The Epley (canalith repositioning) manoeuvre for benign paroxysmal positional vertigo (Review)

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[Intervention Review]

The Epley (canalith repositioning) manoeuvre for benign paroxysmal positional vertigo

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ABSTRACT

Background

This is an update of a Cochrane Review first published in *The Cochrane Library* in Issue 1, 2002 and previously updated in 2004 and 2007.

Benign paroxysmal positional vertigo (BPPV) is a syndrome characterised by short-lived episodes of vertigo in association with rapid changes in head position. It is a common cause of vertigo presenting to primary care and specialist otolaryngology clinics. Current treatment approaches include rehabilitative exercises and physical manoeuvres, including the Epley manoeuvre.

Objectives

To assess the effectiveness of the Epley manoeuvre for posterior canal BPPV.

Search methods

We searched the Cochrane Ear, Nose and Throat Disorders Group Trials Register; CENTRAL; PubMed; EMBASE; CINAHL; Web of Science; Cambridge Scientific Abstracts; ICTRP and additional sources for published and unpublished trials. The date of the most recent search was 23 January 2014.

Selection criteria

Randomised controlled trials of the Epley manoeuvre versus placebo, no treatment or other active treatment for adults diagnosed with posterior canal BPPV (including a positive Dix-Hallpike test). The primary outcome of interest was complete resolution of vertigo symptoms. Secondary outcomes were conversion of a 'positive' Dix-Hallpike test to a 'negative' Dix-Hallpike test and adverse effects of treatment.

Data collection and analysis

We used the standard methodological procedures expected by The Cochrane Collaboration.

Main results

We included 11 trials in the review with a total of 745 patients.

Five studies compared the efficacy of the Epley manoeuvre against a sham manoeuvre, three against other particle repositioning manoeuvres (Semont, Brandt-Daroff and Gans) and three against a control (no treatment, medication only, postural restriction). Patients were treated in hospital otolaryngology departments in eight studies and family practices in two studies. All patients were adults aged 18 to 90 years old, with a sex ratio of 1:1.5 male to female.

There was a low risk of overall bias in the studies included. All studies were randomised with six applying sealed envelope or external allocation techniques. Eight of the trials blinded the assessors to the participants' treatment group and data on all outcomes for all participants were reported in eight of the 11 studies.

Complete resolution of vertigo

Complete resolution of vertigo occurred significantly more often in the Epley treatment group when compared to a sham manoeuvre or control (odds ratio (OR) 4.42, 95% confidence interval (CI) 2.62 to 7.44; five studies, 273 participants); the proportion of patients resolving increased from 21% to 56%. None of the trials comparing Epley versus other particle repositioning manoeuvres reported vertigo resolution as an outcome.

Conversion of Dix-Hallpike positional test result from positive to negative

Conversion from a positive to a negative Dix-Hallpike test significantly favoured the Epley treatment group when compared to a sham manoeuvre or control (OR 9.62, 95% CI 6.0 to 15.42; eight studies, 507 participants). There was no difference when comparing the Epley with the Semont manoeuvre (two studies, 117 participants) or the Epley with the Gans manoeuvre (one study, 58 participants). In one study a single Epley treatment was more effective than a week of three times daily Brandt-Daroff exercises (OR 12.38, 95% CI 4.32 to 35.47; 81 participants).

Adverse effects

Adverse effects were infrequently reported. There were no *serious* adverse effects of treatment. Rates of nausea during the repositioning manoeuvre varied from 16.7% to 32%. Some patients were unable to tolerate the manoeuvres because of cervical spine problems.

Authors' conclusions

There is evidence that the Epley manoeuvre is a safe, effective treatment for posterior canal BPPV, based on the results of 11, mostly small, randomised controlled trials with relatively short follow-up. There is a high recurrence rate of BPPV after treatment (36%). Outcomes for Epley manoeuvre treatment are comparable to treatment with Semont and Gans manoeuvres, but superior to Brandt-Daroff exercises.

PLAIN LANGUAGE SUMMARY

The Epley manoeuvre for benign paroxysmal positional vertigo (BPPV)

Background

Benign paroxysmal positional vertigo (BPPV) is caused by a rapid change in head movement. The person feels they or their surroundings are moving or rotating. Common causes are head trauma or ear infection. BPPV can be caused by debris in the semicircular canal of the ear, which continues to move after the head has stopped moving. This causes a sensation of ongoing movement that conflicts with other sensory information. The Epley manoeuvre is a treatment that is performed by a doctor (or other health personnel with appropriate training, e.g. audiological scientist, physiotherapist) and involves a series of four movements of the head and body from sitting to lying, rolling over and back to sitting. It is understood to work by moving the canal debris out of the semicircular canal. This linked video demonstrates how the Epley manoeuvre is performed.

Study characteristics

We included 11 studies in the review, with a total of 745 participants. Five studies (334 patients) compared the efficacy of the Epley manoeuvre against a sham manoeuvre, three against other particle repositioning manoeuvres (Semont, Brandt-Daroff and Gans) and three with a control (no treatment, medication only, postural restriction). Patients were treated in hospital otolaryngology (ear, nose

and throat) departments in eight studies and family practices in two studies. All patients were adults aged 18 to 90 years old, with a sex ratio of 1:1.5 male to female.

Key results

For resolution of vertigo the Epley manoeuvre was significantly more effective than a sham manoeuvre or control. None of the trials that compared Epley versus other particle repositioning manoeuvres reported vertigo resolution as an outcome.

When studies looked at the conversion from a positive to a negative Dix-Hallpike test (a test to diagnose BPPV) in the patients, the results significantly favoured the Epley treatment group when compared to a sham manoeuvre or control. There was no difference when Epley was compared with the Semont or Gans manoeuvre. In one study a single Epley treatment was more effective than a week of three times daily Brandt-Daroff exercises.

Adverse effects were not often reported. There were no serious adverse effects of treatment. Rates of nausea during the repositioning manoeuvre varied from 16.7% to 32%. Some patients were unable to tolerate the manoeuvres because of cervical spine (neck) problems.

The review of trials found that the Epley manoeuvre is safe and effective in the short term. Other specific sequences of physical movements, the Semont and Gans manoeuvres, have similar results.

Quality of the evidence

There was a low risk of overall bias in the studies included. All trials were randomised, with five studies applying sealed envelope or external allocation techniques. Seven of the trials blinded the assessors to the patients' treatment group and data on all outcomes for all participants were reported in most studies. This evidence is up to date to January 2014.

BACKGROUND

Description of the condition

This is an update of a Cochrane review first published in *The Cochrane Library* in Issue 1, 2002 and previously updated in 2004, 2007 and 2010.

Benign paroxysmal positional vertigo (BPPV) is a syndrome characterised by short-lived episodes of vertigo (a sensation of instability, often with a sensation of rotation) in association with rapid changes in head position. It is a common cause of vertigo presenting to primary care and specialist otolaryngology, neuro-otology, neurology and audiological clinics. There are a number of aetiologies associated with secondary BPPV. Common causes appear to be head trauma (17%) and vestibular neuritis (inflammation or infection of the nerve supplying the vestibule; an important part of the balance system) (15%) (Baloh 1987). Other putative causes include vertebrobasilar ischaemia (reduced blood flow in the area of the brain supplied by the basilar artery), labyrinthitis (inflammation or infection of the inner ear), as a complication of middle ear surgery and following periods of prolonged bed rest. However, most cases appear to be idiopathic (without known cause), with secondary BPPV being responsible for approximately 10% of cases (von Brevern 2007). Presentation may be atypical in elderly patients: less typical positioning symptoms and more frequent complaints of dizziness between attacks, leading to delayed diagnosis and subsequent treatment (Oghalai 2000)

Incidence and prevalence

The peak incidence of idiopathic BPPV is between 50 and 70 years of age, although the condition is found amongst all age groups. The incidence of idiopathic BPPV ranges from 11 to 64 per 100,000 per year (Froehling 1991; Mizukoshi 1988), increases by approximately 38% per decade of life and is twice as common in females as males. The lifetime prevalence is 2.4% (von Brevern 2007). Sex distribution is about equal for post-traumatic and post-vestibular neuritis (Baloh 1987; Katsarkas 1978).

Aetiology

Balance is normally achieved by brain centres that monitor and synthesise information from the eyes, the vestibular system (part of the inner ear) and position sensors in major joints. Angular acceleration (i.e. turning movements) is detected by the semicircular canals. There are three semicircular canals set in orthogonal planes in each ear (six semicircular canals in total: each ear providing reciprocal information) and they are therefore well placed to detect angular acceleration in any plane of head movement. The

lateral semicircular canals are filled with a fluid called endolymph. The main sense organ in each canal is called the crista, which is stimulated by movement of the cupula. Head rotation causes relative movement of the endolymph in the semicircular canal, which bends the cupula and the embedded hairs of the hair cells and causes stimulation of the relevant vestibular nerve.

The cause of benign positional vertigo is believed to be canalithiasis, principally affecting the posterior semicircular canal. In canalithiasis, free-floating debris in the semicircular canal is hypothesised to act like a plunger, causing continuing movement of the endolymph even after head movement has ceased. This causes movement of the cupula and bending of the hairs of the hair cells, and provokes vertigo.

An alternate theory, cupulolithiasis, asserts that canal debris becomes attached to the cupula whose specific gravity is normally the same as endolymph but with attached debris would become heavier, thus responding to any change in gravitational position of the head (rather than angular acceleration).

The latter theory has become less favoured, in part, with the introduction of positioning techniques to treat BPPV. With free-floating debris (canalithiasis), successively turning the head should continue to provoke nystagmus (repeated jerky movements of the eyes) in the same direction if the direction of rotation remains constant: the debris sinks to the most gravitationally dependent position of the canal each time. However, cupulolithiasis would predict a change in direction of the nystagmus as the head continues to turn. The heavy cupula under the influence of gravity should deviate in the opposite direction as the crista of the semicircular canal passes through the vertical plane. Clinical observation during positional manoeuvres confirms that when the direction of rotation is constant the direction of the nystagmus remains the same. The horizontal and anterior canals may also be affected by canalithiasis, although less frequently. When the aetiology is secondary to a labyrinthitis or end organ ischaemic injury (reduced blood supply causing damage to vital sensory cells) other components of the vestibular system in addition to a discrete posterior semicircular canal lesion may be affected.

