CANALITH REPOSITIONING MANEUVERS FOR TREATMENT OF APOGEOTROPIC LATERAL SEMICIRCULAR CANAL BPPV: A SYSTEMATIC REVIEW

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CERTIFICATE

This is to certify that this dissertation entitled "**Canalith repositioning maneuvers for treatment of apogeotropic lateral semicircular canal BPPV: a systematic review**" is the bonafide work submitted in part fulfillment for the degree of Masters of Science (Audiology) of the student Registration number: 19AUD034. This has been carried out under the supervision and guidance of the faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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CERTIFICATE

This is to certify that this dissertation entitled "**Canalith repositioning maneuvers for treatment of apogeotropic lateral semicircular canal BPPV: a systematic review**" has been carried out under my supervision and guidance. It is also being certified that this dissertation has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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DECLARATION

This is to certify that this dissertation entitled "**Canalith repositioning maneuvers for treatment of apogeotropic lateral semicircular canal BPPV: a systematic review**" is the result of my own study under the guidance of Dr. Niraj Kumar Singh, Associate Professor in Audiology, Department of Audiology, All India Institute of Speech and Hearing, Mysore and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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गुरूर्ब्रह्मा गुरूर्विष्णुः गुरूर्देवो महेश्वरः ।
गुरूर्साक्षात परब्रह्म तस्मै श्री गुरवे नमः ।।

"Realize that the Guru is Brahma Himself. He is Vishnu and He is Shiva (Maheshwar). Guru is Parabrahma (Supreme God or the Absolute Truth). With this knowledge, I (salute) offer my obeisance to the Guru."

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Abstract

Benign Paroxysmal Positional Vertigo is one of the most common causes of peripheral vestibular vertigo. It is can be caused by attachment of otoliths to the cupula (cupulolithiasis) or otoconia freely floating in the semicircular canals (canalolithiasis).

It is critical to get a clear diagnosis of the affected side and rule out any BPPV subtypes before starting the treatment. Some researchers converted LC-BPPV from its apogeotropic to geotropic form in most patients, while others have established the efficacy of various procedures (Gufoni, Head Shaking, and Sham) to relieve vertigo and nystagmus. Although various therapeutic maneuvers are available, the question of which maneuver is superior for treating apogeotropic LC-BPPV remains unanswered.

This systematic review aimed to evaluate the effectiveness of Gufoni, Head shaking, and Sham maneuvers in alleviating vertigo and nystagmus encountered by individuals with LC-BPPV and comparing these treatment outcomes.

The search terms 'BPPV,' 'Lateral canal BPPV,' "Apogeotropic LC-BPPV,' 'repositioning maneuvers,' 'modified Guffoni maneuver,' 'Sham maneuver,' 'Head shaking Maneuver' were entered into different databases (Google Scholar, Science Direct, and PubMed). The inclusion and exclusion criteria were clearly stated, and only articles fulfilling the criteria were chosen, while others were excluded. The screening of articles was done independently by two reviewers at all stages. The quality analysis was done using the CASP scale on the final selected articles.

The database search resulted in 543 articles, of which eight were included at final stage as well as for the qualitative analysis. According to the qualitative analysis, three studies were rated as moderate, and five as strong. All eight studies were characterized as randomized control trials, with a level of evidence of level two. The

study features, sample demographic information, diagnosis, and management strategies employed were all derived from the articles.

Seven of the included studies utilized Gufoni, three used Head Shaking, and four used Sham. Gufoni had the highest success rate of the three, and these rates were comparable across all investigations. When Head-Shaking was utilized alone, fair results were reported, but when paired with Barbecue, the rates increased. In comparison to the other two, Sham has shown the least effectiveness.

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CHAPTER-1

INTRODUCTION

The peripheral vestibular apparatus consists of a bony labyrinth housed within the membranous part consisting of the otolith organs (utricle and saccule) and the three semicircular canals. Sensory organs of semicircular canals are called ampulla which, contain hair cells embedded in the cupula, and otolith organs have maculae as their sensory organs. Semicircular canals detect angular movement, whereas otoliths are responsible for linear acceleration and head position concerning gravity. Any damage or deterioration in the vestibular system can cause vestibular disorder, with vertigo being a primary symptom. Benign paroxysmal positional vertigo (BPPV) is one of the most common causes of peripheral vestibular vertigo (Kim et al., 2014). Bárány, in 1920 described the symptoms of nystagmus and vertigo caused by a change in the position associated with the disorder of the otolithic organ (Bárány, 1920). Later, Dix and Hallpike coined the terminology “positional nystagmus of the benign paroxysmal type” (Dix & Hallpike, 1952).

In a vast majority of individuals, the cause of BPPV is uncertain, and therefore it is primarily idiopathic. The most common possibility could be the mechanical damage caused by a head trauma involving the ear that causes BPPV (Katsarkas & 1999). BPPV can also occur secondary to other inner ear disorders like labyrinthitis, vestibular neuritis, Meniere's disease, etc., that lead to the detachment of otoconia from the utricular macule (Karlberg et al., 2000). The incidence of BPPV is reported to be higher in individuals suffering from migraines despite the related pathophysiology being unclear (Ishiyama et al., 2000).

1.1 Incidence and Prevalence

BPPV constitutes about 17% of all peripheral vertigo cases (Katsarkas & 1999, 2009). The incidence and prevalence of BPPV have been reported to be 10.7-64 per 100,000 populations (Bhattacharyya et al., 2008). BPPV's prevalence rate was reported to be 2.4% (Bhattacharyya et al., 2008). In individuals exceeding 60 years of age, this prevalence rate increases by 3.4%, and the incidence for an overall lifetime was noted to be 10% (Von Brevern et al., 2007).

1.2 Characteristics

The state can be described by brief recurrent attacks of vertigo caused due to the changes in head position with respect to gravity, specifically when getting out of bed, rolling over in bed, or tilting the head back (Lee & Kim, 2010; Von Brevern et al., 2017). The vertigo span can last for few seconds to a minute. The severity of positional vertigo can vary from mild intermittent to severely disabling such that it interferes with the daily living activities, and affects the quality of life.

1.3 Canal involvement

In the 1980s, it was believed that the pathology causing BPPV symptoms was solely present in the posterior semicircular canal. However, later in 1985, McClure introduced the theory and clinical features associated with lateral canal benign paroxysmal positional vertigo (LC-BPPV). He also represented seven incidents of geotropic nystagmus on the application of the Dix-Hallpike maneuver with no indication of any central lesions (McClure, 1985). Subsequently, another variant of LC-BPPV, the apogeotropic type, was also established. In this type, the nystagmus beats away from the ground during lateral head turning in the supine position (Baloh et al., 1995).

Theoretically, any one or more of the three semicircular canals (SCC) may be involved in BPPV; however, posterior SCC is the most commonly affected canal due to its pro-gravity orientation (being inferiorly placed to the other two) (Bradshaw et al., 2010). Posterior SCC-BPPV constitutes about 60-90 percent of all BPPV, and lateral canal BPPV has been reported in 16 to 31% of BPPV (Caruso et al., 2005). The involvement of the anterior SCC is infrequent, usually ≤1% (Caruso et al., 2005). In this study, we focused on the lateral canal BPPV.

Horizontal nystagmus, a shorter latency in the start of symptoms, a longer duration of the elicited symptoms, and no fatigue in symptoms after repeated testing are the key characteristics of LC-BPPV (Baloh et al., 1995). Lateral semicircular canal benign paroxysmal positional vertigo was introduced first by Cipparrone et al. (1985) and McClure (1985).

1.4 Pathophysiology of LSCC BPPV

Schucknecht first provided the theory of BPPV pathophysiology. The disorder is caused as a result of dislodgement of the otoconia particles from the macula of otolith organs, especially utricle, which either deposit on the cupula of the semicircular canal (cupulolithiasis) or remain freely-floating in the semicircular canals (canalithiasis) (Schuknecht, 1969). It causes the semicircular canals to be more gravity-sensitive. A change in head position in that semicircular canal's plane stimulates the cupula, leading to intense brief spells of vertigo.

The literature shows two significant variants of the LC-BPPV: the geotropic and the apogeotropic (ageotropic) type. The geotropic nystagmus suggests the presence of canalolithiasis involving the lateral SCC's non-ampulated arm. The highest amount of nystagmus is directed towards the ear in the lower position during the supine roll test. The canalothiasis variant will cause ampulopetal fluid movement

when lying on the affected side, which leads to excitation and causes the movement of nystagmus towards the affected ear. Whereas, lying on the unaffected side induces ampulofugal fluid movement and generates inhibitory action. This action, in turn, produces a less intense nystagmus towards the normal ear (Kurtzer, 2017).

