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# Effect of Vestibular Rehabilitation on Dizziness and Balance Disorders in Traumatic Brain Injury Patients: A Systymatic Review

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## Abstract

*Background:* A traumatic brain injury is an alteration in brain function, or other evidence of brain pathology, caused by an external force. It is a common cause of long term disability in the areas of physical, cognitive, behavioral, and emotional functioning in young adults.

*Aim of Study:* To summarize the best evidence of the effect of vestibular rehabilitation for dizziness and balance disorders in traumatic brain injury patients.

*Subjects and Methods:* By using electronic database: Pubmed, Cochrane library and google scholar. Randomized Control Trials (RCTs) were only included in this review and the others were excluded according to eligibility criteria.

*Results:* Five RCTs were only included in this review with 230 patients met the inclusion criteria, the duration of treatment ranged from twice to four times aweek for four to eight weeks. The results showed level (1a) evidence for the effectiveness of vestibular rehabilitation therapy in improving dizziness and balance disorders in traumatic brain injury patients. All included studies showed positive effects in the measured outcomes, Meta-analyses statistics used in this review in three studies that measured dizziness, and descriptive analysis in three studies that measured balance. Vestibular rehabilitation has no significant effect in dizziness and balance disorders in traumatic brain injury patients.

*Conclusion:* The current study showed that, vestibular rehabilitation is a safe and beneficial intervention, speeding up recovery but has no superior effect on dizziness and balance disorders in traumatic brain injury patients compared to other conventional rehabilitation interventions. This evidence is based on a limited number of RCTs and more high-quality RCTs are needed to support this evidence.

***Key Words:*** *Vestibular rehabilitation – Traumatic brain injury – Concussion – Head trauma – Balance – Dizziness – Unsteadiness – Systematic Review.*

## Introduction

**TRAUMATIC** brain injury (TBI) has an impact on a patient's functional abilities and quality of life [1]. After a traumatic brain injury TBI, dizziness and balance disorders are thought to be negative prognostic factors that could lead to functional limits and emotional distress, which would lower the patient's quality of life and hinder their ability to resume work [2]. The word "dizziness" is quite general. Along with the more overt signs of vertigo (the sensation of spinning) and instability, it also includes a generalized sense of confusion and loss of balance [3]. Balance disorders are linked with longer hospitalization, increased the risk of falling, delayed recoveries, increased medical complications and gait problems [4]. Vestibular rehabilitation therapy (VRT) is accepted and often used for dizziness and balance problems management. Vestibular rehabilitation is a comprehensive concept which includes balance training and compensation after a vestibular injury in other causes of vertigo, dizziness and balance disorders [5]. Dizziness and balance disorders are frequently reported by traumatic brain injury (TBI) patients, with an incidence of 23% to 81% [6].

Specific exercises are used in the vestibular rehabilitation therapy approach to reduce dizziness, improve balance, and boost overall activity levels. Exercises to reduce dizziness emphasis exposure to particular stimuli for habituation or attenuation of the brain's dizziness responce.Exercises for increasing the quality of sensory information for balance control and coordination of muscular responses are part of balance retraining [7]. According to studies, people with TBI who had vestibular rehabilitation therapy (VRT) have less dizziness and balance disorders [8].

## Subjects and Methods

*Data sourses:*

The three electronic databases PubMed, Cochrane library and Google scholar were searched

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from inception up to May 2022. Searching was done related the three main criteria of patients, intervention and outcome. For patient (Traumatic brain injury "OR Concussion" OR Head trauma "OR Brain injury").For intervention (Vestibular rehabilitation). For outcome (dizziness "OR balance disorders" "OR mobility" OR unsteadiness).