Symptoms

Patients with posterior canal BPPV typically have episodic vertigo in association with a rapid change in head position, particularly movement relative to gravity and involving neck extension. The vertigo typically lasts for anything from a few seconds to one minute. Attacks may be associated with nausea, and the nausea may persist for much longer than the sensation of vertigo: sometimes for a few hours. Typical manoeuvres provoking vertigo include lying down in bed, extending the neck to reach up for objects on high shelves, bending over and sitting up from supine. A patient's balance is usually normal between episodes. Exceptions to this would be those situations in which BPPV occurs in association with a partial vestibular paresis, e.g. following vestibular neuronitis or labyrinthitis, where sudden head movements of any sort may provoke momentary sense of vertigo, or aetiologies such as ischaemic end organ damage that compromise other vestibular receptors. Horizontal canal BPPV typically causes vertigo when turning over in bed from side to side.

Many cases of BPPV resolve spontaneously within a few weeks or months. Attacks tend to occur in clusters and symptoms may recur after an apparent period of remission. It is important to distinguish BPPV from central positional vertigo (which may occur with multiple sclerosis, cerebellar disease and brainstem ischaemia), in which one of more of the classical features of BPPV will be absent. There may be no latent period, no fatiguability of the nystagmus, nystagmus which is not classically rotatory and the provocation is not always associated with nausea or a sensation of vertigo, which is typically quite intense for patients with BPPV.

Diagnosis

The Dix-Hallpike test (Hallpike manoeuvre) (Dix 1952), or the lateral head-trunk tilt (Brandt 1999), are used to confirm the diagnosis of posterior canal BPPV. A positive test provokes vertigo and nystagmus when a patient is rapidly moved from a sitting position to lying with the head tipped 45 degrees below the horizontal, 45 degrees to the side and with the side of the affected ear (and semicircular canal) downwards. (Please see linked video demonstrating a positive Dix-Hallpike test). The nystagmus typically has a latency of a few seconds before onset and fatigues after approximately 30 to 40 seconds. The nystagmus is rotatory with the fast phase beating towards the lower ear (geotropic). The nystagmus adapts with repeated testing. Further investigation is not recommended or required to make the diagnosis of BPPV in this clinical context (Bhattacharyya 2008). The sensitivity and specificity of the Dix-Hallpike test are 79% (95% confidence interval (CI) 65% to 94%) and 75% (95% CI 33% to 100%) respectively (Halker 2008). Optic fixation (the eyes being able to fix on a specific object) may reduce the severity of the nystagmus and it is possible to test patients wearing Frenzel glasses (glasses with strong prisms for lenses, which remove the ability of the eyes to focus on an object). However, increasing the sensitivity of the Hallpike manoeuvre by wearing Frenzel glasses will reduce its specificity, since asymptomatic normal subjects can develop positional nystagmus on positional testing when optic fixation is removed. A proportion of patients with a typical history of posterior canal BPPV, who have a negative Hallpike manoeuvre on the first occasion, may demonstrate a positive test on retesting after a period of a few days, or have reproducible symptoms and paroxysmal nystagmus when testing with positional electronystagmography. (ENG involves a special headset worn by the patient during positional movements. Any eye movements are objectively measured and recorded by electrodes placed around the eyes) (Norre 1995). There are no other specific investigations that can confirm or exclude the diagnosis of BPPV.

Treatment *o*ptions

There are a number of treatment options available for posterior canal BPPV. In many cases, spontaneous remission occurs before medical advice is sought, and patients may simply seek an explanation for their symptoms without needing or demanding treatment. Regular medication (e.g. betahistine hydrochloride, prochlorperazine) is rarely prescribed as a treatment since there is no pathophysiological rationale for these agents to be effective, although vestibular suppressants and antihistamines may provide partial relief of nausea that can persist after acute attacks.

In extreme circumstances, patients with frequent episodes of intractable vertigo showing no sign of spontaneous remission may require or seek surgical treatment. This includes vestibular neurectomy, where the singular nerve which selectively supplies the posterior semicircular canal is divided. Although the debris may continue to cause abnormal deflection of the cupula, the resulting sensory signal can no longer reach the brainstem for higher processing. In posterior semicircular canal obliteration surgery the posterior semicircular canal is exposed by drilling away part of the mastoid bone, and then packed firmly to obliterate the endolymphatic channel, thus also effectively removing the ability of the semicircular canal to produce aberrant sensory information.

Description of the intervention

The Epley manoeuvre

Brandt-Daroff exercises (Brandt 1980) and canalith repositioning manoeuvres (Epley 1992; Semont 1988) are the main therapies for most patients who seek active treatment for their symptoms. They are purported to act by dispersion of the canal debris from the posterior semicircular canal into the utricle, where it is inactive. These modalities of treatment all have a sequence of head and/or trunk positioning manoeuvres as a common factor. In recent years the Epley manoeuvre has become particularly popular (Epley 1992). The technique involves a series of four movements of the head and body from sitting to lying, rolling over and back to sitting. (Please see linked video demonstrating how the Epley manoeuvre is performed). The technique can be modified by the addition of a headband which vibrates, putatively to encourage the movement of the particles through the semicircular canals (Li 1995).

Why it is important to do this review

BPPV is a common cause of vertigo presenting in both primary and secondary care. It is both unpleasant to experience as a symptom and restricts activities. The Epley manoeuvre is a precise but relatively straightforward therapy that can be administered by a range of suitably trained healthcare professionals in a variety of healthcare settings.

OBJECTIVES

To assess the effectiveness of the Epley manoeuvre for posterior canal BPPV.

METHODS

Criteria for considering studies for this review

Types of studies

Randomised controlled trials.

Types of participants

Participants should be adults (age greater than 16 years) who have a clinical diagnosis of benign paroxysmal positional vertigo. The clinical diagnosis must state that the patient had a positive Dix-Hallpike positional test with clear and classical features of positional nystagmus.

Types of interventions

Epley manoeuvre (as classically described).

Comparison interventions:

- Placebo
- Medication
- Positional exercises
- Other canalith repositioning procedures
- Vestibular neurectomy
- Posterior semicircular canal obliteration surgery

Comparisons sought:

- Epley manoeuvre versus placebo
- Epley manoeuvre versus untreated controls
- Epley manoeuvre versus other active treatment

Types of outcome measures

Primary outcomes

- Complete resolution of vertigo symptoms.

Secondary outcomes

- Conversion of a positive Dix-Hallpike test to a negative Dix-Hallpike test. (Although this could be considered a spurious outcome measure since it has no relevance to a patient's perception of their condition, it is the only relatively objective sign of improvement).
- Adverse effects of treatment.

Search methods for identification of studies

We conducted systematic searches for randomised controlled trials. There were no language, publication year or publication status restrictions. The date of the last search was 23 January 2014, following previous searches in March 2013, May 2010, September 2009, July 2006, September 2003 and 2001.

Electronic searches

We searched the following databases from their inception: the Cochrane Ear, Nose and Throat Disorders Group Trials Register; the Cochrane Central Register of Controlled Trials (CENTRAL 2013, Issue 12); PubMed; EMBASE; CINAHL; AMED; LILACS; KoreaMed; IndMed; PakMediNet; CAB Abstracts; Web of Science; ISRCTN; ClinicalTrials.gov; ICTRP; Google and Google Scholar. In search updates prior to 2013 we also searched BIOSIS Previews and CNKI.

We modelled subject strategies for databases on the search strategy designed for CENTRAL. Where appropriate, we combined subject strategies with adaptations of the highly sensitive search strategy designed by The Cochrane Collaboration for identifying randomised controlled trials and controlled clinical trials (as described in the*Cochrane Handbook for Systematic Reviews of Interventions* Version 5.1.0, Box 6.4.b. ((Handbook 2011)). Search strategies for major databases including CENTRAL are provided in Appendix 1.

Searching other resources

We scanned reference lists of identified studies for further trials. We searched PubMed, TRIPdatabase and Google to retrieve existing systematic reviews possibly relevant to this systematic review, in order to search their reference lists for additional trials. We sought abstracts from conference proceedings via the Cochrane Ear, Nose and Throat Disorders Group Trials Register.

Data collection and analysis

Selection of studies

One author scanned the search results to identify trials that appeared broadly to address the subject of the review. Both authors scrutinised the full text of these articles for eligibility.

Data extraction and management

Two authors independently extracted data from the studies using standardised data forms. Any differences between authors were resolved by discussion and consensus.

Assessment of risk of bias in included studies

Two authors undertook assessment of the risk of bias of the included trials independently, with the following taken into consideration, as guided by the*Cochrane Handbook for Systematic Reviews of Interventions* (Handbook 2011):

- sequence generation;
- allocation concealment;
- blinding;
- incomplete outcome data;
- selective outcome reporting; and
- other sources of bias.

We used the Cochrane 'Risk of bias' tool in RevMan 5.3 (RevMan 2014), which involves describing each of these domains as reported in the trial and then assigning a judgement about the adequacy of each entry: 'low', 'high' or 'unclear' risk of bias.

Data synthesis

Where studies were comparable, we pooled data using an odds ratio with 95% confidence interval. We assessed heterogeneity using the I^2 statistic, which describes the percentage of the variability in effect estimates that is due to heterogeneity rather than sampling error (chance).