On the supine roll test, the apogeotropic nystagmus (nystagmus is directed towards the ear in the higher position) suggests cupololithiasis on the side with less intense nystagmus or canalolithiasis with otoconia particles freely floating in the ampulated arm of the lateral SCC (Hall et al., 1979). The cupulolithiasis variant will cause the inverse nystagmus, i.e., laying on the affected side causes ampulofugal fluid movement in the canal, which leads to signal inhibition. This, in turn, directs nystagmus opposite to the affected ear (towards the normal ear). In contrast, ampulopetal fluid movement begins while lying towards the unaffected side and deflection to an excitatory position, causing nystagmus to beat towards the affected ear (Kurtzer, 2017).

Geotropic LC-BPPV is represented as having short-latency, prolonged duration of horizontal nystagmus, and weak fatigability. Apogeotropic LC-BPPV has similar characteristics as that of the geotropic variant except for the direction of nystagmus, which beats opposite to the ground ear on performing supine roll test (White et al., 2005).

1.5 Management procedures available

Determining the involved side (lateralization) and the sub-type of BPPV is critical for selecting LC-BPPV's proper treatment. Depending on the involvement of the SCC, the treatment varies. The treatment of individuals with BPPV can be done simply by carefully administering some specific maneuvers. These maneuvers act on the basis that performing the relevant head movements during the maneuvers can carry

the free-floating otoconia crystals from the affected semicircular canal back inside the utricle using gravity and inertia, hence eliminates troublesome vertigo (Lee & Kim, 2010; Parham, 2014).

Despite the numerous repositioning maneuvers available to treat apogeotropic LC-BPPV, it is still imprecise to decide which one is superior. Hence, treating apogeotropic LC-BPPV is a challenge for many clinicians (White et al., 2005). Therapeutic maneuvers for apogeotropic LC-BPPV have two primary objectives, detaching the otolith particles from the cupula, and expulsion of the otolith debris via the ampulary arm of the lateral canal.

Various repositioning treatments are available for Lateral Canal BPPV. The maneuvers available for the treatment of the geotropic variant are Gufoni maneuver (Gufoni et al., 1998), Barbecue Roll maneuver (Lempert & Tiel-Wilck, 1996), Forced prolonged procedure (Vannucchi et al., 1994), and modified Zuma maneuver (Ramos et al., 2021). For the apogeotropic variant, the maneuvers available are Head-shaking maneuver (Vannucchi et al., 1997), modified Sémont maneuver (Casani et al., 2002), Cupulolith repositioning maneuver (CuRM) (Kim et al., 2012), Modified Guffoni maneuver (Appiani et al., 2005) and Zuma maneuver (Maia, 2016).

The Head-shaking maneuver for the apogeotropic variant (Vannucchi et al., 1997) is a physical involving 30 rapid head shakes in the right to left direction, three times in continuity at the yaw plane in the supine position. The patient is asked to follow the maneuver twice a day for three days. Treatment aims to crumble and transfer the particles back to the otolith organ. Alternatively, as per the currently proposed procedure, the patient's head should move sideways in a sinusoidal fashion for 15 seconds at a rate of 3Hz, when the patient is seated erect with 30◦ flexion of the head.

The Modified Sémont maneuver (Casani et al., 2002) requires the patient to lie down quickly on the bed from the sitting position on the affected side, and the head is rotated 45° passively towards down; this posture should be sustained for around 2-3mins, and the patient is briskly returned to the sitting position.

In CuRM (Kim et al., 2012), initially, the patient should be in the supine position then his/her head is turned by 135° towards the affected side. To detach otoliths from the cupula, the vibrations from a 60Hz hand-held vibrator are applied at the superio-posterior auricular region of the lesion side (suprameatal triangle) for 30sec. Next, the patient's head should be rotated by 45° to the unaffected side (lateral decubitus to lesion side). Further, the head position is changed by 90° to the unaffected side (supine position). After that, the head is turned over by 90° to the healthy side. In the last position, the patient's head is directed by 90°towards the healthy side (prone position) and then the patient is slowly brought to a sitting position without extending the neck. Every position should be held for a minimum of 3 minutes to detach and relocate all the otoliths.

The modified Guffoni maneuver (Appiani et al., 2005) starts with the sitting position from which the patient is moved to side-lying position quickly towards the lesion side. This position should be maintained 15 seconds beyond the point when the symptoms completely subside. The patients' head is then briskly rotated upwards by 45°. This position is maintained for another 60 seconds. Then the patient is returned to the sitting position.

Zuma maneuver (Maia, 2016) starts with patients being in a sitting position. This is followed by lying down quickly towards the affected side. This position is held for 3 minutes. Then patient's head is turned by 90° upwards and the position is held for a further duration of 3 minutes. Next, the patient's body is brought to a supine position

while the head remains rotated by 90° towards the healthy side, and this position, like the previous ones, is held for another 3 minutes. For the last position, the patient's head is tilted forward marginally and he/she is slowly returned to the sitting position.

1.7 Need of the study

The selection of appropriate repositioning maneuvers for the management of Lateral Canal BPPV seems to be complex. The accurate interpretation of the side affected and ruling out the sub-type of BPPV is crucial to successful treatment. Although different therapeutic maneuvers have been proposed, the uncertainty persists regarding which maneuver is better to treat apogeotropic LC-BPPV.

Some authors stated that they had converted the apogeotropic form to a lateral canal BPPV geotropic form in most patients (Appiani et al., 2005). A randomized control study reported 59% resolution in vertigo and nystagmus on the individual application of the modified Guffoni maneuver for apogeotropic Lateral Canal BPPV (Kim et al., 2012a). This randomized clinical trial has observed improved response rates on the administration of head-shaking maneuver compared to individuals treated with a sham maneuver (Kim et al., 2012a).

The findings of a recent retrospective study comparing participants treated with Zuma maneuver and the modified Guffoni maneuver in cases of apogeotropic Lateral Canal BPPV reported resolution of vertigo and nystagmus in subjects with no experience of BPPV. A positive outcome of 59% was reported for the Zuma maneuver and 48% for the modified Guffoni maneuver (Linera et al., 2019).

Despite the recent development of specific management procedures designed for LC-BPPV, a single precise maneuver is not available. Several authors have reported satisfactory results with various repositioning maneuvers used to treat apogeotropic variant of LC-BPPV. Several randomized controlled trials have been

aimed at determining the effectiveness of various repositioning maneuvers. A few of them compare these movements in order to determine their responsive rate and recommend which is superior to the other. The above section shows several randomized control trials comparing the head-shaking maneuver and Guffoni maneuver, the two most popular maneuvers for treating apogeotropic LC-BPPV. However, a systematic review with assimilated information about each one's outcome is missing. Hence, there is a need to conduct a systematic review of the randomized control trials comparing the efficacy and strengths of these maneuvers. Systematic reviews of Randomized Control Trials (RCTs) and individual RCTs are considered the best evidence-based resources because they are thoroughly designed and free of bias with less probability of errors, thus providing results that are more reliable.

1.8 Aims and Objectives

The current study aims to carry out a systematic review of the randomized control trials related to repositioning maneuvers used for the alleviation of the symptoms associated with the apogeotropic variant of LC-BPPV.

CHAPTER 2

METHODS

The present study aimed to carry out a systematic review of the randomized clinical trials that compared the efficacy of various treatment maneuvers used for the apogeotropic variety of LC-BPPV. The steps followed to accomplish this aim are delineated in the sub-sections that follow.

2.1 Databases and search terms

An electronic literature search was carried out. The electronic databases searched included PubMed, Google Scholar, and Science direct. Other search engines such as the Scopus, Cochrane library etc. was not available at the institute, and hence they were not searched. The search terms used for each of these databases were 'BPPV', 'Lateral canal BPPV', 'Apogeotropic LC-BPPV', 'repositioning maneuvers', 'modified Guffoni maneuver,' 'Sham maneuver' and 'Head shaking Maneuver'. The 'Mesh' terms and synonyms of the search words were used in different combinations using the Boolean operators ‘AND,' 'OR,' and 'NOT' to create multiple search strategies. Table 2.1.1 shows various search strings used in the present study. These search strategies were entered into different databases to ensure comprehensive literature search without restrictions on the publication date and the participants’ age. Reference lists of all eligible studies were also reviewed to identify other potentially relevant studies.

