EFFECTIVENESS OF CAWTHORNE COOKSEY EXERCISE IN IMPROVING BALANCE FOR PATIENTS WITH DIZZINESS AND VERTIGO: A SYSTEMATIC REVIEW

1 Barnana Roy, 2 Dr. Prasanna Mohan, 3 Dr. Anjali Suresh, 4 Dr. S. Senthil Kumar
1 Postgraduate student, 2 Associate Professor, 3 Professor and HOD, 4 Professor and research supervisor
1 Department of physiotherapy,
1 Garden City University, Bengaluru, India

Abstract: Dizziness is a variety of symptoms regarding disorders of spatial orientation and motion perception, which can affect objectively the ability to achieve a stable gaze, posture, and gait. Vertigo is a rotational, spinning perception of movement either of the self or surrounding objects that are either not occurring or is occurring differently from how it is perceived. This dizziness and vertigo can impair balance in adults leading to a high risk of falls. This study aimed to assess the effectiveness of Cawthorne Cooksey exercise for improving balance in patients with vertigo and dizziness. Articles from five databases, published from 2003 to 2021 are searched following inclusion criteria: (1) Randomized controlled trials, (2) Patients with dizziness and vertigo with or without vestibular dysfunction, (3) Patients having balance impairment, (4) Cawthorne Cooksey exercise as intervention, (5) Articles published in English. Eight studies met the inclusion criteria of this systematic review. The method for search strategy and quality of evidence is done by Prisma protocol for systematic review (2020) and PEDro (physiotherapy evidence database) scale, respectively. All the included randomized control trials proved to be good evidence quality. Valid outcome measures for balance and dizziness are used to assess the effectiveness of Cawthorne Cooksey exercises. Cawthorne Cooksey exercise is effective as a vestibular intervention protocol for improving balance in patients with dizziness and vertigo, provided a modified or multimodal form is used or used in combination with other effective intervention protocols.

Keywords Cawthorne Cooksey exercise, balance, vertigo, dizziness, vestibular rehabilitation

I. INTRODUCTION

The term dizziness is used to describe a variety of symptoms regarding disorders of spatial orientation and motion perception, such as the illusion of rotatory motion or the feeling of unsteadiness, which can affect a stable gaze, posture, and gait [1]. Symptoms like vertigo, lightheadedness, near faintness, motion sickness, or unsteadiness are observed in patients with dizziness. Common disorders associated with dizziness are BPPV (Benign paroxysmal positional vertigo), vestibular neuritis, manière’s disease, migraine-associated dizziness, posterior circulation Tic, stroke, orthostatic hypotension, motion sickness, anxiety disorders, bilateral vestibulopathy etc [2,3]. It impacts 15% to 20% of adults yearly in large population-based studies. Its prevalence increases with age which is 30% beyond 60 years of age, 50% beyond 85 years, and two to three times higher in women than in men [4]. Dizziness is classified into 1) Vertigo, 2) Disequilibrium, 3) Presyncope (near-faint), 4) Lightheadness [5].

Vertigo is a rotational movement perceived by self or sometimes surrounding objects. It is classified into Peripheral vestibular vertigo (BPPV), Vestibular neuritis, Ménière’s disease; Central vestibular syndromes, downbeat and upbeat nystagmus, episodic ataxia type 2, vestibular migraine or migraine with vestibular aura, and phobic postural vertigo [6,7]. Vertigo affects both men and women but is about two to three times more common in women than men [9]. Dizziness including vertigo affects about 15% to over 20% of adults yearly [10].