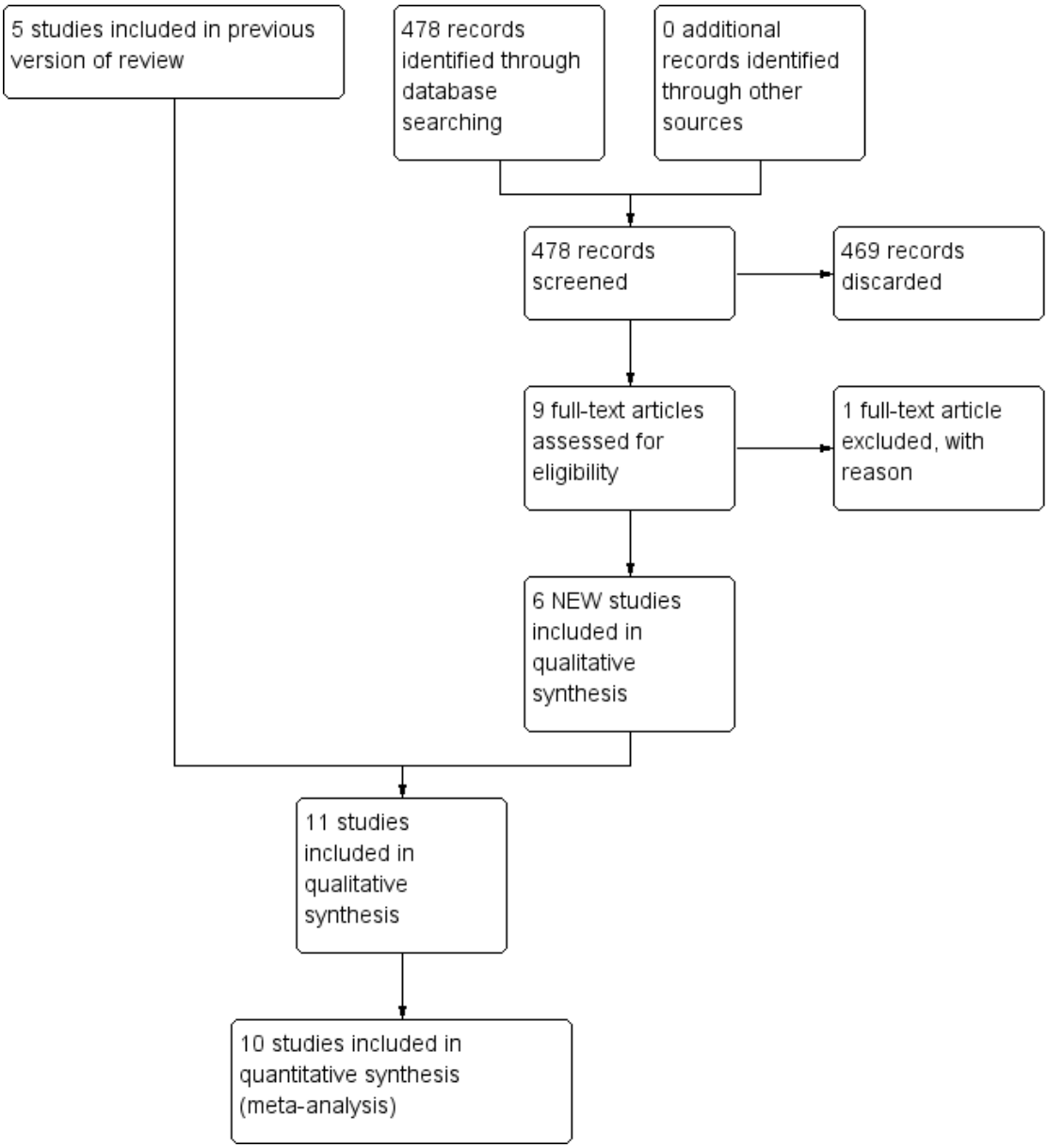
RESULTS

Description of studies

Results of the search

From the 2014 update searches we retrieved a total of 478 references: we removed 469 of these in first-level screening and on the basis of the abstract. We identified no further trials from scanning reference lists. Two articles are awaiting assessment at the time of publication (Dashti Gholamali 2010; Okhovat 2003) (see Characteristics of studies awaiting classification). We identified no ongoing studies. We included six new studies in the review (Amor Dorado 2012; Bruintjes 2014; Dispenza 2012; Liang 2010; Mazoor 2011; Xie 2012), and excluded one further study (Arbaç 2003). See Figure 1 (study flow diagram).

Figure 1. Study flow diagram.



In 2010, update searches retrieved a total of 412 references: we removed 270 of these in first-level screening (i.e. removal of duplicates and clearly irrelevant references), leaving 142 references for further consideration. We excluded 138 on the basis of the abstract. We identified two further trials for consideration from a scan of the reference lists of a recent review article (Bhattacharyya 2008). Screening the references of second recent review did not identify any further trials (Helminski 2010). There were no trials in progress or awaiting assessment. We included two new studies (Munoz 2007; von Brevern 2006).

The original version of this review (2002) included two studies (Froehling 2000; Lynn 1995); we included one further study at update in 2004 (Yimtae 2003).

Included studies

A total of 11 studies, totalling 745 patients are included in the review (Amor Dorado 2012; Bruintjes 2014; Dispenza 2012; Froehling 2000; Liang 2010; Lynn 1995; Mazoor 2011; Munoz 2007; von Brevern 2006; Xie 2012; Yimtae 2003). See Characteristics of included studies for study details.

Design

All 11 studies were randomised controlled trials. The assessors were blinded in eight trials. In four trials the patients were also blinded by receiving a realistic 'sham' physical treatment.

Sample sizes

Sample sizes were generally small, ranging from 36 to 103 patients in total, with published data on a total of 745 patients.

Setting

Two trials were conducted in a primary care setting (Munoz 2007; Xie 2012); the remainder were conducted in secondary or tertiary care in otolaryngology departments.

Participants

All the trials addressed the diagnosis and treatment of BPPV in adults only. The age range of participants was 18 to 90 years. The male to female ratio was 1:1.5 across the seven trials where gender was listed as a baseline characteristic.

In 10 of the studies a clinical diagnosis of BPPV was based on clinical history and examination including a positive Dix-Hallpike test. Where the inclusion criteria did not explicitly state a positive Dix-Hallpike test for inclusion, the application of a negative Dix-Hallpike test as an outcome suggested that a positive test was implicit in the diagnosis of BPPV for inclusion and we assumed this.

One trial applied an alternative provocation test (Dispenza 2012), a side-lying test to reproduce symptoms in the patients (Halker 2008). Although less commonly used than the Dix-Hallpike test it is a recognised assessment tool and does not introduce bias into the trial since it was applied across all treatment groups.

Interventions

Only one trial compared the treated group against untreated controls (Yimtae 2003). Four studies from earlier versions of the published review and one recent publication used 'sham' treatments that were comparable to an Epley treatment in terms of movement, time taken and contact with researchers. Other recent studies sought to compare the Epley treatment against the Semont manoeuvre (Dispenza 2012; Mazoor 2011), Brandt-Daroff exercises (Amor Dorado 2012), and the hybrid Gans manoeuvre (Dispenza 2012). In two studies, all patients had either medication (Liang 2010) or postural restrictions (Xie 2012) prescribed and the experimental group received the Epley treatment as an additional intervention.

Outcomes

All trials reported conversion of the Dix-Hallpike test from positive to negative as a primary outcome measure. Three trials made no mention of symptoms at follow-up, reporting only the result of the Dix-Hallpike test (Amor Dorado 2012; Dispenza 2012; Mazoor 2011). Two studies asked participants to complete a diary of symptoms (Froehling 2000; Lynn 1995). Other studies relied solely on patients' reports of symptoms during repeat Dix-Hallpike testing at follow-up (Munoz 2007; von Brevern 2006). Most trials reported symptoms only up to four weeks maximum. In two trials, the effect of treatment was assessed immediately or after only 24 hours (Munoz 2007; von Brevern 2006). However, two trials reported long-term follow-up of patients up to and including one year and four years respectively after treatment, considering the rate and frequency of recurrence as a secondary outcome measure of the trial (Amor Dorado 2012; Bruintjes 2014).

Excluded studies

The methodological quality of the identified studies was generally low and we excluded 18 because of concern about a high probability of bias. The source of bias leading to exclusion in the majority of trials was inadequate sequence generation and allocation concealment. There was no disagreement between the authors about inclusion/exclusion of studies. See Characteristics of excluded studies.

Risk of bias in included studies

Allocation

Six studies reported computer-generated randomisation with sealed envelopes or external allocation techniques. The remaining trials all stated that they were randomised but did not provide details of the randomisation strategy or allocation concealment.

Blinding

In eight of the trials patients were assessed by faculty staff who were blinded to the treatment. In four of the trials the patients were also blinded to their treatment by being administered a realistic (but non-therapeutic) sham positioning treatment. Of the remaining three trials, one stated that assessors were not blinded and two trials did not comment.

Incomplete outcome data

Eight of the 11 trials reported data from all patients entered into the study. In three trials, it is unclear from the report whether the number of patients completing the trial, for whom data are reported, was the number of patients recruited.

