its membrane or the displacement of otoliths into the long arm of the posterior semicircular canal, the

area most gravitationally influenced within the membranous labyrinth (Atacan et al., 2001).

Beyond the recent history of canalplasty and stapes surgery, already recognized as predisposing factors for an otolithic etiology, our interpretation is supported by three converging arguments: (1) the occurrence of positional vertigo aligned with PSC stimulation in association with a selective ipsicanal VOR deficit, pointing toward an isolated canal dysfunction; (2) the abrupt and sustained remission of symptoms immediately after CRM, as perceived by the patient, pointing towards a lithiasic etiology; and (3) the measurable improvement in VOR performance post-CRM, demonstrated by an increased gain and a more organized, lower-latency grouped saccade pattern. Together, these findings suggest a canalith jam mechanism as well as a possible coexistent cupulolithiasis, rather than alternative vestibular diagnoses. This diagnosis remains inferential, although it is strongly supported by the clinical course and objective vestibular findings.

Nevertheless, certain features of this case diverge from previously reported descriptions of canalith jam. Notably, no spontaneous nystagmus was observed at the time of evaluation (only when elicited by mastoid vibration) and the positional nystagmus recorded was subtle, contrasting with the spontaneous and positionally enhanced nystagmus reported in other case reports of canalith jam (Luis et al., 2013; Ko et al., 2014; Castellucci et al., 2021b, 2022). One possible explanation is that the patient developed a posterior complete canalith jam, with an otolith clot fully entrapped in the non-ampullary arm of the PSC continuously bending the cupula toward the utricle and inhibiting its afferents, which initially led to a spontaneous downbeating nystagmus. A coexisting posterior cupulolithiasis would account for the positional reversal of the nystagmus in the Half-Hallpike position, as noted. In fact, in canalith jam, spontaneous nystagmus is direction-fixed and modulated by gravity by either augmenting or counteracting the continuous underlying endolymphatic flow. If a canalith jam presents with an additional clot on the cupula of the same canal, spontaneous nystagmus (inhibitory) might transiently reverse in the position in which gravity generates a maximal ampullofugal bending of the overloaded cupula, counteracting the continuous inhibitory deflection.

Furthermore, one can also hypothesize that an initial canalith jam in the non-ampullary arm of the canal may have partially and progressively disintegrated over the subsequent month, leading to a concomitant cupulolithiasis. This hypothesis could account for the lack of spontaneous nystagmus at the initial outpatient examination. An alternative hypothesis is that the first clinical assessment occurred more than a month after symptom onset, a delay that may have allowed central compensation to suppress spontaneous nystagmus, as is commonly observed in posterior canal paresis due to inferior vestibular neuritis (Wüthrich et al., 2023).

In addition, although the vHIT trace improved after the final CRM session, with both gain recovery and a shift toward covert saccades, complete normalization was not achieved. This residual deficit may reflect structural labyrinthine damage sustained during surgery, which could have facilitated otolith displacement into the posterior semicircular canal. Audiological findings add further nuance: while the surgery achieved partial closure of the air–bone gap, there was also a mild deterioration of bone conduction thresholds, consistent with possible inner ear injury. This raises the likelihood of a dual mechanism – mechanical dislodgement of otoconia leading to canalith jam, combined with structural inner ear trauma, which reflects the audiometric and partly the vHIT findings.

As previously proposed for all semicircular canals (Ko et al., 2014; Castellucci et al., 2021b, 2022), a plug of entrapped otoconia within a semicircular canal may account for the selective reduction in VOR gain observed in this case. Such a plug would obstruct endolymphatic flow and prevent dynamic responses of the PSC ampulla, which would recover once the obstruction cleared following successful CRM. Castellucci et al. (2021b) described a case of PSC BPPV presenting with spontaneous downbeat nystagmus, in which the vHIT demonstrated selective canal hypofunction that recovered after successful CRM, supporting a transient mechanical block within the canal. Similarly, the same author later reported a similar pattern of anterior canal involvement, characterized by spontaneous upbeat nystagmus and isolated anterior canal hypofunction on vHIT, again interpreted as a canalith jam mechanism reversible with CRM (Castellucci et al., 2022). Finally, Ko et al. (2014) described a case of horizontal canalolithiasis, suspected to have been transiently converted into a canalith jam. The patient presented with spontaneous nystagmus and canal paresis on bithermal caloric testing, which completely resolved within 24 hours.

While the presentation of selective PSC hypofunction could mimic a lesion of the inferior vestibular nerve or ischemia in the territory of the common cochlear artery, these diagnoses would typically involve additional deficits, such as abnormal cervical VEMPs or significant sensorineural hearing loss, respectively (Castellucci et al., 2021a). The absence of such findings, together with the symptom resolution and improvement of PSC function after CRM, supports complete canalith jam as the most plausible explanation for the isolated dysfunction observed.

Early postoperative vertigo following stapes surgery has been attributed to BPPV from otoconial detachment, serous/chemical labyrinthitis, perilymph leakage, direct trauma to the labyrinth, excessive penetration of the prosthesis into the vestibule, and transient alterations in labyrinthine fluid pressure or blood supply (Necula et al., 2023). Our case highlights that the spectrum of the BPPV-related complications may be broader than previously recognized, as the identification of a posterior canalith jam introduces a novel pathophysiological mechanism for persistent vertigo in this setting. Unlike other postoperative vestibular complications, canalith jam is potentially reversible with CRM. This underscores the value of functional vestibular testing, particularly vHIT, in distinguishing canalith jam from more permanent lesions such as labyrinthine injury. Recognizing canalith jam as a possible sequela of stapes surgery may therefore refine the diagnostic approach and expand the therapeutic options for patients with unexplained postoperative vertigo.

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Data availability statement

Not applicable.

Ethical approval

This case report was conducted in accordance with the ethical standards of the institutional and national research committees and with the principles of the Declaration of Helsinki.

Informed consent

Written informed consent has been obtained from the patient to publish this paper.

Conflicts of interest

The authors have no competing interests to declare that are relevant to the content of this article.

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