Balance is defined as the ability to maintain the body's mass in base of support area conditioned with voluntary activities and coping with protuberances (internal or external) and requires interaction between sensory (visual, vestibular, somatosensory) and motor systems within the central nervous system. [11] Dizziness and imbalance put older people at a significantly higher risk of falling where BPPV is a major cause followed by Ménière's disease. [12]
Vestibular rehabilitation (VR) exercises mainly focus on head, body movements, co-ordination of eyes with the head, balance tasks and they are proved to be effective in treating dizziness and imbalance.[13] Exercises commonly used in VR management of older adults with balance and vertigo are VOR (vestibulo-ocular reflex) adaptation exercises, substitution exercises, balance and gait training, canalith repositioning exercises,[14] Epley maneuver, [15] gaze stability exercises, [16,17] optokinetic stimulation, [18] CCE(Cawthorne Cooksey exercise) [19] etc.

CCE is a common protocol for VR, which involves balance centers, such as visual, proprioceptive, and vestibular activities. [20] Patients are encouraged to move into positions that provoke symptoms and central nervous system then attempts to reduce this error signal by modifying the gain of the vestibular system, through adaptation of the vestibular system. This exercise program includes (1) Adaptation exercises to improve the gain of VOR (2) Habituation exercises, the use of repeated head and visual movement activities to facilitate a reduction in the symptoms provoked by a specific movement, (3) Balance and gait exercises to improve in both static and dynamic balance abilities (4) General conditioning exercises.[21] None of the previous review studies have focused on CCE intervention separately to check effectiveness in improving balance indicating the current lack of literature in this area. Thus, this systematic review aims to provide a summary of the evidence on the effectiveness of CCE in improving balance for patients with dizziness and vertigo with or without vestibular dysfunction.

II. METHODS

This study was conducted according to PRISMA, a preferred reporting protocol for systematic review and meta-analysis.

2.1 Eligibility criteria:

Inclusion criteria consisted of the following: (1) Randomized control trials and randomized clinical trials (RCT), (2) Publication year 2003-2021, (3) Patients with dizziness and vertigo with or without vestibular dysfunction, (4) Balance impairment, (5) CCE,(6) Outcome measures for assessing dizziness, balance, postural control, risk of fall, (7) Articles published in English, (8) Participant’s Age above 18 years, (9) No restriction regarding country, race, gender, (10) Pedroscore for articles ≥ 6 or higher.

Exclusion criteria consisted of the following: (1) Associated cardiovascular, neurological, and orthopedic disorders, (2) Balance impairment other than dizziness and vertigo, (3) Study with data not reliably extracted, duplicate, or overlapping data, (4) abstract-only papers as preceding papers, conference, editorial, and author response theses and books case reports, case series, and systematic review studies, (5) articles without available full text.

2.2 Search strategy:

A search of existing literature from the years 2003-2021 was completed from the following databases: PubMed, Google Scholar, Cochrane Library, PEDro (physiotherapy evidence database), and Research gate using keywords such as CCE, balance, balance impairment, vertigo, dizziness, vestibular rehabilitation. After removing duplicates, relevant articles were identified by titles and abstracts. and underwent full-text screening and were ranked as relevant or irrelevant according to the inclusion criteria. Finally, the remaining relevant articles underwent data extraction.

2.3. Methodological quality and risk of bias:

Methodological quality and risk of bias of the individual studies were evaluated using the PEDro scale. [22,23] The quality of trials can be scored as “1” when a trial met the criteria and “0” when a trial did not meet the criteria. The total PEDro scores of 0-3 are considered ‘poor’, 4-5 ‘fair’, 6-8 ‘good’, and 9-10 ‘excellent’. Therefore, articles with a score of 6 or higher are considered high quality, and those with scores of less than 6 are defined as lower quality. [22]

III. RESULT

3.1 Study selection:

A total of 564 articles were identified according to the search strategies from the above-mentioned databases. After duplication removal, 512 articles remained which were analyzed by their titles and abstracts. 48 of these articles were selected to be read in their entirety. After this analysis, 8 trials were considered eligible for this systematic review. Figure 1 contains the study extraction flowchart, in line with Prisma recommendations.