Table 2.1.1

Search strings used for literature search in different databases

Database	Search strings	No. of articles obtained
PubMed	"Benign Paroxysmal Positional Vertigo"[Mesh] OR "BPPV"[tw] OR "LC-BPPV"[tw] OR "HC-BPPV"[tw] OR "apogeotropic horizontal canal benign paroxysmal positional vertigo*"[tw] OR "apogeotropic benign paroxysmal positional vertigo"[tw]	120
	“Canalith repositioning maneuvers”[tw] OR “Sham maneuver”[tw] OR “Modified Guffoni maneuver”[tw] OR “Head Shaking maneuver”[tw] OR “therapeutic head shaking maneuver”[tw]	24
	"Semicircular Canals"[Mesh] OR “Horizontal Semicircular canal*”[tw] OR “Lateral Semicircular canal*”[tw]	104
	"horizontal semicircular canal BPPV"[tw] AND "sham maneuver"[tw] OR "gufoni maneuver"[tw] OR "head shaking maneuver"[tw]	11
Google scholar	Lateral semicircular canal BPPV and sham maneuver or modified gufoni maneuver or head shaking maneuver	35
	Sham maneuver or Modified Gufoni maneuver or Head Shaking maneuver or therapeutic head shaking maneuver	37
	LC-BPPV or HC-BPPV or apogeotropic LC-BPPV or apogeotropic benign paroxysmal positional vertigo	11
	Apogeotropic horizontal canal benign paroxysmal positional vertigo OR apogeotropic benign paroxysmal positional vertigo	113
Science direct	Lateral semicircular canal BPPV and sham maneuver or modified gufoni maneuver or head shaking maneuver	04

	Repositioning maneuvers for apogeotropic lateral canal BPPV	59
	Management of horizontal or lateral canal BPPV	172
	Apogeotropic horizontal canal benign paroxysmal positional vertigo or apogeotropic benign paroxysmal positional vertigo	93

2.2 Inclusion and exclusion criteria

This systematic review included articles involving the human subjects. The language of publication of all them was English. The details of other criteria used for inclusion of the articles in this systematic review are mentioned in Table 2.2.1.

Table 2.2.1

Inclusion criteria for assessing the articles as per PICOTS format.

Population or participants and conditions of interest	Individuals diagnosed with only Lateral canal BPPV exhibiting apogeotropic nystagmus.
Interventions or exposures	All Patients with LC-BPPV were treated with modified Gufoni, Head shaking, or Sham maneuvers.
Comparisons of control groups	Comparison of the three maneuvers with each other in terms of the resolution rate.
Outcomes of interest	Treatment efficacy of these maneuvers in the resolution of BPPV.
Timing	No limits were placed on the date of publication. The search was run just before the final analysis to identify more studies to be included.
Settings or source of population	Randomized control trials, quasi-randomized trials

The articles that included individuals with BPPV of the posterior semicircular canal, the anterior semicircular canal, or multiple semicircular canals were excluded from the present study. Further, articles on subjects with other peripheral vertigos like Meniere's disease, labyrinthitis, vestibular neuritis, superior semicircular canal dehiscence were not considered for inclusion in the present study. Furthermore, the studies where the outcome of one/or both of these treatment maneuvers are compared with placebo, no treatment or any other medical treatment (such as, Betahistine, surgery etc.), but not with each other, were excluded. The present study also excluded the studies where treatment maneuvers other than that for apogeotropic LC-BPPV are used. Furthermore, the studies using any form of modification of the original maneuvers were not included in the present review. As final criteria, studies using cohort, retrospective case-control, or single case study designs were excluded.

2.3 Role of reviewers

Three reviewers were included in the process. Two reviewers carried out the screening of articles based on their titles and abstracts independently using the predefined inclusion and exclusion criteria described above. The disagreements between them were resolved with the help of the third reviewer. The final selection of the articles at each of these stages was through a majority.

2.4 Procedure

The studies obtained were compiled together using a Mendeley desktop reference management system. The articles identified from different databases were converted into Research Information Systems (RIS) format and uploaded to the software used for review (Rayyan). Rayyan is a web-based platform developed by Qatar Computing Research Institute. It is a free service that offers many features like

creating a review, inviting collaborators to a review, uploading and labelling of citations, suggestions for exclusion/inclusion of citations, and collaborative decisions.

The total number of articles selected after the preliminary search was 783 out of which, 259 were obtained from PubMed, 196 from Google Scholar, and 328 from Science Direct. Among these, 240 duplicates were detected. Among the duplicates, 138 were detected as exact matches by the Rayyan software, 48 were marked as duplicates and deleted by the first reviewer. A total of 36 articles that were initially not resolved by the software, were found to be not duplicates during manual verification, and hence were retained. Both reviewers identified an additional 18 articles as duplicates, that were missed by the software. All duplicates were removed, and the remaining 543 articles were included for further screening.

The initial screening of all the obtained articles was done based on the title. After the screening of both the reviewers, 99 articles were included, 319 were excluded, 40 were questionable (maybe) and the disagreement between the reviewers was found for 85 articles. The conflict was resolved by the third reviewer. This resulted in inclusion of 163 articles and exclusion of 380 articles after the title screening stage.

In the second stage, the screening based on the abstracts was done for the articles that were included after the title-based screening (n = 163). The abstract screening showed agreement between reviewers for 118 articles (inclusion = 52, exclusion = 46, query = 20) and disagreement for 45 articles. Like the title-based screening, the discrepancy was resolved by the third reviewer and the final included articles were 45 and excluded were 118.

The full-text screening was applied for the articles selected at the abstract level (n = 45). Among these, 8 were included and 37 were excluded. Since there were no

significant discrepancies reported between the two authors, there was no need for a third reviewer at this stage. Table 2.4.1 shows the details of the number of articles and the decision on them.

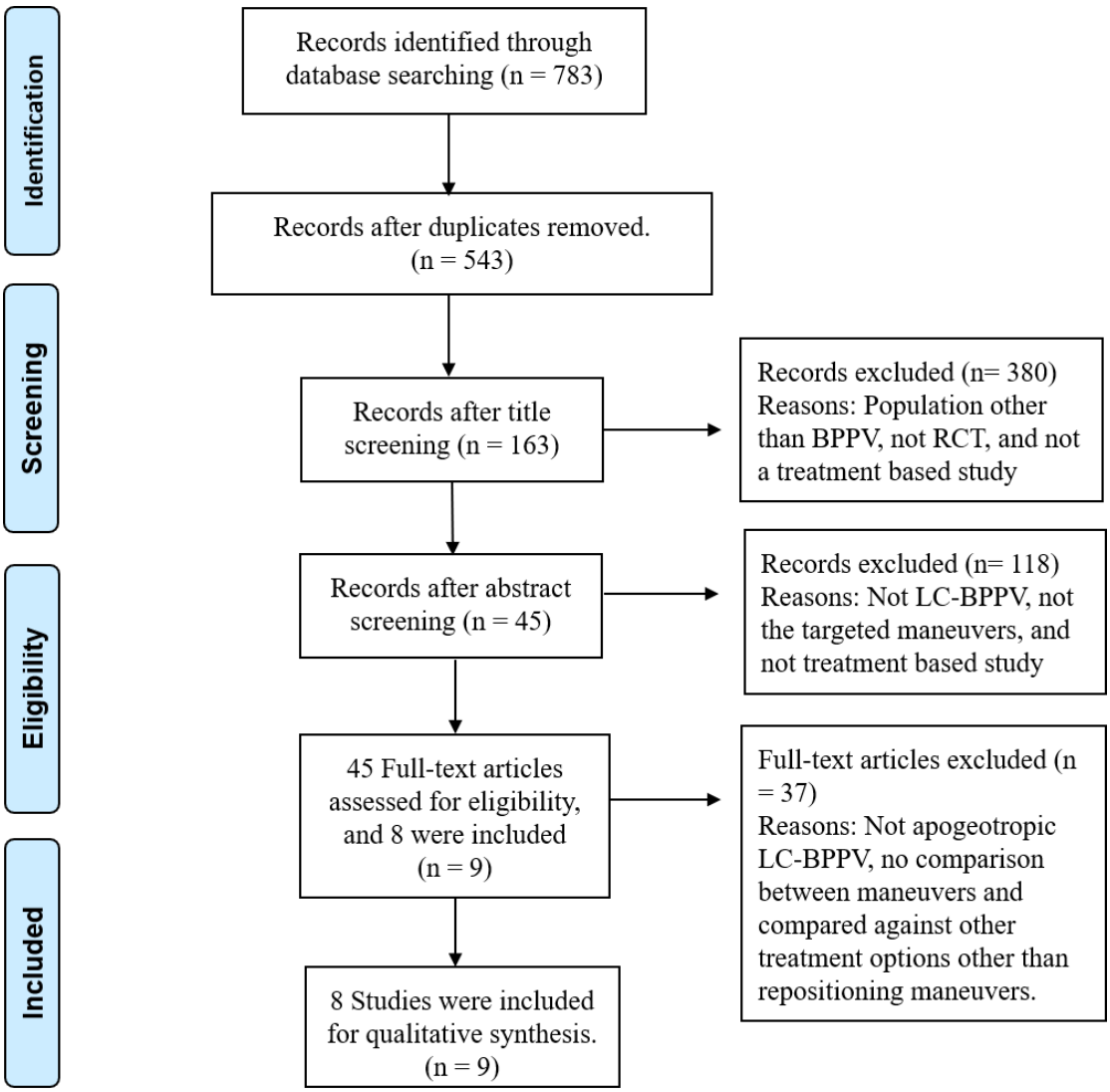
Table 2.4.1

The exact number of articles included, excluded, questionable and in conflict during each stage of screening.