*Study selection:*

Two independent reviewers reviewed the collected records, first by title then by abstract and finally by full text, using the following inclusion criteria: (1) Design: Randomized control trials puplished in english language from 2011 up to May 2022. (2) Population: Adults (age >18 years) from both genders with any type of Traumatic brain injury (TBI). (3) Intervention: Any forms of vestibular rehabilitation therapy. (4) Control / Comparator: Traditional treatment or no intervention. (5) Outcome: Dizziness measured by: Dizziness Handicap Inventory (DHI) and The Rivermead Post-concussion Symptoms Questionnaire (RPQ3) and Balance measured by: Videonystagmography, Berg Balance Scale (BBS) and Balance error Scoring System (BESS). Studies were excluded from this review if they met any of the following criteria: (1) Cross sectional, cohort, case control, case series, case studies and any reviews other than RCTs. (2) Articles published in non-English language.

Data were extracted from the articles by one of the reviewers (N.G.R). As well as a second reviewer doublechecked it.

## Results

*Search results:*

Of the 1127 retrieved articles, 263 were eliminated as duplicates, 846 were eliminated because they did not fulfill the established inclusion and exclusion criteria of the articles, 13 presented with inadequate study design and were therefore not included. The search last updated in May 2022; five papers were included in the review after they were evaluated against the eligibility criteria. Results of the search are presented in the following PRISMA flowchart (Fig. 1) **[9]**.

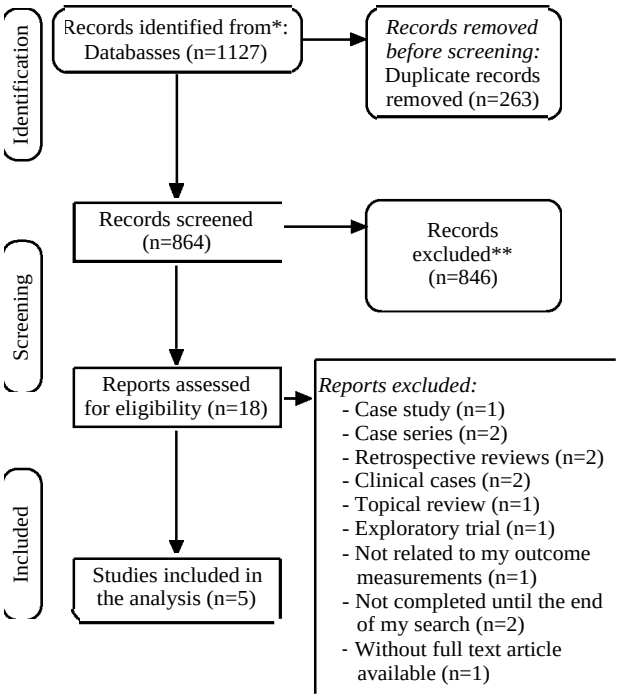


Fig. (1): Preferred Reporting Items for Systematic Reviews and Meta-Analyses diagram of study refinement and selection procedure (PRISMA).

*Quality assessment:*

The PEDro scale was used to assess the methodological quality of the included studies **[10]**. Two authors independently used the PEDro scale to assess the studies, and the third author resolving any disagreements.

The methodological quality was rated using the following classification: PEDro score of less than 4=poor quality; 4-5=fair quality; 6-8=good quality; and 9-10=excellent quality **[11]**.

*Description of the included studies:*

The collected studies were summarized in Table (2). From Table (2) we can conclude that there is homogeneity in patient's characteristics as age average and duration of diagnosis, intervention as all patients treated by the different form of vestibular rehabilitation therapybut there is heterogeneity in outcomes measurements.

Table (1): Methodology assessment of studies according to the Physiotherapy Evidence Database (PEDro) scale.

| Study | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Total score (0:10) | Quality |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Naguib et al., 2014 | Y | N | Y | N | N | N | Y | Y | N | Y | 5 | Fair |
| Cuthbert et al., 2014 | Y | N | Y | Y | Y | Y | Y | N | Y | Y | 8 | Good |
| Jafarzadeh et al., 2018 | Y | N | N | N | N | N | Y | N | Y | Y | 4 | Fair |
| Kleffelgaard et al., 2019 | Y | Y | Y | N | N | Y | N | Y | Y | Y | 7 | Good |
| Soberg et al., 2021 | Y | N | Y | N | N | Y | Y | Y | Y | Y | 7 | Good |