Selective reporting

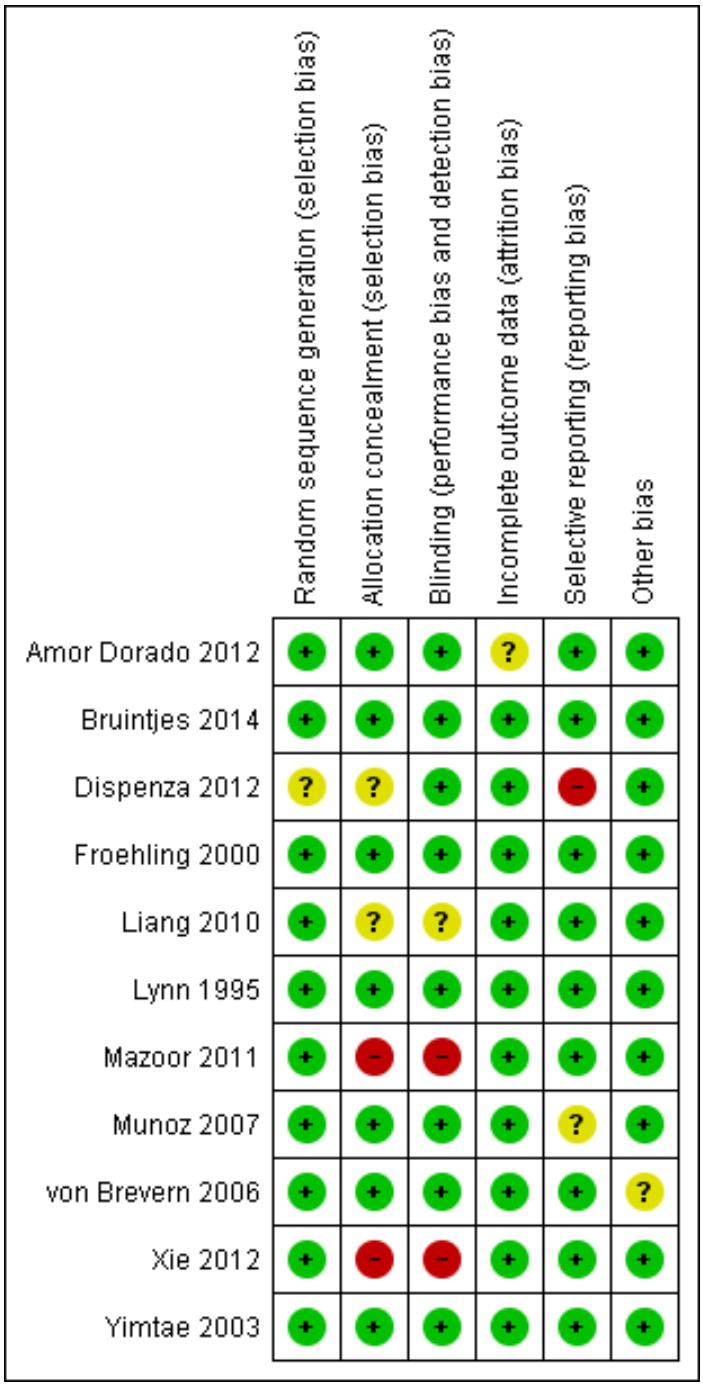
Ten of the 11 trials reported all outcome data for all available patients. In Munoz 2007, published data relate to retesting immediately after the treatment manoeuvre had been administered. Patients were retested at one week with a Dix-Hallpike test before another treatment (if needed). These data were collected but not published and were not made available after a direct request to the principal author.

Other potential sources of bias

In von Brevern 2006, there was no explanation of the disparity in the number of patients in the treatment versus the control groups (58 versus 45).

Our judgements about each risk of bias item for each included study can be found in the 'Risk of bias' summary (Figure 2).

Figure 2. 'Risk of bias' summary: review authors' judgements about each risk of bias item for each included study.



Effects of interventions

The 11 included trials comprised a total of 745 patients.

Epley manoeuvre versus sham (placebo) manoeuvre or control

Complete resolution of vertigo symptoms

Four trials report symptom outcome as a dichotomous variable, where success was defined as complete resolution of symptoms (Froehling 2000; Lynn 1995; Munoz 2007; von Brevern 2006). No attempt was made to analyse differences in groups of patients who were improved but still had symptoms, or patients who failed to improve. Yimtae 2003 graded symptoms, but for the purpose of analysis these have been combined to give data for complete resolution, or not. A statistically significant difference in symptom resolution in favour of the treatment group was observed in each trial. Pooled trial data yield an odds ratio (OR) of 4.42 (95% confidence interval (CI) 2.62 to 7.44; five studies, 273 participants; I^2 = 71%) in favour of treatment (Analysis 1.1).

Conversion of a positive Dix-Hallpike test to a negative Dix-Hallpike test

In all trials there was a statistically significant difference in the conversion from a positive to a negative Dix-Hallpike test in favour of the treatment group. Pooled trial data yield an odds ratio of 9.62 (95% CI 6.0 to 15.42; eight studies, 507 participants, I^2 = 68%) in favour of treatment (Analysis 1.2).

In the two studies, which treated all patients with an 'active' treatment (either medication or postural restriction exercises) and then randomised half the patients to receive additionally a modified Epley treatment, the outcomes were reported as a composite measure of symptom resolution and Hallpike test result (Liang 2010; Xie 2012). For the purposes of analysis this has been rationalised to a dichotomous variable of 'cured' versus 'persisting symptoms'. There was a statistically significant effect of treatment in each trial at seven days, favouring the group that also received an Epley treatment in each case: OR 12.35 (95% CI 1.51 to 101.36) for Liang 2010 and OR 41.73 (95% CI 12.29 to 141.65) for Xie 2012.

Adverse effects of treatment

There were few reported adverse effects and no serious complications of treatment. The only reported problems were inability to tolerate the positioning manoeuvres because of cervical spine problems and emesis (vomiting) during the treatment (Froehling 2000).

Epley manoeuvre versus other active treatment

Complete resolution of vertigo symptoms

None of the three trials comparing the Epley manoeuvre to other treatments reported vertigo resolution as a primary outcome.

Conversion of a positive Dix-Hallpike test to a negative Dix-Hallpike test

Amor Dorado 2012 compared Epley treatment (as a single administered manoeuvre) versus Brandt-Daroff exercises performed three times daily for one week. There was an 80.5% resolution rate in the Epley group versus 25% resolution in the Brandt-Daroff exercises group after seven days (Analysis 2.1). There was no difference in resolution after one month, although the number of patients in each group was not provided. After one month, nine of 40 patients in the Brandt-Daroff group dropped out and were treated with the Epley manoeuvre so comparative data for longer-term symptom control are not available.

It is noteworthy that this is the only trial which addresses long-term recurrence of symptoms in a systematic way. In total, 15 patients (36.5%) in the Epley treatment group experienced recurrence of symptoms over 48 months. Six patients (15%) experienced two recurrences. One patient (2.5%) experienced three recurrences. Although there are potentially confounding factors relating to patients dropping out of the Brandt-Daroff group, it is salient to note that for the remaining 31 patients in this group long-term recurrence rates and time to first episode of recurrence were not significantly different.

Dispenza 2012 and Mazoor 2011 both compared Epley treatment with the Semont manoeuvre. There was no difference between treatments in resolution of nystagmus for pooled data at the seven-day post-treatment point: OR 0.78 (95% CI 0.32 to 1.88; two studies, 117 participants; I^2 = 26%) (Analysis 3.1).

In addition, Dispenza 2012 compared Epley treatment with the hybrid Gans manoeuvre. There was no difference between treatments in resolution of nystagmus at the seven-day post-treatment point: OR 0.67 (95% CI 0.18 to 2.52; one study, 58 participants) (Analysis 4.1).

Adverse effects of treatment

Rates of nausea varied from 16.7% to 32% (Amor Dorado 2012; Mazoor 2011), and nausea was also found for patients treated with the Semont manoeuvre. There was no difference between treatment groups.

DISCUSSION

The 28 studies identified by the search strategy as being trials of the Epley manoeuvre in the treatment of posterior canal benign paroxysmal positional vertigo (BPPV) were generally of low methodological quality, particularly in the key areas of allocation concealment and blinding of assessors to outcome. The principal patient-orientated outcome variable is subjective: resolution of a patient's symptoms of vertigo. We considered assessor blinding to be an important issue. Conversion to a negative Hallpike manoeuvre is the only objective marker of any physiological change resulting from treatment. Many patients, especially with relatively mild symptoms, can develop sophisticated strategies to avoid provoking symptoms on a day-to-day basis, and may self report as being 'symptom-free', but will still experience typical vertigo with appropriate provocation during a Dix-Hallpike test. Its inclusion as a secondary outcome measure is considered an important outcome variable.

We included 11 studies in the review (Amor Dorado 2012; Bruintjes 2014; Dispenza 2012; Froehling 2000; Liang 2010; Lynn 1995; Mazoor 2011; Munoz 2007; von Brevern 2006; Yimtae 2003; Xie 2012); these compared the efficacy of the Epley manoeuvre against a sham manoeuvre or control group, or other particle repositioning manoeuvres. Individual and pooled data showed a statistically significant effect in favour of the Epley manoeuvre over controls. There was no difference in resolution in comparison to the Semont manoeuvre. The Epley treatment resulted in a significantly higher resolution at seven days when compared to Brandt-Daroff exercises but after one month no difference was found.

The natural resolution of BPPV is an extremely important issue. In two included studies, 20% of control patients had resolution of their symptoms and 27% (Lynn 1995) and 38% (Froehling 2000) of control patients were found to have a negative Hallpike manoeuvre at follow-up. This emphasises that the natural history of posterior canal BPPV is for spontaneous resolution over time. In one of the studies included at the 2010 update, the authors explicitly stated that they sought to re-test patients after only 24 hours in an attempt to delineate the specific effect of treatment by minimising the confounding factor of spontaneous resolution (von Brevern 2006). We excluded a study because although well randomised it was unblinded (Asawavichianginda 2000). Nonetheless, it does not seem inappropriate to note that after three months 84% of the control group (n = 25) who received no treatment had converted to a negative Hallpike manoeuvre. The majority of participants recruited in this study had symptoms for less than two weeks before inclusion in the trial. This would suggest that trials that include patients very early in the course of their disease and have only modest numbers may report no benefit of treatment if a large spontaneous resolution rate overshadows a genuine benefit of treatment (a type II statistical error: failing to demonstrate a real difference between treatment and control). This is precisely the circumstance where meta-analysis may clarify a treatment effect that is not explicit from individual randomised controlled trials. In contrast, the trial by Sridhar et al found only a 15% spontaneous resolution rate in the control group after 12 months (Sridhar 2003). This variation is the most likely explanation for the heterogeneity noted in resolution of vertigo symptoms (Analysis 1.1), where patients were recruited from different settings (tertiary care, secondary care, family practice) with varying duration of symptoms prior to inclusion. The natural history of untreated BPPV therefore remains unclear. If more trials are included in future updates of this review, we will consider a sensitivity analysis examining the effect size stratified by mean (or median) symptom duration. It might seem attractive to consider a 'minimum duration of symptoms' as a specific requirement for patient or trial inclusion in the review. However, such a decision would inevitably introduce a rather arbitrary inclusion criterion as there is no well founded basis for choosing a specific time period. Furthermore, imposing this type of criterion does not reflect day-to-day clinical practice. Most practitioners would offer a patient with BPPV treatment with the Epley manoeuvre at their first presentation, rather than deferring treatment to allow for the possibility of spontaneous resolution, irrespective of the duration of their symptoms. If one accepts that the mechanism producing symptoms of posterior canal BPPV is similar for patients irrespective of symptom duration (as seems intuitive), there is no obvious reason why the Epley manoeuvre should be more or less effective at different times between the onset of the disease and its natural resolution. What is perhaps surprising is that the condition resolves spontaneously at all.