3.2 Study characteristics: The characteristics of the studies are selected, in terms of the study year, author names, country of origin, number of participants in randomized groups, inclusion and exclusion criteria of the studies, interventions, outcome measures, and key findings. these are summarized in table 1.
Records identified from:
Databases (n =5)
  Google scholar =455
  PubMed= 9
  PEDro = 0
  Cochrane library=0
  Research gate = 100

Duplicate records removed before screening (n = 52)

Records screened (n= 512)

Records assessed for eligibility (n= 48)

Studies included
1. Stefano Corna et.al. 2003
4. Mayra Cristina Aratani a et.al. 2019
5. Wojciech Smólka et.al 2020
6. Mohammad Hossein Kaveh et.al. 2021
7. Bilgehan Tekin Dal et.al 2021
8. Ekin Taçalan et.al. 2021

Reports excluded:
1. Not published in English (n= 4)
2. Failed to fulfill the inclusion criteria(n=15)
3. Case series, observational study, cohort study, systematic review etc. (n=13)
4. Full text not available (n=8)

Fig. 1. Flowchart of search strategy, according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)
Table 1. Study Characteristics Of the articles

<table>
<thead>
<tr>
<th>Study</th>
<th>Inclusion Criteria</th>
<th>Exclusion Criteria</th>
<th>Experimental Group Interventions</th>
<th>Control Group Interventions</th>
<th>Duration</th>
<th>Outcome Measures</th>
<th>Key Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. Divya et. al. (2016)</td>
<td>1. Age 35 – 65 years 2. Recurrent episodes of vertigo 3. No improvement after 2 weeks of medications 4. Positive Dix-Hallpike test 5. ABC scale &lt;50% 6. Posterior Canal BPPV</td>
<td>1. Patients with negative Dix-Hallpike test, 2. ABC scale &gt;50% 3. Anxiety - disorder 4. Anterior or Lateral Canal BPPV 5. CNS (central nervous system) pathology</td>
<td>Modified Epley’s maneuver and CCE with medications</td>
<td>Brandt– Daroff exercise with medications</td>
<td>3 sessions per week (20 minutes per session) for a period of 3 weeks</td>
<td>1. ABC 2. DHI</td>
<td>Modified Epley’s maneuver and CCE had statistically significant improvement in balance confidence and reduction in the intensity of dizziness of posterior canal benign paroxysmal positional vertigo participants</td>
</tr>
<tr>
<td>Mohammad Hossein Kaveh et.al. (2021)</td>
<td>1.Age 60- 74 years 2. History of falling over past 6-12 months 3. Positive Romberg sign, 4. Minimum score of 24 in MMSE 5. Minimum score of 21 in BBS, 6. No visual impairment, no neck disability, non-use of ambulatory assistive devices (AAD), and no orthopaedic, neural impairments.</td>
<td>1.Unwillingness to cooperate 2. Musculoskeletal disorders requiring ambulatory assistive devices</td>
<td>1. Cawthorne-cooksey (CC) 2. Sensory-motor system training</td>
<td>No other activities or interventions had received by the control group during the study period and usual care were continued</td>
<td>Two-hour sessions twice in a week for 8 weeks (2 hrs per session) (16 sessions)</td>
<td>1. BBS 2. Romberg test 3. MMSE (Mini mental state examination) 4. DHI 5. FES-1 (Fall efficacy scale-international) 6. LEIPAD 7. VNG (video nystagmography)</td>
<td>CCE is more effective in improving balance and symptoms of dizziness.</td>
</tr>
<tr>
<td>Study</td>
<td>Inclusion Criteria</td>
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<td>Mayra Cristina Aratania et al. (2019)</td>
<td>1. Age 65 years or above 2. Diagnosed with vestibular disorder 3. Complaint of chronic dizziness for two months or more after the first occurrence</td>
<td>1. Dizziness not resulting from a vestibular disorder 2. BPPV 3. Cognitive deficits 4. Locomotion with a walker or wheelchair 5. Practice of regular physical activity 6. Exposed to VR treatment in the previous six months 7. Use of medication for vestibular disorders</td>
<td>Multimodal Cawthorne &amp; Cooksey protocol</td>
<td>Conventional Cawthorne &amp; Cooksey protocol</td>
<td>50-minutes sessions, twice weekly, for two months (16 sessions)</td>
<td>1. DHI 2. VAS (Visual analogue scale) 3. VADL (vestibular disorders activities of daily living scale) 4. GDS (Geriatric Depression Scale) 5. ABC</td>
<td>Significant improvement between baseline and post-treatment in both the groups but multimodal protocol more effective than conventional one.</td>
</tr>
<tr>
<td>Study</td>
<td>Inclusion Criteria</td>
<td>Exclusion Criteria</td>
<td>Experimental Group Interventions</td>
<td>Control Group Interventions</td>
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<td>Key Findings</td>
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<tr>
<td>Stefano Corna et al.</td>
<td>1. Imbalance due to a unilateral vestibular deficit 2. Patients must not have had rehabilitation treatment or chronic pharmacologic treatment for vertigo in at least the previous 3 months.</td>
<td>1. Central or peripheral neurologic disease 2. Postural imbalance due to benign positional vertigo.</td>
<td>Instrumental rehabilitation (sinusoidal support surface translation)</td>
<td>Conventional rehabilitation (CCE)</td>
<td>10 sessions for 30 minutes with 2 sessions daily (morning, afternoon), for 5 consecutive days.</td>
<td>1. DHI 2. Stabilometry 3. Tinetti</td>
<td>Instrumental rehabilitation is more effective than CCE in improving balance control</td>
</tr>
<tr>
<td>Bilgehan Tekin Dal et al. (2021)</td>
<td>1. Age 18 -65 years 2. Dizziness for longer than 3 months, 3. History of at least 1 bout of dizziness per month, 4. Scored normal on Sensory Organization Test (SOT) conditions 5. Chronic unilateral peripheral vestibular disorder</td>
<td>1. BPPV 2. Meniere disease, bilateral vestibular disorders, 3. Central nervous system disorders, 4. Psychiatric disorders, 5. Who did not understand simple verbal commands, 6. Visual impairment 7. Movement limitations because of orthopedic problems, or 7. Medication for dizziness.</td>
<td>1. Group 1- activity based home program, 2. Group 2 exercise-based home program (both groups CCE was given)</td>
<td>No intervention</td>
<td>60 minutes, session twice a day, 5 days per week, for a total of 4 weeks</td>
<td>1. VAS 2. VADL 3. SMART Balance Master System device. 4. SOT (Sensory Organization Test)</td>
<td>The activity-based home program was more effective than the exercise-based home treatment program in patients with chronic peripheral vestibular disorders</td>
</tr>
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</table>
Table 1. (continue)