Table (2): Summary of included studies.

| Author (Year) | Subjects number (M/F) | Selection criteria | Intervention | Protocol | Outcome (measure) | Main results |
|---|---|---|---|---|---|---|
| Naguib et al., 2014 | Age range 60 (43/17) (20:50) | - Patients had not previously complained of otologic or other causes of balance difficulties, nor had they used any sedatives or tranquillizers. | - G Ibetahistine dihydrochloride)<br>- G II standard Vestibular Rehabilitation program)<br>- G HIbetahistinedihydrochloride and standard vestibular rehabilitation program) | - Betahistinedihydrochloride tablets 48 mg/d<br>- Vestibular rehabilitation program twice a day, six days a week, with a rest on the seventh day | - Balance (Videonystagmography) | - Patients with head injuries who underwent vestibular therapy right away (with or without the addition of betahistinedihydrochloride) recovered faster than those who only received betahistinedihydrochloride. |
| Cuthbert et al., 2014 | 20 (13/7) 18 y or more | -From the time of the accident until they were admitted for rehabilitation, patients had been continuously hospitalised.<br>- Were able to give permission within 21 days of admission<br>- Occurred within 6 months of the injury.<br>- Obtained a minimum Berg Balance Scale score of 15<br>- Were successful in finishing a 10-minute test utilising the readily available VR gaming device (the Nintendo Wii). | - G I Virtual Reality Therapy (VRT)<br>- G II : Extra Standard Care (ESC) | - Training four-times per week for a total of four weeks. | - Balance (Berg Balance Scale (BBS) | - Both groups demonstrated improved static balance over the course of the study, with no significant differences between groups. |
| Jafarzadeh et al., 2018 | 20 (NR) (18:60) | - Vertigo and dizziness brought on by head trauma within the previous six months.<br>- No neck, cervical, ocular, or cognitive issues were found during the neurologic and otologic evaluations.<br>- A Glasgow coma score of at least 9. (10).<br>- Variations that show a vestibular anomaly on cervical Vestibular Evoked Myogenic Potential (cVEMP) or Dynamic Posturography. | - G I medical therapy (Betaserc) and Vestibular rehabilitation<br>- G II the usual medical therapy (Betaserc) | - Training for four weeks. | - Dizziness (unsteadiness) (Dizziness Handicap Inventory DHI ) | - No significant difference between the two groups in the total score and subtests at the beginning of the program |

Table (2): Count.

| Author (Year) | Subjects number (M/F) | Selection criteria | Intervention | Protocol | Outcome (measure) | Main results |
|---|---|---|---|---|---|---|
| Kleffel gaard et al., 2019 | 65 (20/45) (16:60) | - Patients with traumatic brain injury reported mild, moderate, or severe feelings of dizziness on the Rivermead-PostConcussion Symptoms<br>- Had a positive Romberg's test | - G I vestibular rehabilitation therapy (VRT)<br>- G II no treatment | - Training twice weekly for eight weeks | - Dizziness (Dizziness Handicap Inventory DHI) and (The Rivermead Post-concussion Symptoms Questionnaire (RPQ3))<br>- Balance (Balance Erorr Scoring System BESS) | - No group differences were seen at the beginning. At the first follow-up, the DHI result showed statistically significant mean differences in favour of the intervention.<br>- The DHI outcome showed no significant between-group differences at the second follow-up.<br>- At the two follow-ups, there were no significant between-group differences in the other outcomes (RPQ3 and BESS). |
| Soberg et al., 2021 | 65 (19/45) (16:60) | - Patients with a TBI diagnosis reporting mild, moderate, or severe feelings of dizziness on the Rivermead Post-concussion Symptoms Questionnaire<br>- Had a positive Romberg's test.<br>- Had a score on the DHI >15 points. | - G I vestibular rehabilitation therapy (VRT)<br>- G II usual treatment | - VRT 16 sessions over eight weeks | - Dizziness (The Rivermead Post-concussion Symptoms Questionnaire (RPQ3)) | - No significant between-group differences in theRPQ3 outcome |

G: Group.