Adverse effects of treatment

Absence of serious side effects is particularly important for a treatment that is targeted at a condition that would be expected to resolve spontaneously over time in the majority of individuals.

Confounding factors

Long-term follow-up was lacking in most of the included studies. Lynn 1995 and Yimtae 2003 assessed patients one month after treatment completion and Froehling 2000 assessed patients between one and two weeks after completion. Amor Dorado 2012 was notable in following patients for a period of 48 months after treatment. This demonstrated a 36% overall recurrence rate of BPPV. This study did not include untreated controls and it is not possible to comment on whether particle repositioning manoeuvres affect the long-term recurrence rate. Bruintjes 2014 followed patients for one year and in contrast found that of the 21 of 22 patients with symptom resolution after initial treatment, this effect was maintained at the 12-month follow-up with no recurrence.

AUTHORS' CONCLUSIONS

Implications for practice

There is evidence that the Epley manoeuvre is a safe, effective treatment for posterior canal BPPV, based on the results of 745 patients in 11, mostly small, randomised controlled trials.

Long-term recurrence of BPPV is common, with up to 36% of patients experiencing symptom recurrence over 48 months after successful initial treatment with the modified Epley manoeuvre, although research evidence on this subject is conflicting and based on only two small trials.

There is evidence from small numbers of patients that the Epley manoeuvre is comparable to the Semont and Gans manoeuvre for posterior canal BPPV, but more effective than Brandt-Daroff exercises in the short term.

Implications for research

Further research in this field should consider the following criteria.

1. The use of a rigorous randomisation technique with respect to adequate pre-allocation concealment.

2. Stratified randomisation of participants based on duration of symptoms. This may help to address the concern that a high proportion of patients with short symptom duration may experience spontaneous remission of the disease during the study period.

3. The blinding of outcome assessors.

4. The inclusion of a post-treatment Hallpike manoeuvre as part of the reported results.

5. Long-term follow-up of patients.

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* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Amor Dorado 2012

Methods	**Allocation:** prospective randomised controlled trial **Design:** parallel
Participants	**Number:** 81 patients **Age:** mean age 59 **Gender:** not reported **Setting:** hospital otolaryngology department **Eligibility criteria:** minimum duration of symptoms 1 week. Typical symptoms with positive Dix-Hallpike test and no prior treatment for BPPV **Exclusion criteria:** patients who did not develop typical nystagmus on Dix-Hallpike testing, and previous cervical spine injury **Baseline characteristics:** symptoms present for mean of 50/57 days prior to treatment. Greater proportion of men in Epley group (62%) versus Brandt-Daroff group (39%) (P value = 0.05)
Interventions	**Intervention group:** modified Epley manoeuvre n = 40 **Comparator group:** Brandt-Daroff exercises (5 cycles, TDS for 1 week) n = 41 **Use of additional interventions:** not reported
Outcomes	**Primary outcome:** percentage of patients with a negative Dix-Hallpike test after treatment **Secondary outcomes:** 1. Short- and long-term recurrence of symptoms, assessed at 7 days, then 1, 6, 12, 24, 36 and 48 months 2. Adverse effects of treatment
Notes	-

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated
Allocation concealment (selection bias)	Low risk	Remote external allocation of group
Blinding (performance bias and detection bias) All outcomes	Low risk	Assessor blind to treatment group

Amor Dorado 2012 (*Continued*)

Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Data are reported only for patients who had 48 months of follow-up. It is unclear whether there was complete follow-up, or whether this represented only a proportion of patients who were entered into the trial
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	-

Bruintjes 2014

Methods	**Allocation**: randomised, double-blind, sham-controlled trial **Design**: parallel allocation
Participants	**Number**: 44 patients **Age**: mean age 59, all over 18 **Gender**: 18 male, 26 female **Setting**: multidisciplinary dizziness clinic in teaching hospital **Eligibility criteria**: typical history and classic Dix-Hallpike test **Exclusion criteria**; previous Epley treatment, cervical disc herniation, severe communication problem **Baseline characteristics**: sham patients slightly older than Epley group (62.5 versus 55. 7 years; P value = 0.08) and patients in Epley group had lower median DHI score (23 (range 8 to 66) versus 33 (range 16 to 72); P value = 0.08)
Interventions	Intervention group: modified Epley manoeuvre, repeated up to 2 times if persistent positive Dix-Hallpike test Control group: sham manoeuvre (similar to Semont diagnostic manoeuvre), repeated up to 2 times All patients advised to sleep propped up for 48 hours and to avoid lying on affected side for 48 hours
Outcomes	Primary: proportion of patients with negative Dix-Hallpike test at 12 months Secondary: 1. Proportion of patients with negative Dix-Hallpike test at 1, 3, 6 months 2. DHI 3. Adverse events
Notes	Sham manoeuvre is the same as a single Brandt-Daroff manoeuvre

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computer-generated random sequence prior to study start

Bruintjes 2014 (*Continued*)

Allocation concealment (selection bias)	Low risk	Sealed envelope allocation
Blinding (performance bias and detection bias) All outcomes	Low risk	Assessors and patients both blind to treatment group
Incomplete outcome data (attrition bias) All outcomes	Low risk	Losses accounted for; last observation carried forward method
Selective reporting (reporting bias)	Low risk	Outcomes pre-defined and all reported
Other bias	Low risk	-

Dispenza 2012

Methods	**Allocation:** prospective randomised controlled trial **Design:** parallel
Participants	**Number:** 88 patients **Age:** 32 to 80 years **Gender:** 40 males, 48 females **Setting:** 2 tertiary hospital otolaryngology departments **Eligibility criteria:** provocation test for BPPV was side-lying manoeuvre, rather than Dix-Hallpike test **Exclusion criteria:** patients with multiple canal symptoms, whiplash, other causes of vertigo **Baseline characteristics:** symptom duration from 5 days to 2 months
Interventions	**Intervention group:** modified Epley n = 27 **Comparator group:** Semont versus 'hybrid' manoeuvre (defined in text) n = 30/31 Treatment repeated in the initial session if persisting symptoms/signs on retesting **Use of additional interventions:** patients retested immediately after treatment and manoeuvre performed again if needed
Outcomes	**Primary outcome:** persistence of nystagmus on repeat provocation testing at 1 week **Secondary outcomes:** 1. Number of manoeuvres performed to clear symptoms at first visit 2. Adverse effects: discomfort of the manoeuvre(s)
Notes	Side-lying test is applied less commonly than the Dix-Hallpike test but applies the same physiological principles to the diagnosis in terms of individually challenging the posterior semicircular canals in turn (Halker 2008). The hybrid manoeuvre is an alternative particle repositioning manoeuvre (Roberts 2006). The trial report also includes data on a cohort of patients who were allocated (not randomised) to receive the hybrid manoeuvre because of co-morbidity (e.g. obesity, neck problems). Data from these patients are presented separately in the paper and have not been included or addressed further in this review

Dispenza 2012 (*Continued*)

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	States randomisation, but no details. Author contacted for clarification but no response
Allocation concealment (selection bias)	Unclear risk	As above
Blinding (performance bias and detection bias) All outcomes	Low risk	Assessors blinded to treatment group
Incomplete outcome data (attrition bias) All outcomes	Low risk	No loss to follow-up
Selective reporting (reporting bias)	High risk	Discomfort levels for Epley and Semont manoeuvres are not reported
Other bias	Low risk	-

Froehling 2000

Methods	**Allocation:** prospective randomised controlled trial; randomisation stratified by age and sex **Design:** parallel
Participants	**Number:** 50 patients **Age:** greater than 18 years old **Gender:** 18 males, 32 females **Setting:** hospital otolaryngology department **Eligibility criteria:** positional vertigo and nystagmus on Hallpike testing **Exclusion criteria:** bilateral disease, CNS disease, otitis media, otosclerosis, intolerant of Dix-Hallpike manoeuvre **Baseline characteristics:** median symptom duration 43 days for the experimental group, 35 days for the sham group
Interventions	**Intervention group:** modified Epley manoeuvre n = 24 **Comparator group:** sham manoeuvre (lying on the affected side for 5 minutes) n = 26 **Use of additional interventions:** not reported
Outcomes	**Primary outcome:** Subjective improvement by question, "Do you feel your dizziness has completely resolved?" **Secondary outcomes:**

Froehling 2000 (*Continued*)

	Conversion of Dix-Hallpike test from positive to negative	
Notes	Follow-up only at 1 to 2 weeks after treatment; no long-term assessment	
Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Age/sex stratification suggests appropriate sequence generation
Allocation concealment (selection bias)	Low risk	-
Blinding (performance bias and detection bias) All outcomes	Low risk	Assessor blinded to treatment; patients received realistic sham treatment
Incomplete outcome data (attrition bias) All outcomes	Low risk	No missing outcome data
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	-