<table>
<thead>
<tr>
<th>Study</th>
<th>Inclusion Criteria</th>
<th>Exclusion Criteria</th>
<th>Experimental Group Interventions</th>
<th>Control Group Interventions</th>
<th>Duration</th>
<th>Outcome Measures</th>
<th>Key Findings</th>
</tr>
</thead>
</table>
| Ekin Taçalan et al. (2021) | 1. Aged between 20-70  
2. Posterior semicircular canal BPPV with upbeat-torsional nystagmus and positional vertigo  
3. Agreeing to participate in the study | 1. central nervous system disorders causing dizziness  
2. Cervical and/or lumbar pathology  
3. Lower extremity pain or an operation that prevented standing and/or weight bearing  
4. Anterior or horizontal canal BPPV  
5. Previously undergone a VR program | Epley’s maneuver with CCE | Epley’s maneuver | 10 times, twice a day for 6 weeks | 1. Patient Assessment Questionnaire  
2. WBB (Wii Balance Board)  
3. BBT  
4. Dix-Hallpike Test  
5. VSS-SF (Vertigo Symptom Scale-Short Form)  
6. DHI | CCE do not have any additional effects in improving posterior semicircular canal BPPV symptoms. |
| Wojciech Smółka et al. (2020) | 1. Age 40–64 years  
2. Symptoms of vertigo and the loss of balance  
3. Incidence of falls  
4. Chronic unilateral vestibular  
5. Patient’s written consent acted as the inclusion criteria | 1. Central migraine,  
2. BPPV,  
3. Ménière’s disease,  
4. Perilymphatic fistula,  
5. Symptoms persisting for NYHA II (New York Heart Association Classification Class II), or myocardial insufficiency | CCE and simple balance exercises | Customized group vestibular rehabilitation in an outpatient setting. | 1. Twice a day for 15 minutes for 6 weeks (experimental group)  
2. Once a week for 1 hour 30 minutes for 6 weeks (control group) | 1. ALFA stabilometric platform  
2. DGI  
3. BBS  
4. TUG TEST  
5. DHI  
6. Vertigo evaluation with VAS | Customized, supervised outpatient rehabilitation program is superior to the results achieved with home-based unsupervised Cawthorne-Cooksey and balance exercise. |