Synthesis of Results:

*Statistical analysis:*

*Dizziness (DHI):*

Two studies assessed dizziness by DHI between experimental group and control group to improve dizziness in patients after traumatic brain injury (Fig. 2). There was substantial heterogeneity in dizziness between two studies (n=2 studies, n=78 participants, $p$=0.08; $I^2$=66%). There was no significant difference ($p$=0.88; $p$>0.05) in overall effect of dizziness (SMD=–0.07; 95% CI, –0.94 to 0.81) between experimental group and control group.

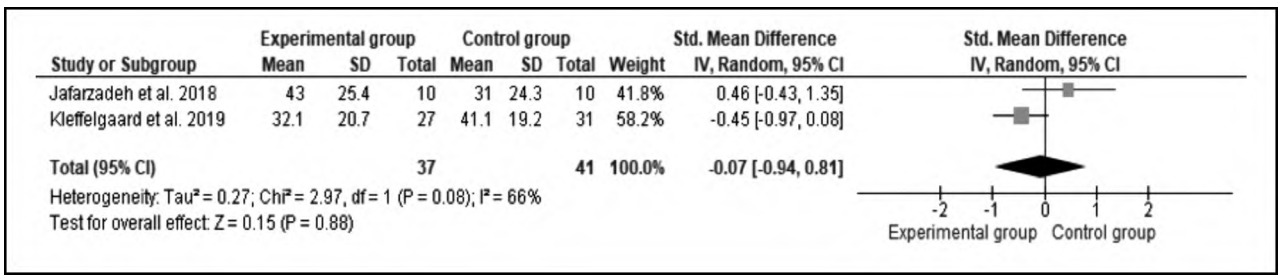


Fig. (2): Forest plot overall meta-analysis of Dizziness Handicap Inventory (DHI) Dizziness (RPQ3).

*Dizziness (RPQ3):*

Two studies assessed dizziness by RPQ3 between experimental group and control group to improve dizziness in patients after traumatic brain injury (Fig. 3). There was moderate heterogeneity in dizziness between two studies (n=2 studies, n=185 participants, $p$=0.23; $I^2$= 31 %). There was no significant difference ($p$=0.10; $p$>0.05) in overall effect of dizziness (SMD=–0.31; 95% CI, –0.67 to 0.05) between experimental group and control group.

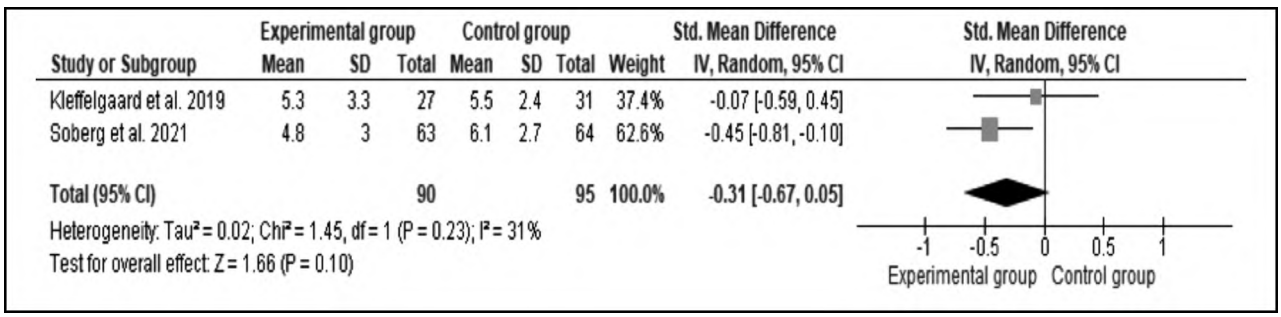


Fig. (3): Forest plot overall meta-analysis of The Rivermead Post-concussion Symptoms Questionnaire (RPQ3).

Descriptive analysis:

*Balance:*

There were three studies Naguib et al., **[12]**, Cuthbert et al., **[4]** and Kleffelgaard et al., **[2]** were analytic by descriptive way.