		Before conflict resolution				After conflict resolution	
S. No.	**Stages**	**Included**	**Excluded**	**Maybe**	**Conflict**	**Included**	**Excluded**
1.	Title screening done on 543 articles	99	319	40	85	163	380
2.	Abstract screening on 163 included articles	52	46	20	45	45	118
3.	Full text screening for 45 included articles	8	37	0	0	0	0
4.	Overall remaining articles at the end of screening	8	535	0	0	0	0

Figure 2.4.1

PRISMA chart explaining the systematic search process followed in this systematic review.



2.5 Quality assessment

Critical Appraisal Checklist Programme (CASP) (Brice R., 2020) standard checklist for Randomized Controlled Trial was used for quality analysis of the articles. The scale consists of 11 questions; the first three questions (Section A) are screening questions about the validity of the basic study design. Section B assesses whether or not the study is methodologically sound and worth continuing with the appraisal. Sections C and D involves questions of appraisal. This is a 3-point rating scale with possible answers as 'Yes,' 'No' or 'Cannot tell' for each question.

Two reviewers independently assessed the quality of each study. Discrepancies between them were resolved through discussion. The total CASP score of all included articles are shown in the Table 3.5.1. The studies were classified as weak for the scores below 5 and strong when the scores were more than 7. The scores ≥5 and ≤7 were and the remaining considered as moderate.

2.6 Data extraction

The data available in the articles were extracted, including study characteristics, sample demographic information, diagnosis, and management procedures used. The following data were extracted for each included study: (1) Study characteristics: first author, study region, sample size, publication year, and study design (RCT or quasi RCT); (2) Sample demographic information: gender, age (mean ± SD), affected ear (right, left or both) (4) diagnostic indicators: distribution of geotropic and apogeotropic nystagmus, the test used for diagnosis (5) management options: treatment procedures used, recovery criteria defined, intervention outcomes, statistics, evaluation time and follow-up.

CHAPTER 3

RESULTS

3.1 Study selection & characteristics

Overall, 783 articles were identified through the database search. Eight studies were finally included for the qualitative analysis after 534 articles were gradually excluded at each stage. The details of article selection and stages of exclusion were mentioned in the PRISMA analysis chart in Chapter 2 (Figure 2.4.1).

3.2 General characteristics of the study

The study finally included eight articles in the review. The general characteristics (descriptions of the available study features) of the studies included in this review are shown in Table 3.2.1

Table 3.2.1

Descriptions of the available study features.

Author, year	Region	Sample size	Age (mean) & sex	Study design
Casani et al. (2011)	Italy	147	52.76years; 93F/55M	RCT
Kim et al. (2017)	South Korea	209	61.9±12.7years, 133F/76M	RCT
Testa et al. (2012)	Italy	87	53.5years, 55F/32M	RCT
Mandala et al. (2013)	Italy	72	58.1±15.9years, 35F/37M	RCT
Song et al. (2015)	Korea	210	57±13years,	RCT

			158F/52M	
Kim et al. (2012a)	Korea	157	59.9±13.6years, 95F/62M	RCT
Maranhão & Maranhão Filho, (2015)	Brazil	37	65.8±15.8years, 28F/9M	RCT
Fitzgerald, 2012	Korea	157	18-89years	RCT

3.3.1 Study design

All eight studies were classified as randomized controlled trials (Casani et al., 2011; Fitzgerald, 2012; Kim et al., 2017; Kim et al., 2012a; Mandalà et al., 2013; Song et al., 2015; Testa et al., 2012). The duration of studies ranged from 8 months to 8 years.

3.3.2 Set-ups, regions and participants

Four studies were done at the medical centers, department of otolaryngology (Casani et al., 2011; Song et al., 2015; Maranhão & Maranhão-Filho, 2015; Testa et al., 2012), and the remaining four were done in dizziness or neuro-otology clinical setups (Fitzgerald, 2012; Kim et al., 2017; Kim et al., 2012a; Mandalà et al., 2013). Four studies were done in Korea, three in Italy, one in China and Brazil each respectively.

The age range of the participants ranged from 45-75 years approximately across all the studies except the one (Fitzgerald, 2012) with the wide age range of 18-89 years. In all the studies, the number of female participants was more than males except a study that has not specified the gender ratio (Fitzgerald, 2012).

3.3.3 Diagnosis

The primary pre-requisite for all studies was the presence of positional horizontal nystagmus and paroxysmal vertigo (Casani et al., 2011; Maranhão & Maranhão-Filho, 2015). Furthermore, Kim et al. (2017) study had defined specific criteria for inclusion, such as the presence of direction changing nystagmus beating away from the ground (apogeotropic nystagmus) for both side lateral head turns along with the presence of vertigo. In all the studies, the Supine-roll test was used to elicit nystagmus and diagnose LC-BPPV (geotropic or apogeotropic variant). Three studies had also included Dix–Hallpike maneuvers and straight head hanging test to exclude PC-BPPV or AC-BPPV (Song et al., 2015; Kim et al., 2017; Kim et al., 2012a).

3.3.4 Intervention

The Gufoni maneuver was utilized in all the studies except one (Song et al., 2015), Head shaking and the sham maneuver were used in four studies each (Fitzgerald, 2012; Kim et al., 2017; Kim et al., 2012a; Mandalà et al., 2013). The comparison of the head-shaking maneuver, the Gufoni maneuver, or the sham maneuver was done in two studies (Kim et al., 2012a; Fitzgerald, 2012). The other studies have used similar maneuvers, including the Gufoni, the Barbecue roll, the Head shaking, and FPP maneuvers (Maranhão & Maranhão-Filho, 2015; Casani et al., 2011). Two studies compared the vigorous head-shaking (2 Hz for 10 s) and Barbecue roll maneuver (Song et al., 2015; Maranhão & Maranhão-Filho, 2015). Two studies have compared GLM with sham (Mandala et al., 2013; Kim et al., 2017); however, one of these also used additional mastoid oscillation (Kim et al., 2017). One study used the Gufoni maneuver compared to the modified Gufoni maneuver (Testa et al., 2012).

3.3.5 Outcomes

Successful therapeutic treatment was defined as the absence of positional vertigo and nystagmus on the post maneuver supine roll test. The therapeutic treatment was also regarded successful when there was conversion of apogeotropic nystagmus to a geotropic nystagmus on follow-up examination.

3.4 Evidence level

Among eight studies, three studies (Kim et al., 2017; Kim et al., 2012a; Mandalà et al., 2013) were registered randomized controlled trials. Although the other five studies (Casani et al., 2011; Fitzgerald, 2012; Song et al., 2015; Maranhão & Maranhão-Filho, 2015; Testa et al., 2012) were not registered as RCT, considering the randomization of subjects mentioned in the study, they were also categorized as randomized controlled trials. The evidence level was decided based on the rank order of level of evidence pyramid. The levels of evidence of these studies are mentioned in Table 3.4.1.

Table 3.4.1

Level of evidence rating based on the research pyramid.

Author & year	Hierarchy	Level of evidence
Casani et al. (2011)	Randomized control trial	2
Kim et al. (2017)	Randomized control trial	2
Testa et al. (2012)	Randomized control trial	2
Mandala et al. (2013)	Randomized control trial	2
Song et al. (2015)	Randomized control trial	2
Kim et al. (2012a)	Randomized control trial	2
Maranhão & Maranhão-Filho (2015)	Randomized control trial	2
Fitzgerald (2012)	Randomized control trial	2

3.5 Quality analysis

Based on the CASP score, the total score for each of the eight studies ranged from 6 to 11. Therefore, five were classified as 'strong,' (Casani et al., 2011; Kim et al., 2017; Kim et al., 2012a; Mandala et al., 2013; Testa et al., 2012) and the remaining three were rated as moderate (Fitzgerald, 2012; Song et al., 2015; Maranhão & Maranhão-Filho, 2015) Table 3.5.1 shows the outcomes of the CASP analysis. Figure 3.5.1 shows the graphical representation of CASP analysis of all eight studies.