3.3 Participants
All the included articles have an above total sample size of 30 or above. [24,31] The participants from three studies reported to be aged 60 or above [25-28] and two studies reported a mean age of 35-65 years [24,31] and two studies considered young adults aging 18 and above. [29,30] All studies had both male and female participants except for three studies [24,25] which considered only female subjects. Gender distribution was asymmetric in five studies [26,27,29,31] as females are more in number in those samples. Only in one study, [30] there is no mention of gender distribution and males and females are equally distributed in the sample [28]. Seven out of the eight studies included patients having symptoms of dizziness and vertigo with vestibular dysfunction, [24,26-31] only in one study [24] patients are included both with and without vestibular dysfunction.

3.4 Interventions
In all the studies [25-29,31] CCE was given alone as interventions to the experimental group except in two studies [25,31] where CCE was combined with Epley’s maneuver.

S. Divya et al. [24] introduced Modified Epley’s maneuver and CCE with medication in experimental group and Brandt–Daroff exercise with medications for control group and were continued for 3 sessions per week for a period of 3 weeks. The experimental group had shown statistically more significant improvement in balance and the intensity of dizziness of posterior canal BPPV participants than the control group.
Mohammad Hossein Kaveh et al. [25] performed CCE and sensory-motor system training in the experimental group while no interventions were given to the control group. Interventions were given for two-hour sessions twice a week for 8 weeks with two-month follow-up. A significant difference between the experimental and control groups was seen as far as balance, dizziness, fear of fall, and QOL (Quality of life) are concerned, after the vestibular rehabilitation.

Mayra Cristina Aratani a et.al. [26] gave multimodal CCE protocol and conventional CCE protocol in experimental and control group respectively in individual 50-minute sessions, twice a week for two months (16 sessions). All patient-reported outcomes presented significant improvement between baseline and post-treatment for both the groups and multimodal protocol is proved to be superior to conventional protocol.

In the study by Ricci NA et.al. [27] experimental and control group performed multimodal CCE and conventional CCE protocol, respectively. Interventions were given as 50-min sessions, twice a week, for 2 months (a total of 16 sessions). Significant improvement was observed on elderly balance control in experimental group.

Stefano Corna et.al. [28] to compare the effectiveness of vestibular rehabilitation by using CCE with instrumental rehabilitation used sinusoidal support surface translation in the posture and movement laboratory in group 1 and conventional rehabilitation with CCE in group 2 with 10 sessions, with 2 sessions daily (morning, afternoon), for 5 consecutive days. Each session given for 30 minutes for both exercises. The authors concluded that both CCE and instrumental rehabilitation are effective for treating balance disorders of vestibular origin, but the latter is more effective than CCE for improving balance control.

Bilgehan Tekin Dal et.al. [29] in their study gave activity- based home program in group 1, exercise- based home program in group 2 (both groups CCE was given) and in control group (group 3) no intervention for twice a day, 5 days per week, for a total of 4 weeks for 60 minutes. It was observed that the group one was more effective in improving the home management task, the occupational task, and balance than the exercise- based home treatment program in patients with chronic peripheral vestibular disorders.