Liang 2010

Methods	**Allocation:** randomised controlled trial **Design:** parallel
Participants	**Number:** 87 patients **Age:** 43/42 mean age for treatment/control **Gender:** 50 female, 37 male **Setting:** hospital otolaryngology department **Eligibility criteria:** patients included with a typical history of BPPV and positive Dix-Hallpike test **Exclusion criteria:** not reported **Baseline characteristics:** symptom duration not specified
Interventions	**Intervention group:** Epley treatment plus medication n = 43 **Comparator group:** medication only n = 44 **Use of additional interventions:** not reported
Outcomes	**Primary outcome:** resolution of BPPV, categorical assignment as composite measure of symptom resolution and Dix-Hallpike testing - Cured (no vertigo, Dix-Hallpike negative) - Improved (vertigo improved, Dix-Hallpike positive)

Liang 2010 (*Continued*)

	- No response **Secondary outcomes:** none reported
Notes	For the purpose of analysis, the outcomes were collated to a dichotomous variable of 'resolved' (cured outcome group) or persisting symptoms ('improved' and 'no response' groups)

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomised, although no details
Allocation concealment (selection bias)	Unclear risk	No description of technique for allocation
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not mentioned
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patients included in analysis
Selective reporting (reporting bias)	Low risk	All results reported
Other bias	Low risk	-

Lynn 1995

Methods	**Allocation:** prospective randomised controlled trial **Design:** parallel
Participants	**Number:** 36 patients **Age:** between 23 and 90 years **Gender:** 9 males, 24 females **Setting:** hospital otolaryngology department **Eligibility criteria:** symptom duration for minimum 2 months **Exclusion criteria:** bilateral disease **Baseline characteristics:** no difference between groups in sex, median age, self report of dizziness severity, amount of time counselled
Interventions	**Intervention group:** modified Epley manoeuvre n = 18 **Comparator group:** sham manoeuvre (lying in the first lateral position of the Semont manoeuvre for 5 minutes) n = 15 **Use of additional interventions:** patients already taking medication for dizziness were allowed to continue

Lynn 1995 (*Continued*)

Outcomes	**Primary outcome:** resolution of symptoms. Daily diary of symptoms. Report of vertigo in the 7 days prior to reassessment at 1 month was "failure" **Secondary outcomes:** Conversion of Dix-Hallpike test from positive to negative
Notes	Follow-up only at 1 month after treatment; no long-term assessment

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Block randomisation
Allocation concealment (selection bias)	Low risk	Sealed envelopes
Blinding (performance bias and detection bias) All outcomes	Low risk	Assessor blinded. Patients experienced realistic, comparable sham treatment
Incomplete outcome data (attrition bias) All outcomes	Low risk	3 of 36 patients with incomplete data. Appropriate explanation of drop-out, spread between groups
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	-

Mazoor 2011

Methods	**Allocation:** randomised controlled trial **Design:** parallel
Participants	**Number:** 60 patients **Age:** 20 to 75 years **Gender:** 35 female, 25 male **Setting:** hospital otolaryngology department **Eligibility criteria:** typical history of BPPV and positive Dix-Hallpike test **Exclusion criteria:** patients with BPPV secondary to head injury and cervical spondylosis **Baseline characteristics:** no minimum symptom duration stated
Interventions	**Intervention group:** modified Epley manoeuvre n = 30 **Comparator group:** Semont manoeuvre n = 30 **Use of additional interventions:** not reported

Mazoor 2011 (*Continued*)

Outcomes	**Primary outcome:** negative Dix-Hallpike test at day 3, 7 and 30 **Secondary outcome**: adverse effects of treatment
Notes	-

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random number tables
Allocation concealment (selection bias)	High risk	Report states "allocated using random number tables". It is not clear from the paper whether the allocation and sequence from the tables was concealed
Blinding (performance bias and detection bias) All outcomes	High risk	None
Incomplete outcome data (attrition bias) All outcomes	Low risk	All reported
Selective reporting (reporting bias)	Low risk	All reported
Other bias	Low risk	-

Munoz 2007

Methods	**Allocation:** prospective, double-blind, randomised controlled trial **Design:** parallel
Participants	**Number:** 81 patients **Age:** over 18 years of age **Gender:** 56 female, 23 male **Setting:** academic family practice in Canada **Eligibility criteria:** eligible if self report of positional vertigo with a positive unilateral Dix-Hallpike test **Exclusion criteria:** central nervous system disease, otitis media, otosclerosis, inability to tolerate the manoeuvre, severe cervical spine or cardiac disease **Baseline characteristics:** higher proportion of female patients in the treatment group than control (81% versus 61%)
Interventions	**Intervention group:** standard Epley treatment n = 38 **Comparator group:** sham treatment (the sham treatment was an Epley manoeuvre performed as if opposite ear was affected)

Munoz 2007 (*Continued*)

	n = 41 **Use of additional interventions:** not reported
Outcomes	**Primary outcome:** Subjective resolution of symptoms on Dix-Hallpike testing **Secondary outcomes:** Conversion of Dix-Hallpike test from positive to negative
Notes	The patients were immediately re-tested with a Dix-Hallpike test after the treatment. It is this result reported in the outcome We contacted the senior author for clarification. Patients were tested prior to their second treatment, i.e. 1 week following their first treatment (and before the 2nd treatment). Results for these tests were requested but have not been provided The full trial report details include 2 follow-up visits. However, patients in the sham treatment group all had conventional Epley treatment at the 2nd visit (if still symptomatic) and data from these subsequent visits are not included in the analysis

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computer-generated
Allocation concealment (selection bias)	Low risk	Central telephone allocation
Blinding (performance bias and detection bias) All outcomes	Low risk	Testing and assessment by a physician who had not administered the treatment, and was blind to study group
Incomplete outcome data (attrition bias) All outcomes	Low risk	Test results were immediately post-treatment, and available for all patients
Selective reporting (reporting bias)	Unclear risk	Both outcomes are reported for the immediate post-test assessment. It is unclear why results performed before the 2nd intervention were not included
Other bias	Low risk	-

von Brevern 2006

Methods	**Allocation:** prospective, double-blind, randomised controlled trial **Design:** parallel
Participants	**Number:** 67 patients **Age:** 19 to 86 years **Gender:** 19 male, 47 female

von Brevern 2006 (*Continued*)

	Setting: hospital otolaryngology department **Eligibility criteria:** a typical history of positional vertigo combined with a typical pattern and latency of associated nystagmus on Dix-Hallpike testing **Exclusion criteria:** bilateral disease, anterior or horizontal canal BPPV, treatment with Epley manoeuvre previously during this episode of BPPV **Baseline characteristics:** no baseline difference in groups
Interventions	**Intervention group:** Epley manoeuvre n = 36 **Comparator group:** sham treatment (the sham treatment was an Epley manoeuvre performed as if opposite ear was affected) n = 31 **Use of additional interventions:** not reported
Outcomes	**Primary outcome:** Absence of symptoms on repeat Dix-Hallpike testing after 24 hours **Secondary outcomes:** Change of Dix-Hallpike test from positive to negative at 24 hours
Notes	Follow-up period and testing was only 24 hours. Stated aim was to reduce likelihood of any spontaneous resolution in the control (sham) group

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computer-generated randomised numbers
Allocation concealment (selection bias)	Low risk	Sealed envelope allocation
Blinding (performance bias and detection bias) All outcomes	Low risk	The assessor at 24 hours was blinded to the treatment group. Patients were unaware if they were in the treatment or sham group
Incomplete outcome data (attrition bias) All outcomes	Low risk	1 drop-out in study
Selective reporting (reporting bias)	Low risk	Both stated outcomes fully reported
Other bias	Unclear risk	No explanation for disparity in number of patients in treatment versus control groups (58 versus 45)

Xie 2012

Methods	**Allocation:** randomised controlled trial **Design:** parallel
Participants	**Number:** 103 patients **Age:** range 20 to 84 **Gender:** 65 female, 38 male **Setting:** family practice **Eligibility criteria:** a typical history of BPPV and positive Dix-Hallpike test **Exclusion criteria:** not reported **Baseline characteristics:** symptom duration not specified
Interventions	**Intervention group:** modified Epley treatment plus postural restrictions n = 58 **Comparator group:** postural restrictions only n = 45 **Use of additional interventions:** not reported
Outcomes	**Primary outcome:** resolution of BPPV, categorical assignment as composite measure of symptom resolution and Dix-Hallpike testing - Cured (no vertigo, Dix-Hallpike negative) - Improved (vertigo improved, Dix-Hallpike positive) - No response **Secondary outcomes:** none reported
Notes	For the purpose of analysis, the outcomes were collated to a dichotomous variable of 'resolved' (cured outcome group) or persisting symptoms ('improved' and 'no response' groups)

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	States randomised but no details
Allocation concealment (selection bias)	High risk	No details given of methods to conceal allocation
Blinding (performance bias and detection bias) All outcomes	High risk	No blinding of assessors mentioned
Incomplete outcome data (attrition bias) All outcomes	Low risk	Patient data all reported
Selective reporting (reporting bias)	Low risk	Results all reported
Other bias	Low risk	-

Yimtae 2003

Methods	**Allocation:** prospective randomised controlled trial; block randomisation by symptom duration **Design:** parallel
Participants	**Number:** 58 patients **Age:** greater than 18 years old **Gender:** 43 female, 15 male **Setting:** hospital neuro-otology department **Eligibility criteria:** typical history of vertigo with positive Dix-Hallpike test **Exclusion criteria:** neck problems, unstable cardiopulmonary problems **Baseline characteristics:** 31 versus 39 days of symptoms. No other group difference
Interventions	**Intervention group:** modified Epley manoeuvre n = 29 **Comparator group:** untreated control n = 29 **Use of additional interventions:** not reported
Outcomes	**Primary outcome:** resolution of vertigo **Secondary outcomes:** Conversion of Dix-Hallpike test from positive to negative Medication (cinnarizine) taken during study period
Notes	Follow-up weekly for 1 month