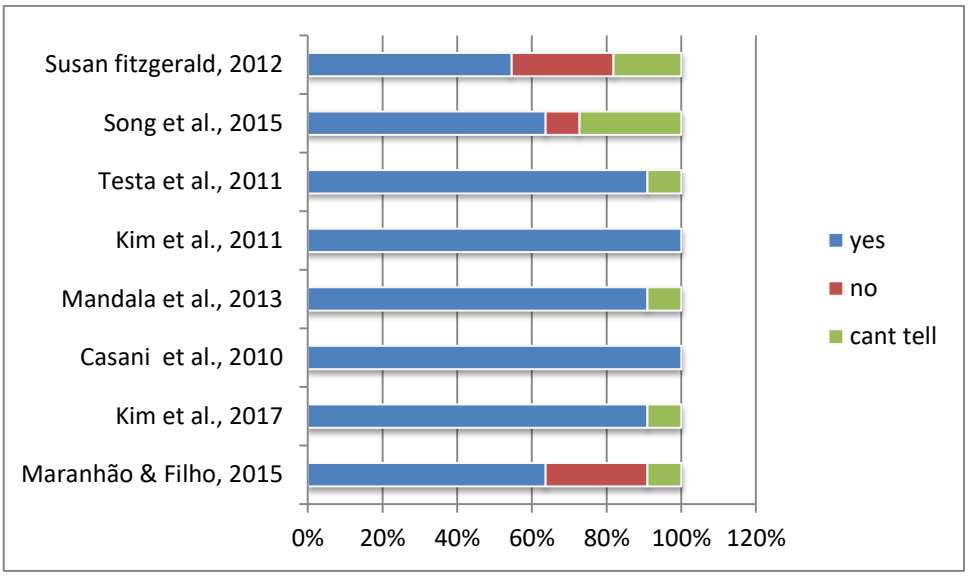
Table 3.5.1

CASP Quality appraisal scores for all included studies.

	Section A			Section B			Section C			Section D		Total
	Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**yes**
Maranhão & Filho, (2015)	Yes	No	Yes	Can't tell	Yes	No	Yes	Yes	Yes	Yes	No	7
Kim et al. (2017)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Can't tell	10
Casani et al. (2010)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	11
Mandala et al. (2013)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Can't tell	10
Kim et al. (2012a)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	11
Testa et al. (2011)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	10
Song et al. (2015)	Yes	No	Yes	Can't tell	Yes	Yes	Yes	Yes	Can't tell	Yes	Can't tell	7
Fitzgerald, (2012)	Yes	Yes	No	Can't tell	Yes	Yes	Yes	No	Yes	Can't tell	No	6

Figure 3.5.1.

Graphical representation of the quality analysis scores obtained from all the studies.



CASP consist of four sections: Section A (validity of study design as RCT, Section B (methodology), Section C (results), and Section D (generalization of results locally). The findings from the included studies in response to the questions are described under each part.

Research question

All the studies had clearly defined the population group, the intervention provided, outcome measured and the comparison chosen, except three studies that have not compared the treatment maneuvers (Maranhão & Maranhão-Filho, 2015; Song et al., 2015)

Randomization of studies

Although all eight studies were classified as randomized controlled trials, only six has described the randomization process in detail. The other two studies included in the qualitative analysis either do not have more than one participant group, or the distribution was done as per requirement.

Dropouts reported

All studies except one have mentioned that the subjects included have completed the requirements. The number of subjects who dropped out was also reported.

Blinding of participants and investigator

Only five studies have reported blinding of participants, whereas three of the studies reported blinding of treatment providers.

The similarity of groups at baseline: All of the studies had similarities in age and gender. However, one study (Fitzgerald, 2012) varied in terms of wide age range, less sample size, and make female ratio. Other characteristics of the studies were highly variable.

Defined study protocol

Treatment procedures were clearly defined for groups in all studies. It was variable for only one study (Maranhão & Maranhão-Filho, 2015) where 18 participants were allotted to Gufoni, 12 to Barbecue roll, both in 4, plus Head shaking in 1 and Head shaking plus Gufoni in 3 patients.

The Follow-up interval of the studies

After re-assessment 30 minutes to 1 hour later the initial maneuver, the patients were followed up on the next day and then weekly for one month (Kim et al., 2012a). Others have reported follow-up on the next day and after one month (Casani et al., 2011) or up to 2 weeks after treatment if symptoms persisted or reoccurred (Mandala et al., 2013). One study has mentioned criteria as per days, i.e., followed up at 7, 15, and 30 days (Testa et al., 2012).

Effect of intervention

Maranhão & Maranhão-Filho (2015), Kim et al. (2012a), and Kim et al. (2017) reported outcomes after administration of maneuvers on the first and second day in terms of the number of participants resolved. Additionally, Kim et al. (2012a) also reported the outcomes after one week and, based on the comparison, suggested which were more efficient. Song et al. (2015) showed a success rate with one versus two repositioning maneuvers. Mandala et al. (2013) described the recovery rate after one and twenty-four hours of treatment and suggested a higher recovery rate for apogeotropic than geotropic LC-BPPV. In addition, Gufoni & Mastoid oscillation were more effective than Sham. Casani et al. (2011) stated that the resolved participants after the first and thirty days, along with which has better performance. Fitzgerald, (2012) compared the efficacy of three maneuvers in resolving BPPV.

Generalization of the results

Outcomes of studies other than the included were also analyzed; following this, the best approach was suggested, which can be accommodated in the clinical practice. Many studies have reported that Gufoni maneuver is beneficial in the treatment of apogeotropic LC-BPPV when compared with other maneuvers such as HSM and BBQ 360° (Maranhão & Maranhão-Filho, 2015; Casani et al., 2011; Kim et al., 2012a; Testa et al., 2012), Lempert maneuver, Forced prolonged positioning and head-shaking (Mandala et al., 2013). The reasons for favorable outcomes of the Gufoni maneuver accounted for were less time-consuming, easier to perform in obese or elderly, and in cervical pain & stiffness patients. Although a study has recommended the Barbecue maneuver after Head-shaking for apogeotropic BPPV, similar findings were not replicated by any other study (Song et al., 2015).

3.6 Data extraction and study summary

Six intervention techniques were used to treat apogeotropic LC-BPPV among eight studies. These included Gufoni maneuver (n = 7) (Maranhão & Maranhão-Filho, 2015; Casani et al., 2011; Kim et al., 2012a; Testa et al., 2012; Mandala et al., 2013; Kim et al., 2017; Fitzgerald, 2012), modified Gufoni's maneuver (n = 1) (Testa et al., 2012). Head-shaking was used in four studies (Maranhão & Maranhão-Filho, 2015; Kim et al., 2012a; Song et al., 2015; Fitzgerald, 2012), Sham maneuver (n = 4) (Kim et al., 2012a; Mandala et al., 2013; Kim et al., 2017; Fitzgerald, 2012), Barbecue roll (n = 3) (Maranhão & Maranhão-Filho, 2015; Song et al., 2015; Casani et al., 2011). Additionally, Mastoid oscillation (n = 1) (Kim et al., 2017), and Forced prolonged positioning (n = 2) (Casani et al., 2011; Maranhão & Maranhão-Filho, 2015) were also used.

Table 3.6.1 shows the summary table based on PICOT. In the outcomes section of the table, the term "success rate" referred to a condition in which the individual no longer experiences vertigo or nystagmus during the supine roll test following treatment for LC-BPPV. The term 'unfavorable outcomes' was considered when the application of the maneuver resulted in the conversion of apogeotropic LC-BPPV to other type of BPPV or remission after the treatment. The 'conclusion' represents the decision made by the authors of those studies based on a reasoning.

Table 3.6.1.