In the study by Ekin Taçałan et.al. [30] experimental group participants performed Epley’s maneuver with CCE and control group participants performed only Epley’s maneuver. Exercises were prescribed for twice a day and repeated 10 times for 6 weeks as a home exercise program. The authors came to this conclusion that Epley’s maneuver is more effective compared to CCE which do not have any additional effects in improving symptoms.

In the study by Wojciech Smółka et.al. [31] experimental group was instructed to perform CCE and simple balance exercises twice a day for 15 min for 6 weeks and control group underwent customized group vestibular rehabilitation in an outpatient setting for once a week for 1 hour 30 minutes for 6 weeks. After 6 weeks authors found that supervised outpatient rehabilitation program in group 1 is superior to the results achieved with home-based unsupervised CCE and balance exercise.

3.5 Outcome measures

3.5.1 Balance - Outcome measures used in articles varied considerably. S. Divya et. al. [24] and Mayra Cristina Aratania et.al. [26] used Activities–Specific Balance Confidence scale (ABC) which is a 16-item scale for balance confidence in 16 different activities scoring from no confidence (0%) to completely confident (100%). [22] BBS (berg balance scale) is considered in three studies. [25,30,31] It consists of 14 items each of which is scored from 0 to 4 and summed to make a total score between 0 and 56. Ricci N/Aet.al. [27] and Wojciech Smółka et.al. [31] have used TUG (the timed up and go test) for evaluating mobility and risk of fall. A score of ≥14 s is predictive of falls. [33,34] DGI (dynamic gait index) is used by Ricci NA et.al. [27] and Wojciech Smółka et.al. [31] This a functional gait scale composed of eight items with the total score ranges from 0 to 24 points. [35,36] Other balance measurements used are the following: Stabilometry by Stefano Corna et.al. [28] Smart Balance Master System device, a computerized dynamic posturography by Bilgehan Tekin Dal et.al. [29,] Nintendo Wii Balance Board (WBB) by Ekin Taçałan et.al. [30] Romberg test by Mohammad Hossein Kaveh [25].

3.5.2 Dizziness - Six out of selected eight studies [24-26,28,30,31] have used DHI (dizziness handicap inventory) to assess dizziness in participants. It includes 25 questions with 3 response levels, namely functional, emotional and physical. Possible scores range from 0 to 100, with higher scores showing worse disabilities [37]. Whitney et. al. proposed that a total score of 0–30 indicates mild, 31–60 moderate, and 61–100 severe handicap [38].

Bilgehan Tekin Dal et.al. [29] used VADL (vestibular disorders activities of daily living scale), a 28 items scale and has good face validity, high internal consistency, and high test-retest reliability [39]. Activity performance is rated between 1 and 10. Other scales used are as follows Vertigo Symptom Scale-Short Form (VSS-SF), [30] Vertigo evaluation with the Visual Analogue Scale (VAS). [26,29,31]

3.6 Risk of Bias

All the eight studies were randomized. [24-31] All the studies have mentioned definitive inclusion and exclusion criteria, baseline comparability, adequate follow up after interventions, intention to treat analysis, between-group comparisons, point estimates and variability pointing to very low risk of bias and high quality of evidence. [24-31] Regarding to anonymous allocation, only three studies [26,27,30] have mentioned how this was carried out (by sealed envelopes). None of the studies mentioned the binding of participants while only six articles [25,29] mentioned binding of accessor. All the articles scored above 6 out of 10 indicating high quality of RCTs. PEDro scale scoring can be seen in table2
Table 2 PEDro score for methodological quality of selected articles