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Block randomisation strongly implies robust strategy. Stratified by duration of symptoms
Allocation concealment (selection bias)	Low risk	-
Blinding (performance bias and detection bias) All outcomes	Low risk	Assessor blinded to treatment group
Incomplete outcome data (attrition bias) All outcomes	Low risk	No missing data
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	Small potential for bias - patients in the control group were untreated, and did not therefore have a similar experience of receiving 'therapeutic' intervention

All 10 trials applied a modified Epley manoeuvre: the sequence of positioning was as originally described by Epley 1992, but without the addition of mastoid oscillation or premedication.
BPPV: benign paroxysmal positional vertigo
CNS: central nervous system
DHI: Dizziness Handicap Inventory
TDS: three times a day

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Angeli 2003	ALLOCATION: Randomised, controlled PARTICIPANTS: 47 patients (>/= 70 years old) with the diagnosis of unilateral posterior semicircular canal BPPV INTERVENTIONS: The canalith repositioning manoeuvre described is fundamentally different from the Epley manoeuvre
Arbağ 2003	ALLOCATION: Patients were allocated to groups; strategy unclear but randomisation not mentioned in text and authors did not reply to request for information
Asawavichianginda 2000	ALLOCATION: 1. No blinding of outcome assessors 2. Performance bias: control group received no exposure to clinical staff during the trial other than assessments, compared to frequent attendance in experimental group PARTICIPANTS: Short duration of symptoms: 62% of cohort reported symptoms of less than 2 weeks duration
Blakley 1994	ALLOCATION: 1. Inadequate randomisation strategy 2. No blinding of outcome assessors 3. Performance bias: control group received less exposure to clinical staff OUTCOME MEASURES: Outcome only by subjective measures
Cohen 1999	ALLOCATION: 1. Inadequate randomisation strategy - sequential allocation 2. No blinding of outcome assessors 3. Risk of attrition bias: complete follow-up for only 58 of 87 participants OUTCOME MEASURES: Outcome only by subjective measures
Cohen 2005	ALLOCATION: Randomisation was a computer-generated spreadsheet, but patients were then sequentially allocated to groups as they attended (see similar, Cohen 1999)

(*Continued*)

Herdman 1993	ALLOCATION: 1. Unclear randomisation strategy 2. No blinding of outcome assessors OUTCOME MEASURES: Objective outcome measures (Dix-Hallpike test) reported in only 48% of participants
Li 1995	ALLOCATION: 1. Unclear randomisation strategy 2. No blinding of outcome assessors
Massoud 1996	ALLOCATION: 1. Unclear randomisation strategy 2. No blinding of outcome assessors
Radtke 1999	ALLOCATION: 1. Inadequate randomisation: 20% of the study population were allocated to receive the Epley manoeuvre because they had previously failed with rehabilitation exercises, which was the control treatment. Remaining patients were allocated alternately 2. No blinding of outcome assessors
Sekine 2006	ALLOCATION: 1. No randomisation or concealed allocation. Patients were allocated to treatment group according to which of 2 institutions they attended 2. Patients and researchers were not blinded to intervention group
Seo 2007	ALLOCATION: Sequential allocation to groups. High risk of bias - no allocation concealment
Sherman 2001	ALLOCATION: 1. Inadequate randomisation; allocation by date of clinic visit 2. High drop-out rate
Soto Varela 2001	ALLOCATION: 1. No description of randomisation strategy 2. Assessors not blinded to treatment group
Sridhar 2003	ALLOCATION: Assessors were not blinded to treatment group of patient
Steenerson 1996	ALLOCATION: 1. Inadequate randomisation: alternative allocation to 2 treatment groups. Control group were patients who refused active treatment 2. No blinding of outcome assessors OUTCOME MEASURES: No objective outcome measure

(*Continued*)

Waleem 2008	ALLOCATION: High risk of bias in assignment of patients to study groups. Patients were allocated by non-probability convenience sampling
Wolf 1999	ALLOCATION: 1. Inadequate randomisation: first 22 patients allocated by date of examination (odd/even). Remaining 19 patients all received active treatment 2. No blinding of outcome assessors 3. Performance bias: control group received less exposure to clinical staff

BPPV: benign paroxysmal positional vertigo

Characteristics of studies awaiting assessment *[ordered by study ID]*

Dashti Gholamali 2010

Methods	Randomised controlled trial
Participants	38 patients (22 female, 16 male) aged 23 to 56 years
Interventions	Epley versus Semont manoeuvre
Outcomes	Primary outcome measure: resolution of vertigo and negative Dix-Hallpike test
Notes	Reference not obtainable Abstract details insufficient for data analysis. No detail of inclusion/exclusion criteria. Recovery rates expressed as percentages, not numbers of patients with no indication of loss to follow-up

Okhovat 2003

Methods	Randomised controlled trial
Participants	130 patients (65:65)
Interventions	Epley treatment versus Semont manoeuvres
Outcomes	Primary outcome measure: resolution of vertigo and negative Dix-Hallpike test Secondary outcome measure: simplicity of performing the manoeuvre
Notes	Reference not obtainable Abstract details insufficient for data analysis. No detail of inclusion/exclusion criteria. Recovery rates expressed as percentages, not numbers of patients with no indication of loss to follow-up

DATA AND ANALYSES

Comparison 1. Epley versus control or placebo manoeuvre

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Complete resolution of vertigo symptoms (subjective report)	5	273	Odds Ratio (M-H, Fixed, 95% CI)	4.42 [2.62, 7.44]
2 Conversion of a positive to a negative Dix-Hallpike test	8	507	Odds Ratio (M-H, Fixed, 95% CI)	9.62 [6.00, 15.42]

Comparison 2. Epley versus Brandt-Daroff exercises

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Resolution of symptoms and nystagmus on Dix-Hallpike test	1	81	Odds Ratio (M-H, Fixed, 95% CI)	12.38 [4.32, 35.47]

Comparison 3. Epley versus Semont manoeuvre

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Resolution of nystagmus on provocation testing, at 7 days	2	117	Odds Ratio (M-H, Fixed, 95% CI)	0.78 [0.32, 1.88]

Comparison 4. Epley versus hybrid (Gans) manoeuvre

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Resolution of nystagmus on provocation testing, at 7 days	1	58	Odds Ratio (M-H, Fixed, 95% CI)	0.67 [0.18, 2.52]

Analysis 1.1. Comparison 1 Epley versus control or placebo manoeuvre, Outcome 1 Complete resolution of vertigo symptoms (subjective report).

Review: The Epley (canalith repositioning) manoeuvre for benign paroxysmal positional vertigo

Comparison: 1 Epley versus control or placebo manoeuvre

Outcome: 1 Complete resolution of vertigo symptoms (subjective report)

Study or subgroup	Treatment n/N	Control n/N	Odds Ratio M-H,Fixed,95% CI	Weight	Odds Ratio M-H,Fixed,95% CI
Froehling 2000	12/24	5/26		17.5 %	4.20 [1.19, 14.83]
Lynn 1995	11/18	3/15		9.3 %	6.29 [1.29, 30.54]
Munoz 2007	12/38	10/41		48.1 %	1.43 [0.53, 3.84]
von Brevern 2006	28/35	3/31		4.6 %	37.33 [8.75, 159.22]
Yimtae 2003	16/25	7/20		20.5 %	3.30 [0.97, 11.29]
Total (95% CI)	**140**	**133**		**100.0 %**	**4.42 [2.62, 7.44]**

Total events: 79 (Treatment), 28 (Control)

Heterogeneity: Chi^2 = 13.73, df = 4 (P = 0.01); I^2 =71%

Test for overall effect: Z = 5.58 (P < 0.00001)

Test for subgroup differences: Not applicable

Analysis 1.2. Comparison 1 Epley versus control or placebo manoeuvre, Outcome 2 Conversion of a positive to a negative Dix-Hallpike test.

Review: The Epley (canalith repositioning) manoeuvre for benign paroxysmal positional vertigo

Comparison: 1 Epley versus control or placebo manoeuvre

Outcome: 2 Conversion of a positive to a negative Dix-Hallpike test

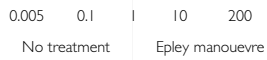
Study or subgroup	Treatment n/N	Control n/N	Odds Ratio M-H,Fixed,95% CI	Weight	Odds Ratio M-H,Fixed,95% CI
Lynn 1995	16/18	4/15		3.9 %	22.00 [3.41, 141.73]
Froehling 2000	16/24	10/26		25.8 %	3.20 [1.00, 10.20]
Yimtae 2003	22/25	13/20		14.0 %	3.95 [0.87, 17.99]
Munoz 2007	13/38	6/41		30.6 %	3.03 [1.01, 9.07]
von Brevern 2006	28/35	3/31		5.1 %	37.33 [8.75, 159.22]
Bruintjes 2014	20/22	10/22		7.3 %	12.00 [2.24, 64.28]
Liang 2010	42/43	34/44		6.3 %	12.35 [1.51, 101.36]
Xie 2012	54/58	11/45		6.9 %	41.73 [12.29, 141.65]
Total (95% CI)	**263**	**244**		**100.0 %**	**9.62 [6.00, 15.42]**

Total events: 211 (Treatment), 91 (Control)

Heterogeneity: Chi^2 = 18.83, df = 7 (P = 0.01); I^2 =63%

Test for overall effect: Z = 9.40 (P < 0.00001)

Test for subgroup differences: Not applicable



Analysis 2.1. Comparison 2 Epley versus Brandt-Daroff exercises, Outcome 1 Resolution of symptoms and nystagmus on Dix-Hallpike test.