Summary table of the included studies based on PICOT

Study ID	Population	Diagnosis		Intervention	Comparison & Outcome		
		Impression	Ear affected		Success rate	Detrimental effect	Conclusions
Maranhão & Maranhão-Filho, (2015)	37	LC-BPPV 26 (70.2%) canalolithiasis 11 (29.7%) cupulolithiasis	equal on either side Right ear = 7 (63.6%); Left ear = 4 (36.3%)	Gufoni, Barbecue roll, Head shaking, and Forced prolonged positioning	Asymptomatic after one maneuver 8 (21.6%): 4 Gufoni and Barbecue roll each. After two maneuvers, 17 (45.9%): 11 Gufoni and 6 Barbecue roll. The complete resolution rate was obtained in 30 (81.0%) at the initial visit.	After Head shaking, three patients (8.1%) converted LC-BPPV cupulolithiasis to canalolithiasis.	Gufoni and BBQ 360° maneuver have proven effective in treating both canalolithiasis and cupulolithiasis LC-BPPV.
Kim et al. (2012a)	Group I = 54 Group II = 52 Group III = 51	Apogeotropic LC-BPPV	Right ear = 81 (52.6%); Left ear = 76 (47.4%)	Head-shaking, Gufoni maneuver and sham maneuver	Immediate efficacies: Gufoni 38/52 (73.1%), head-shaking 33/53 (62.3%), sham 17/49 (34.7%). Long-term results: Gufoni 51/52	Overall, 78 (50.6%), most of them 74 (48.1%), showed transition into geotropic LC-BPPV, and only 4 (2.6%) had transitioned into PC-BPPV.	When compared to the Sham maneuver, the therapeutic effects of gufoni and head-shaking maneuvers were superior. However, therapeutic efficacies did not

					(98.1%), head-shaking 48/53 (6290.6%), sham 41/49 (83.7%).	Transition to geotropic LC-BPPV occurred more frequently in Gufoni than in Head-shaking or Sham group.	differ between Gufoni and Head shaking in both immediate and long-term outcomes.
Song et al. (2015)	Group I = 36 Group II = 22	LC-BPPV (geotropic/ apogeotropic)	-	Head-shaking and Barbecue roll maneuver	With one, maneuver 11/22 (50%) With two maneuvers 16/22 (73%) At one week of treatment, 18/22 (82%) and reaches 22/22 (100%) at one month of treatment.	The one-year recurrence rate for apogeotropic LC-BPPV was 5/22 (23%).	Apogeotropic and multi-canal BPPV needed more follow-ups than PC-BPPV. The one-month success rate for apogeotropic BPPV was higher for weekly follow-ups patients.
Mandala et al. (2013)	Group I = 37 Group II = 35	unilateral LC-BPPV	Right ear = 45 Left ear = 27	Gufoni liberatory (GLM) maneuver & sham treatment (SM)	After 1 hr: GLM 28/37 (75.7%); SM 3/35 (8.6%) After 24 hr: GLM (83.8%) 31/37; SM 4/35 (11.4%)	Transformation of apogeotropic to geotropic, or PC-BPPV. After 1hr: 10 (13.5%) After 24hr: 8 (11.1%)	The geotropic form showed a statistically significant higher rate of recovery with GLM compared to the apogeotropic variant.

Testa et al. (2012)	Group A = 44 Group B = 43	LC-BPPV (geotropic/ apogeotropic)	Right ear = 50 Left ear = 37	Modified gufoni maneuver & Gufoni maneuver	Group A with modified Gufoni maneuver 40 (91%) completely resolved, and 3 (7%) did not show any benefit. Group B with Gufoni maneuver 31 (72%) was cured, and 5 (12%) did not benefit after the treatment.	Group A with modified Gufoni maneuver 1 (2%) has conversion to PC-BPPV. Group B with Gufoni maneuver 7 (16%) converted to PC-BPPV.	The modified Gufoni maneuver shows the same effectiveness in the resolution of symptoms as the Gufoni maneuver (93% vs. 88%). Modified Gufoni, on the other hand, seems to be more effective in reducing the percentage of transformation of LC-BPPV to PC-BPPV (2% vs. 16%).
Kim et al. (2017)	Group I = 70 Group II = 67 Group III = 72	Apogeotropic LC-BPPV	Right ear = 119 (56.9%); Left ear = 90 (43.1%)	Mastoid oscillation, Gufoni maneuver, or sham maneuver	Immediate response: Gufoni 33/70 (47.1%), mastoid oscillation 32/67 (47.8%), Sham 14/72 (19.4%). Short-term responses: Gufoni 51/70 (76.1%), mastoid oscillation 46/67 (71.9%), Sham 38/72 (53.5%).	Transition to geotropic horizontal nystagmus: on first day, 48 (22.9%) and 61 (29.1%) on the second day. There was no evidence of PC or AC-BPPV transition in any of the patients.	The resolution rates of the Gufoni and mastoid oscillation maneuvers were higher than the sham maneuver. The Gufoni and mastoid oscillations, on the other hand, did not show any significant differences.

Casani et al. (2011)	147	LC-BPPV (geotropic/ apogeotropic)	Right ear = 78 Left ear = 69	Gufoni maneuver, Barbecue roll & FPP.	At the first session, 33/54 (61%) with Barbecue roll maneuver along with FPP compared to Gufoni 50/58 (86%). After 1 month 44/54 (81%) with Barbecue maneuver with FPP; 54/58 (93%).	Change to PC-BPPV occurred in 1 patient treated with Barbecue + FPP (2%) and in 4 (7%) patients treated with Gufoni maneuver.	Barbecue along with FPP and Gufoni maneuver both were effective treatments for LC-BPPV. However, Gufoni has a significant due to ease to perform and better patient compliance.
Fitzgerald, (2012)	157	Apogeotropic LC-BPPV		Gufoni maneuver, Head shaking, and sham maneuvers.	After two maneuvers, 38/52 (73.1%) with Gufoni, 33/53 (62.3%), Head shaking, and 17/49 (34.7%) have resolved.	NA	Gufoni and head shaking had better therapeutic effects when compared with sham maneuver. However, there was no difference reported between Gufoni and the head-shaking group.

All studies, except one (Testa et al., 2012), have compared the Gufoni maneuver with another treatment. In five studies, this was head shaking, and in four, sham was used in addition to other maneuvers. Two studies (Kim et al., 2012a; Fitzgerald, 2012) compared Gufoni, Head shaking, and Sham maneuvers. The collective findings of these two studies showed that the Gufoni and head-shaking maneuvers were more effective than the sham maneuver. The rates found by Kim et al. (2012a) and Fitzgerald, (2012) were comparable.

Two studies (Maranhão & Maranhão-Filho, 2015; Casani et al., 2011) used Barbecue roll and FPP in comparison to Gufoni maneuver. Maranhão & Maranhão-Filho (2015) added the head shaking as an additional treatment. In both studies, combined results for apogeotropic and geotropic nystagmus indicated that Gufoni and BBQ 360°, when used along with FPP maneuver, had proven effective treatment of both canalolithiasis and cupulolithiasis LC-BPPV.

Following the same objective, Song et al. (2015) have combined the Head shaking with Barbecue roll maneuver. The success rate increased on the application of both treatments compared to one. For Apogeotropic, more follow-ups were required, which raised the success rates.

Gufoni was compared with Sham by Mandala et al. (2013) and Mastoid oscillation was added by Kim et al. (2017) along with Gufoni and Sham. The collective findings of the studies suggested that the resolution rates for the Gufoni maneuver and mastoid oscillation were higher than the sham maneuver.

Exclusively the Gufoni maneuver was compared with the modified version of it by Testa et al. (2012). They achieved the same effectiveness in the resolution of symptoms with both treatments; however, the modified Gufoni appeared less often associated with a canal conversion.

CHAPTER 4

DISCUSSION

This systematic review evaluated the effectiveness of three Canalith repositioning maneuvers, namely, the Gufoni maneuver, Head-shaking maneuver, and the Sham maneuver, and compared their outcome for the treatment of apogeotropic LC-BPPV.

According to a few investigations, absolute recovery rates associated with apogeotropic LC-BPPV were lower than those associated with geotropic LC-BPPV (Casani et al., 2011). This finding may depend on the location of the otoconia. If the otoconia are free-floating in the posterior arm of the lateral semicircular canal, as happens in the case of geotropic LC-BPPV, they are already near the utricle and therefore shifting them back to the utricle is an easier proposition (McClure, 1985). However, in the case of apogeotropic LC-BPPV, the otoconia are free-floating in the anterior arm (Nuti et al., 1996) or adhered to the cupula in the lateral semicircular canal (Baloh et al., 1995). If the otoconia are free-floating, they must first exit the anterior arm of the lateral semicircular canal and then travel through the posterior arm before returning to the utricle. If the otoconia are linked to the cupula, they must first be removed from the cupula before they take the same migratory route as those in the anterior arm. As a result, it necessitates additional positions and effort, making it difficult to cure. Despite this, many investigations have reported therapeutic maneuvers which are competent in treating apogeotropic variants successfully.

Further, there is sufficient evidence on the effectiveness of individual repositioning maneuvers to treat patients with LC-BPPV with apogeotropic nystagmus. However, the concurrent studies comparing the effectiveness of these

maneuvers are insufficient in number. Thus, this suggests the need to compile the data on different maneuvers' efficacy and recommend the best out of them.