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IV. DISCUSSION

The objective of this systematic review was to examine the effectiveness of CCE for improving balance in people with dizziness and vertigo with and without vestibular dysfunction. Eight studies were included for this review among which two articles showed no improvement in balance [30,31] and rest of the articles showed improvement with some variations. [24-29]. In the study by Wojciech Smółka et.al. [31], no improvement is seen as group one patients who performed customized group vestibular rehabilitation showed more statistical difference than group two patients who performed home-based unsupervised CCE. Likewise, in the study by Ekin Taҫalan et.al. [30], authors concluded that CCE do not have any additional effects when given along with epley’s maneuver. S. Divya et al. [24] and Mohammad Hossein Kaveh [25] concluded that incorporation of CCE along with modified epley’s maneuver and strengthening the sensory-motor system training respectively have given positive outcomes in terms of balance and symptoms of vertigo in study subjects. Interestingly, in the study by Mayra Cristina Aratani et al. [26] and Ricci NA et.al. [27] modified CCE proved to be more helpful for certain static balance improvement and reducing dizziness. Stefano Corna et.al. [28] in their study concluded that both CCE and instrumental rehabilitation improves outcome measures, but instrumental rehabilitation has proved to be more advantageous than CCE alone. Lastly, Bilgehan Tekin Dal et.al. [29] proved that activity based functional CCE are more effective than traditional CCE in improving balance. From these observations it can be concluded that in order to improve vertigo and dizziness symptoms and balance function, CCE is very much effective if applied with other rehabilitation programs, VR and equally effective when applied alone providing multimodal mode of exercise is used. From the other two studies, which showed no significant improvement, it can be concluded that though application of CCE was combined with simple balance exercise in experimental group, it was given as home-based program that might have produced errors in results as exercises remain unsupervised by any qualified physiotherapist. [31] It is also possible that in the study by Ekin Taҫalan et.al. [30] though CCE was given along with epley’s maneuver, the effects of CCE were shadowed possibly because authors used only epley’s maneuver in control group as well, therefore masking the true effect of CCE, contrary to the study by S. Divya et al. [34] where in control group they only used Brandt–Daroff exercise which is inferior to epley’s maneuver in treating posterior BPPV. [30]
While the eight articles are being analysed in this systematic review, some methodological limitations and heterogeneity has been found in the following aspects: session duration, total duration of rehabilitation program, variations in outcome measures used in the studies.

One of the important aspect of limitations found in some of the trials is type of vestibular dysfunction and symptoms duration are not considered. Only six articles have mentioned presence of vestibular dysfunction. Among these two studies included only BPPV (only posterior one, no anterior or lateral). Study by Mohammad Hossein Kaveh et al. did not mention if the dizziness is vestibular or non-vestibular in origin. Therefore, it is important to address specific vestibular dysfunction to understand if the intervention is working only in specific disorder or in all type of vestibular dysfunctions. Three articles have specified unilateral type of vestibular dysfunction whereas as in others unilateral or bilateral involvement not mentioned. Unilateral and bilateral involvement is important aspect cause symptoms are severe in bilateral involvement rather than unilateral ones. The effectiveness of VR is proved to be equal in both unilateral and bilateral vestibular dysfunction. But as patients with bilateral dysfunction shows more disability, therefore those patients need specific and more careful supervision and selection of exercises. As some of the selected articles have not mentioned the duration of symptoms in terms of chronic or acute stage it cannot be concluded if CCE is equally effective in chronic and acute stage.

CCE were given as home program in some of the studies. As a result, there is high probability of errors being produced by the patient or the caregiver as the sessions remained largely unsupervised and this may affect the true outcome of the interventions. None of the articles have considered blinding of the participants which is a very important factor as it may affects the outcome measures and can produce false positive results.

Gender distribution pattern in sampling is a major impact factor in outcome of any studies. Inclusion of both genders male and female are equally important to understand the mass effect of exercise in population. Among all the studies selected for review, Ekin Taçalan et.al. did not mention about gender distribution, whereas two articles taken only female population. Rest of the literatures studied on mixed population (both male and female) but in all of them gender distribution is asymmetrical in nature (females are more in number) except the study by Stefano Corna et.al. Therefore, it cannot be generalized if CCE are having equal positive effects on both male and female should be carefully considered in the future trials.