Review: The Epley (canalith repositioning) manoeuvre for benign paroxysmal positional vertigo

Comparison: 2 Epley versus Brandt-Daroff exercises

Outcome: 1 Resolution of symptoms and nystagmus on Dix-Hallpike test

Study or subgroup	Epley n/N	Brandt-Daroff n/N	Odds Ratio M-H,Fixed,95% CI	Weight	Odds Ratio M-H,Fixed,95% CI
Amor Dorado 2012	33/41	10/40		100.0 %	12.38 [4.32, 35.47]
Total (95% CI)	**41**	**40**		**100.0 %**	**12.38 [4.32, 35.47]**
Total events: 33 (Epley), 10 (Brandt-Daroff)					
Heterogeneity: not applicable					
Test for overall effect: Z = 4.68 (P < 0.00001)					
Test for subgroup differences: Not applicable					

Analysis 3.1. Comparison 3 Epley versus Semont manoeuvre, Outcome 1 Resolution of nystagmus on provocation testing, at 7 days.

Review: The Epley (canalith repositioning) manoeuvre for benign paroxysmal positional vertigo

Comparison: 3 Epley versus Semont manoeuvre

Outcome: 1 Resolution of nystagmus on provocation testing, at 7 days

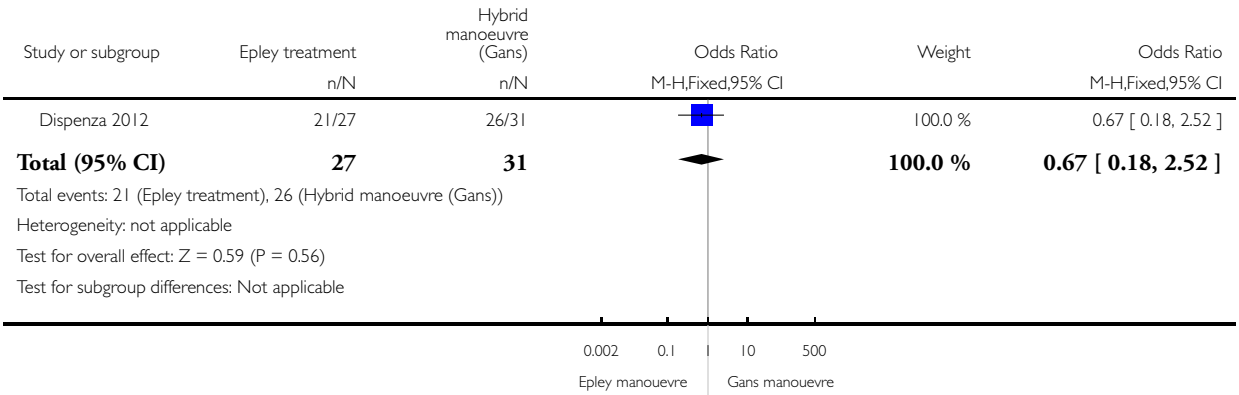
Study or subgroup	Epley maneouvre n/N	Semont manouvre n/N	Odds Ratio M-H,Fixed,95% CI	Weight	Odds Ratio M-H,Fixed,95% CI
Dispenza 2012	21/27	27/30		50.4 %	0.39 [0.09, 1.74]
Mazoor 2011	22/30	21/30		49.6 %	1.18 [0.38, 3.63]
Total (95% CI)	**57**	**60**		**100.0 %**	**0.78 [0.32, 1.88]**
Total events: 43 (Epley maneouvre), 48 (Semont manouvre)					
Heterogeneity: Chi^2 = 1.35, df = 1 (P = 0.25); I^2 =26%					
Test for overall effect: Z = 0.55 (P = 0.58)					
Test for subgroup differences: Not applicable					

Analysis 4.1. Comparison 4 Epley versus hybrid (Gans) manoeuvre, Outcome 1 Resolution of nystagmus on provocation testing, at 7 days.

Review: The Epley (canalith repositioning) manoeuvre for benign paroxysmal positional vertigo

Comparison: 4 Epley versus hybrid (Gans) manoeuvre

Outcome: 1 Resolution of nystagmus on provocation testing, at 7 days



APPENDICES

Appendix 1. Search strategies

CENTRAL	PubMed	EMBASE (Ovid)
#1 VERTIGO single term (MeSH) #2 DIZZINESS single term (MeSH) #3 vertig* OR dizziness OR paroxysmal OR BPPV #4 #1 OR #2 OR #3 #5 PHYSICAL THERAPY MODALITIES explode all trees (MeSH)	#1 "Vertigo" [Mesh] OR "dizziness" [Mesh] OR vertig* [tiab] OR dizziness [tiab] OR paroxysmal [tiab] OR BPPV [tiab] #2 "PHYSICAL THERAPY MODALITIES" [Mesh] OR "head Movements" [Mesh] OR epley* [tiab] OR semont* [tiab]	1 exp vertigo/ 2 Dizziness/ 3 (vertig* or dizziness or paroxysmal or BPPV).tw. 4 1 or 3 or 2 5 HEAD POSITION/ 6 exp HEAD MOVEMENT/

(*Continued*)

#6 HEAD MOVEMENTS single term (MeSH) #7 epley* OR semont* OR canalith* OR otolith* OR particle OR position* OR reposition* OR maneuver* OR manoeuvr* #8 #5 OR #6 OR #7 #9 #4 AND #8	OR canalith* [tiab] OR otolith* [tiab] OR particle [tiab] OR position* [tiab] OR reposition* [tiab] OR maneuver* [tiab] OR manoeuvr* [tiab] #3 #1 AND #2	7 VESTIBULAR STIMULATION/ 8 (epley* or semont* or canalith* or otolith* or particle or position* or reposition* or maneuver* or manoeuvr*).tw. 9 8 or 6 or 7 or 5 10 4 and 9
Web of Science	**CAB Abstracts (Ovid)**	***mRCT***
#1 TS=(epley* OR semont* OR canalith* OR otolith* OR particle OR position* OR reposition* OR maneuver* OR manoeuvr*) #2 TS=(vertig* OR dizziness OR paroxysmal OR BPPV) #3 #2 AND #1	1 (vertig* or dizziness or paroxysmal or BPPV).tw. 2 (epley* or semont* or canalith* or otolith* or particle or position* or reposition* or maneuver* or manoeuvr*).tw. 3 1 AND 2	((vertig% OR dizziness OR paroxysmal OR BPPV) AND (epley% OR semont% OR canalith% OR otolith% OR particle OR position% OR reposition% OR maneuver% OR manoeuvr%))

FEEDBACK

Herxheimer 2003

Summary

Describe the Epley manoeuvre

1. The review is very valuable. It would be still more useful if it included or was linked to a detailed description of the Epley manoeuvre, and illustrated with one or more diagrams. The references to Epley's original paper and to the two trials reviewed are in rather obscure and not easily accessible places.

2. The coversheet states that various dates have "no been supplied by the reviewer". Surely most of this information must be in the editorial office or easily obtained by the CRG.

I certify that I have no affiliations with or involvement in any organisation or entity with a direct financial interest in the subject matter of my criticisms. AH

Reply

Thank you for your comments.

1. A diagram of the Epley manoeuvre (from the original 1992 paper) has been reproduced with permission as an additional figure.

2. All relevant dates have been completed. Where not applicable dates are left necessarily blank. The Cochrane Library provides the default statement 'not supplied by reviewer' and we are unable to change this.

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WHAT'S NEW

Last assessed as up-to-date: 23 January 2014.

Date	Event	Description
3 December 2014	New citation required and conclusions have changed	We included six new studies in the review (Amor Dorado 2012; Bruintjes 2014; Dispenza 2012; Liang 2010; Mazoor 2011; Xie 2012). We excluded one further study (Arbağ 2003). Two studies are awaiting classification (Dashti Gholamali 2010; Okhovat 2003). Our conclusion about the efficacy of the Epley manoeuvre when compared to control is unchanged, but we have added new conclusions about the comparison with other particle repositioning manoeuvres No trials reported change in vertigo on the basis of frequency and/or severity as we had specified as our original outcome measures. Vertigo was presented as a symptom which was either 'present' or 'absent'. We therefore changed the primary outcome measure to 'complete resolution of symptoms' in this update
23 January 2014	New search has been performed	New searches run.

HISTORY

Protocol first published: Issue 3, 2001

Review first published: Issue 1, 2002

Date	Event	Description
26 April 2012	Amended	Linked video content added, demonstrating the Dix-Hallpike test and the Epley manoeuvre (see Background).
28 September 2009	New search has been performed	New searches run. Two new studies included; four studies excluded. Risk of bias method adopted. No changes to review conclusions
30 October 2008	Amended	Converted to new review format.
14 February 2007	New search has been performed	New searches run July 2006. No new studies included. One new study excluded from the review. Minor update Issue 2, 2007
25 February 2004	New citation required and conclusions have changed	Substantive update Issue 2, 2004.

CONTRIBUTIONS OF AUTHORS

The two authors contributed equally to searching, selection of trials, 'Risk of bias' assessment and data extraction.

DECLARATIONS OF INTEREST

Malcolm Hilton: none known.

Darren Pinder: none known.

SOURCES OF SUPPORT

Internal sources

- None, Other.

External sources

- None, Other.

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

The original protocol included the Epley manoeuvre (either as classically described or with mastoid oscillation). Mastoid oscillation and other adjunctive treatments are now the subject of a separate review (Hunt 2012). The change in protocol does not alter the inclusion of any trials up to and including the 2014 update.

No trials reported change in vertigo on the basis of frequency and/or severity as specified as original outcome measures. Vertigo was presented as a symptom that was either 'present' or 'absent'. We therefore changed the primary outcome measure to 'complete resolution of symptoms' at the 2014 update.

INDEX TERMS

Medical Subject Headings (MeSH)

Semicircular Canals; Benign Paroxysmal Positional Vertigo [rehabilitation]; Exercise Movement Techniques [adverse effects; methods]; Randomized Controlled Trials as Topic

MeSH check words

Adult; Aged; Aged, 80 and over; Female; Humans; Male; Middle Aged