This review's inclusion and exclusion criteria considered the diagnosed LC-BPPV using the appropriate test and specific maneuvers used for its treatment. To prevent confounding variables, we excluded studies with subjects who were not apogeotropic LC-BPPV and treatment choices other than repositioning procedures.

4.1 Comparison between Gufoni, Head shaking and Sham maneuver

Eight studies were ultimately included for the review, and all of them were considered for the qualitative analysis. The seven selected studies found favorable outcomes on the application of Gufoni and head-shaking maneuver over Sham. The success rate of the Gufoni maneuver (72% to 86%) (Kim et al., 2012b; Mandala et al., 2013; Testa et al., 2012; Kim et al., 2017; Casani et al., 2011; Fitzgerald, 2012) was slightly better than the Head-shaking maneuver (62.3%) (Kim et al., 2012b; Fitzgerald, 2012) but way better than the Sham maneuver (11.4% to 53.5%) (Kim et al., 2012b; Mandala et al., 2013; Kim et al., 2017b; Fitzgerald, 2012).

Although the Gufoni maneuver is effective, there is currently inadequate information to compare it to other procedures in treating apogeotropic LC-BPPV. Casani et al. (2011) verified this by finding no significant difference in therapeutic efficacy between the Gufoni technique and the Barbeque roll in both immediate and one-month later effects. Regardless, Casani et al. (2011) suggested using the Gufoni maneuver as a primary treatment option because of its high success rate, ease of execution, and better patient compliance.

Gufoni may offer a substantial advantage because most studies agreed on its simplicity, and it has been approved for use in older, immobile, or obese patients (Casani et al., 2011; Korres et al., 2011; Mandala et al., 2013). The only minor

drawback could be the likelihood of BPPV conversion to a different form; however, such cases could be successfully treated with suitable therapeutic measures.

The anatomical explanation behind the effectiveness of Gufoni maneuver lies in the pathophysiology of the procedure. When the patient is rapidly shifted in a side-lying posture on the affected side during the maneuver, the horizontal canal assumes a vertical orientation, and the particles move towards the bottom of the canal due to rapid deceleration and gravity. In the second stage, the patient's head is abruptly tilted by 45^{o} upward. This movement causes the particles to move from the anterior arm to the posterior arm of the horizontal canal by using the force of inertia. Eventually the otoconia particles fall into the utricle (Appiani et al., 2005; Vannucchi et al., 1997).

The Gufoni maneuver for the apogeotropic form of LC-BPPV is simple to implement compared to the barbecue maneuver, which requires multiple rotations and can be challenging to perform in the elderly, obese, or patients with cervical stiffness. It takes less time than a Forced prolonged position on the affected ear's side, and it is less demanding than the repetitive lateral movement of the Head-shaking maneuver (Appiani et al., 2005).

The rationale for the therapeutic Head-shaking maneuver's efficacy could be the rapid acceleration and deceleration that leads to the detachment of the otoliths from the cupula (Oh et al., 2009). The main objectives of this maneuver are to dislodge otolithic debris from the cupula or remove debris from the anterior arm of the lateral canal into the utricle (Appiani et al., 2005; Casani et al., 2002; Nuti et al., 1998; Vannucchi et al., 1997). The detachment would result in the remission of positional vertigo and nystagmus immediately or conversion to geotropic LC-BPPV.

According to one of the studies, Head-shaking is superior to modified Semont’s maneuver in treating apogeotropic LC-BPPV in immediate resolution of

positioning vertigo and nystagmus after a single application of each maneuver (37.3% versus 17.3%) (Oh et al., 2009). However, this is the only study reporting such a finding and therefore requires more studies on the similar line to validate its findings. Additionally, while the Head-shaking maneuver seems better than the modified Semont's maneuver, the absolute efficacy for both are below the chance result of 50%.

The Sham technique was used to confirm that canalith repositioning procedures were effective in treating apogeotropic HC-BPPV. As it was assumed that the sham maneuver might serve as a control group with no standard procedure, the findings of the studies revealed that the sham maneuver could also have a treatment effect. Therefore, the actual efficacy for the Head-shaking and the Gufoni maneuvers might be below the reported values.

The Sham maneuver procedures used by various researchers are variable. Mandala et al. (2013) used GLM performed on the wrong side as a sham maneuver with a resolution rate of around 10%. Another variation involves the patients immediately lying on the unaffected side for 1 minute before returning to the sitting position (Fitzgerald, 2012; Kim et al., 2017; Kim et al., 2012b). This could be because the initial phase of the sham maneuver would have caused the otoliths to dislodge from the cupula, and the second stage had caused them to relocate from the lateral canal's anterior arm (Mandalà et al., 2013).

4.2 Comparison of Gufoni, Head shaking, and Sham with other maneuvers available

These maneuvers (Gufoni, Head shaking, and Sham amneuvers) were compared to other maneuvers utilized in the treatment of apogeotropic LC-BPPV. When Gufoni was compared to Barbecue roll combined with FPP, resolution rates were 93% for Gufoni and 81% for Barbecue with FPP. The outcome measures for

both were performed after the completion of the one-month period required for FPP. In hour honest opinion, this seems an unfair comparison as the outcomes of the Gufoni maneuver could have been negatively impacted by a month month gap after the treatment as this gap allows a chance of recurrence (Casani et al., 2011). In another investigation, the Gufoni maneuver had a 40.5% resolution rate compared to the 27% resolution rate of the Barbecue maneuver with FPP (Maranhão & Maranhão-Filho, 2015).

The low success rate in the study by Maranhão & Maranhão-Filho (2015) could be attributed to the way the results were portrayed in this study. This study had shown separate results for the apogeotropic and the geotropic nystagmus variants, whereas the results in Casani et al. (2011) were based on the total number of patients, combining geotropic and apogeotropic nystagmus.

A combination of the Head-shaking maneuver with the Barbecue maneuver was compared with the Barbecue maneuver alone (Maranhão & Maranhão-Filho, 2015). The combination approach yielded a resolution rate of 73% as against the 50% resolution rate when the Barbeque maneuver was used alone. Better performance with the combination technique could be attributed to an additional help from the Head-shaking maneuver that might have caused detachment of particles from the cupula, thereby converting the cupulolithiasis to canalolithiasis. This was then treated effectively by the Barbecue maneuver that followed.

4.3 The comparison of the present review with other reviews incorporating similar maneuvers

A systematic review by Van Den Broek et al. (2014) verified the findings reported in the present study. They used three RCTs (Casani et al., 2011; Kim et al., 2012a; Mandala et al., 2013), two of which was identical to that included in the current

review. All three studies compared the Gufoni maneuver with another treatment. Mandala et al. (2013) relied solely on the sham maneuver whereas Kim et al. (2012b) had used Barbecue roll along with Sham. Casani et al. (2011) had used Barbecue roll and FPP in comparison to Gufoni. Both sham-controlled studies showed that the Gufoni maneuver was more effective (Kim et al., 2012b; Mandala et al., 2013). The rates found by Mandala et al. (2013) (11%) were notably lower than Kim et al. (2012b) (35%). Further, due to differences in population groups, the results of all the three studies could not be compared since Kim et al. (2012b) only included geotropic variants, whereas Casani et al. (2011) and Mandala et al. (2013) used both geotropic and apogeotropic.

The comparison among the three maneuvers included in the present review for treating apogeotropic LC-BPPV showed that the Gufoni manoeuvre outperforms the others in terms of ease of execution. Head shaking was used both individually (Fitzgerald, 2012; Kim et al., 2012a) as well as in combination with other maneuvers (Maranhão & Maranhão-Filho, 2015; Song et al., 2015). It has been shown to be an effective treatment option in both instances. The sham maneuver, which was utilized as a control group, had the lowest success rates of all three, although it had achieved fair outcomes in cases of geotropic LC-BPPV (Kim et al., 2012b).

CHAPTER 5

SUMMARY AND CONCLUSIONS

The most prevalent cause of peripheral vestibular vertigo is Benign Paroxysmal Positional Vertigo. It is caused by otoliths adhering to the cupula (cupulolithiasis) or free-floating otoconia in the semicircular canals (canalolithiasis). The most commonly affected canal is the posterior canal, followed by the lateral canal.

The accurate diagnosis of the side affected and ruling out the sub-type of BPPV is crucial to successful treatment. Although various therapeutic maneuvers are available, the question of which maneuver is superior for treating apogeotropic LC-BPPV remains unanswered. Some researchers converted LC-BPPV from its apogeotropic to geotropic form in most patients (Appiani et al., 2005). The modified Guffoni maneuver has been shown to resolve vertigo and nystagmus when used individually (Kim et al., 2012a). Few investigations have found that individuals administered with the Head-shaking maneuver performed better than those by a sham maneuver (Kim et al., 2012a).