Medication and its effects on intervention outcomes are of significant value as medication can decrease the efficacy or mask the effects of a rehabilitation program. Studies should specify the type of medication (related to vestibular disorder or dizziness and vertigo), and dosage for the same; which was not followed by S. Divya et. al. despite having considered medication in the control group. Only two articles have included participants without medication indicating their study results have strong value to check the efficacy of the exercises.

When CCE is used in combination with other interventions, it is difficult to estimate how much contribution the CCE is having in bringing the improvement in the patients, meaning if the other interventions are masking the true effects of CCE or not.

Patients should be cognitively intact as a proper level of cognition is important for the patients to understand the exercise program and perform. Moreover, vestibular dysfunction, is closely related to cognitive impairment, especially in elderly population and one recent study concluded that vestibular impairment is associated with hippocampal atrophy. Therefore, cognitive assessment should be done and cognitive deficit should be an exclusion criterion for the studies, followed by only a few articles. Dizziness is linked with poor vision. Moreover, vision being one of the multisensory inputs in maintaining balance, it is crucial to have an intact vision before performing vestibular rehabilitation or any balance-related exercises. Only Mohammad Hossein Kaveh et.al. performed oculomotor assessment.

During recovery, balance can be profoundly influenced by psychological factors, such as cognitive, emotional, and behavioral responses to dizziness. Psychological disorders are rarely of primary causes, but it can be common contributing and modulating factors for persons aged 60 or above with dizziness. One of the most common degenerative disorders in aged people is dementia which can also be associated with depression and other psychological disorders. These disorders can affect the daily living standards of an individual including balance. Therefore, proper assessment of psychological state is important. Most of the articles discussed in this review have used DHI which despite having psychological components as items, lacks validity as it is a self-reported questionnaire, thereby missing out on minor errors regarding emotional, behavioural, and psychological aspects.

SNHL (sensory neural hearing loss) is known to cause acute damage not only to auditory function but also to the vestibular function. Approximately 30-60% of patients with SNHL have been reported to have vertigo or imbalance. In a systematic review and meta-analysis study, authors concluded that vestibular damage is associated with SNHL. Therefore, auditory assessment is important to know the origin of the dizziness, balance problem as well the severity of the same. In addition, SSSH is prevalent in society ranging from neonates to school-going children indicating the significance of including children in the study population in future trials, which is absent in the present studies.

Lastly, all included articles investigated the short-term effects of the interventions and none of the articles have mentioned if the therapeutic interventions had any adverse effects on patients except by Ekin Taçalan et.al.

Future trials should control gender bias, mention blinding of the subjects, exclude self-reported outcome measures and include proper psychological, cognitive, visual, and auditory assessment of the patients. Future trials should also observe the long-term effects of the CCE, and the difference in effectiveness between home-based programs and clinical setups (under the supervision of a qualified therapist). In addition, the effects of medication and adverse effects of interventions should be
considered. The type of vestibular dysfunction involved, bilateral or unilateral involvement is also of value to understand the true effect of CCE on patients.

One pilot study was done recently to study the effect of CCE given virtually through developing a gaming program for patients with Meniere’s disease where balance was significantly improved.[62] Therefore, CCE in form of virtual reality and telerehabilitation can be considered a potential area for research in the future. Additionally, in recent years of pandemic, strong evidence has been found indicating patients with symptoms of dizziness show balance impairments due to covid-19. [53,54] So, in future, study population should include patients affected with covid-19 to investigate the effects of CCE.

V. CONCLUSION

The aim of this study was to investigate the effectiveness of CCE for improving balance in people with dizziness and vertigo with and without vestibular dysfunction. After assessing all the included studies, it can be concluded that CCE is effective as a vestibular intervention protocol for improving balance in patients with dizziness and vertigo, provided a modified or multimodal form is used or CCE is used in combination with other effective intervention protocols.

REFERENCES

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