Some randomized controlled trials comparing the procedures for treating apogeotropic LC-BPPV have been published. A systematic review with aggregated information about each one's outcome is missing. Therefore, there is a needed to evaluate the efficacy of various methods as a preliminary step. Hence, the present systematic review aimed to evaluate the effectiveness of Gufoni, Head-shaking, and Sham maneuvers in alleviating vertigo and nystagmus encountered by individuals with LC-BPPV and comparing their outcomes.

The databases that were searched included Google Scholar, Science Direct, and PubMed. The search terms used for each of these databases were 'BPPV,' 'Lateral

canal BPPV,' "Apogeotropic LC-BPPV,' 'repositioning maneuvers,' 'modified Guffoni maneuver,' 'Sham maneuver,' 'Head shaking Maneuver.' These search words were combined with Boolean operators' AND', 'OR,' and 'NOT' to create different search strategies. The inclusion and exclusion criteria were clearly stated, and only articles that met those criteria were chosen, while others were excluded. At each level, the reasons for exclusion were documented. The screening of articles was done independently by two reviewers in three stages: title, abstract, and full-text screening. The third reviewer settled any disagreement between the two reviewers. The quality analysis was done using the CASP scale on the final selected articles.

The database search resulted in 543 publications, of which eight research articles were eventually included in the qualitative analysis. According to the qualitative analysis, three studies were found to be moderate, and five were strong. In addition, a thorough explanation of the responses to all of the questions of quality analysis was provided for each study. All eight studies were characterized as randomized control trials, with a level of evidence of level two. The study features, sample demographic information, diagnosis, and management strategies employed were all derived from the articles.

Seven of the included studies utilized Gufoni, three used Head-shaking, and four used Sham maneuver. The Gufoni maneuver had the highest success rate of the three, and these rates were comparable across all investigations. When Head-shaking maneuver was utilized alone, fair results were reported, but when paired with Barbecue, the rates increased. In comparison to the other two, Sham manuever had shown the least effectiveness.

The Gufoni maneuver and the Head-shaking maneuvers have been proven successful in resolving LC-BPPV symptoms with high repositioning success rates,

despite the differences in comparing treatments and follow-up time. However, the effectiveness of Head-shaking maneuver reduces when used alone as a treatment option. Based on these facts and the research results, it appears that the Gufoni maneuver is the most effective technique for treating apogeotropic LC-BPPV because of its short-term (single-treatment) complete cure rate.

5.1 Implications of the review

The study provides information on the treatment efficacy or utility of Gufoni, Head-shaking and Sham maneuvres in an individual with apogeotropic LC-BPPV. This study also suggests that the Gufoni maneuver is superior to the other. As a result, the findings of the study should be considered when deciding on a treatment option for apogeotropic LC-BPPV in clinical practise.

5.2 Strengths, limitations of the study, and future directions

The systematic review's primary strengths are as follows: There have been no previous studies of this kind. This review has precisely stated inclusion and exclusion criteria, along with a systematic search strategy, that allows for a verifiable methodology. All eight studies included were classified as level 2 evidence. The risk of bias was minimized because all three authors actively participated in the data collection process; the study characteristics are highlighted under categories of the quality analysis domains, and the outcomes are reported under three domains (success rate, unfavourable effect, and conclusions) in the summary table for each study.

The systematic review's significant limitations are as follows: Only two RCTs (Kim et al., 2012a) have truly compared the effectiveness of all three procedures listed in the study. Other databases such as Scopus, Cochrane, and others were unavailable for data extraction. There are only a few randomized controlled trials that compare the effectiveness of the liberatory maneuvers. Three studies had moderate methodological

quality (Fitzgerald, 2012; Song et al., 2015; Maranhão & Maranhão-Filho, 2015). As a result, the findings from such research cannot be generalized. Because all studies' outcome assessment duration differed, it is difficult to establish a correlation between the maneuvers' outcomes. Furthermore, various risk factors, such as high variability in treatment group distribution, differences in the follow-up time after treatment application, and combined results for apogeotropic and geotropic groups, may compromise the accuracy of these results.

Other than the focused approaches in the review, other techniques should be explored to gain a better understanding of the management of apogeotropic LC-BPPV. Therefore, a more thorough examination of this population is required, as well as the addition of various strategies for the treatment of apogeotropic LC-BPPV. This will also serve in selecting a strategy for patients with apogeotropic LC-BPPV that has a higher recovery rate than others. There are specific factors that influence the treatment process on a case-by-case basis; taking them into account as part of research will result in a better outcome clinically. A review of variables influencing the outcome of treatment procedures or variables that aid in the selection of the most appropriate therapeutic maneuver among all can be considered for future research in this area.

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APPENDIX I

Critical appraisal skill programme

Randomised Controlled Trial Standard Checklist

Study and citation: …….

Section A: Is the basic study design valid for a randomised controlled trial?			
1. Did the study address a clearly focused research question? CONSIDER: Was the study designed to assess the outcomes of an intervention? Is the research question 'focused' in terms of: • Population studied • Intervention given • Comparator chosen • Outcomes measured?	**Yes**	**No**	**Can't tell**
2. Was the assignment of participants to interventions randomised? CONSIDER: • How was randomisation carried out? Was the method appropriate? • Was randomisation sufficient to eliminate systematic bias? • Was the allocation sequence concealed from investigators and participants?	**Yes**	**No**	**Can't tell**
3. Were all participants who entered the study accounted for at its conclusion? CONSIDER: • Were losses to follow-up and exclusions after randomisation accounted for? • Were participants analysed in the study groups to which they were randomised (intention-to-treat analysis)? • Was the study stopped early? If so, what was the reason?	**Yes**	**No**	**Can't tell**
Section B: Was the study methodologically sound?			
4. Were the participants 'blind' to intervention they were given?	**Yes**	**No**	**Can't tell**

• Were the investigators 'blind' to the intervention they were giving to participants? • Were the people assessing or analysing outcome/s 'blinded'?			
5. Were the study groups similar at the start of the randomised controlled trial? CONSIDER: • Were the baseline characteristics of each study group (e.g. age, sex, socio-economic group) clearly set out? • Were there any differences between the study groups that could affect the outcome/s?	**Yes**	**No**	**Can't tell**
6. Apart from the experimental intervention, did each study group receive the same level of care (that is, were they treated equally)? CONSIDER: • Was there a clearly defined study protocol? • If any additional interventions were given (e.g. tests or treatments), were they similar between the study groups? • Were the follow-up intervals the same for each study group?	**Yes**	**No**	**Can't tell**
Section C: What are the results?			
7. Were the effects of intervention reported comprehensively? CONSIDER: • What outcomes were measured, and were they clearly specified? • How were the results expressed? For binary outcomes, were relative and absolute effects reported? • Were the results reported for each outcome in each study group at each follow-up interval? • Was there any missing or incomplete data? • Was there differential drop-out between the study groups that could affect the results? • Were potential sources of bias identified? • Which statistical tests were used? • Were p values reported?	**Yes**	**No**	**Can't tell**

8. Was the precision of the estimate of the intervention or treatment effect reported? CONSIDER: • Were confidence intervals (CIs) reported?	**Yes**	**No**	**Can't tell**
9. Do the benefits of the experimental intervention outweigh the harms and costs? CONSIDER: • What was the size of the intervention or treatment effect? • Were harms or unintended effects reported for each study group? • Was a cost-effectiveness analysis undertaken? (Cost-effectiveness analysis allows a comparison to be made between different interventions used in the care of the same condition or problem.)	**Yes**	**No**	**Can't tell**
Section D: Will the results help locally?			
10. Can the results be applied to your local population/in your context? CONSIDER: • Are the study participants similar to the people in your care? • Would any differences between your population and the study participants alter the outcomes reported in the study? • Are the outcomes important to your population? • Are there any outcomes you would have wanted information on that have not been studied or reported? • Are there any limitations of the study that would affect your decision?	**Yes**	**No**	**Can't tell**
11. Would the experimental intervention provide greater value to the people in your care than any of the existing interventions? CONSIDER: • What resources are needed to introduce this intervention taking into account time,finances, and skills development or training needs? • Are you able to disinvest resources in one or more existing interventions in order to be able to re-invest in the new intervention?	**Yes**	**No**	**Can't tell**

APPRAISAL SUMMARY: Record key points from your critical appraisal in this box.

What is your conclusion about the paper? Would you use it to change your practice or to recommend changes to care/interventions used by your organisation? Could you judiciously implement this intervention without delay?