Naguib et al., (2014) reported that early vestibular rehabilitation accelerated recovery, which was facilitated by the administration of betahistinedihydrochloride, since the mean recovery time in patients receiving solely betahistine was 62.1 days (SD 20.8 days). That was markedly (Pb.05) longer than the 37.6 days (SD 18.2 days) for individuals who only got early vestibular rehabilitation or the 34.4 days (Pb.05) for those who received both treatments (SD 14.0 days).

Cuthbert et al., (2014) demonestrated that for Berg Balance Scale BBS there was no significant between group differences as ($p$=0.17; $p$>0.05) and also for Functional Gait Assessment FGA there was no significant between group differences as ($p$=0.18; $p$>0.05).

Kleffelgaard et al., (2019) demonestrated that there is no significant between group differences in the Balance Error Scoring System BESS were found as ($p$=0.15; $p$>0.05).

*Level of evidence:*

Based on modified sacketts scale there is level 1 a evidence for the effect of vestibular rehabilitation therapy on improving dizziness and balance disorders when compared to conventional therapy; with no significant difference between both groups' results.

## Discussion

The purpose of the current review was to evaluate the effect of vestibular rehabilitation on dizziness and balance disorders in traumatic brain injury patients. The review was able to answer the main research questions, the number of studies and patients was limited, so it was difficult to draw a final conclusion.

Five RCTs are included in this study with two outcomes dizziness and balance disorders, Dizziness is measured in three studies Jafarzadeh et al., **[16]**, Kleffelgaard et al., **[2]** and Soberg et al., **[3]**. Jafarzadeh et al., **[16]** and Kleffelgaard et al., **[2]** measured dizziness by Dizziness Handicap Inventory (DHI), this allowed to do meta-analysis for the results. Kleffelgaard et al., **[2]** also measured dizziness by Rivermead Post-concussion Symptoms Questionnaire (RPQ3) similar to Soberg et al., **[3]** and this allowed to do meta-analysis for the results.

Balance is measured in three studies Naguib et al., **[15]**, Cuthbert et al., **[4]** and Kleffelgaard et al., **[2]**. Naguib et al., **[15]** measured balance by Videonystegmography, Cuthbert et al., **[4]** measured balance by Berg Balance Scale (BBS) and Kleffelgaard et al., **[2]** measured balance by Balance Error Scoring System (BESS), different ways of measurement did not allow to do meta-analysis so the results were analyzed descriptively.

Two studies Jafarzadeh et al., **[16]** and Kleffelgaard et al., **[2]** measured dizziness by DHI with forty-three patients in intervention group and forty-two patients in control group and demonstrated that there is no significant differences between both groups.

Two studies Klefflegaard et al., **[2]** and Soberg et al., **[3]** measured dizziness by RPQ3 with sixty-six patients in intervention group and sixty-four patients in control group and demonstrated that there is no significant differences between both groups.

Naguib et al., **[15]** measured balance by Videonystegmography with twenty patients in each group and demonstrated that early vestibular rehabilitation with the concomitant use of betahistinedihydrochloride sped up recovery and improved balance.

Cuthbert et al., **[4]** measured balance by BBS with ten patients in intervention group and ten patients in control group and demonstrated that there was no significant differences between both groups.

Klefflegaard et al., **[2]** assessed balance by BESS with thirty-three patients in intervention group and thirty-two patients in control group and demonstrated that there was no significant differences between both groups.

Naguib et al., **[15]** and Jafarzadeh et al., **[16]** reported that patients receiving vestibular rehabilitation and medication (betahistine Dihydrochloride) showed greater progress than patients receiving medication only.

Similar to Murray et al., **[12]** who reported in his systematic review that there was a little support for VRT after mild traumatic brain injury (mTBI) or concussion.

As Booth et al., **[13]** reported in their systematic review that vestibular rehabilitation therapy had a moderate to strong impact on reducing dizziness and balance impairments in patients with concussions; however, the systematic review included two randomized controlled trials and four case series studies, so the conclusion can't be confirmed.

Simultaneous treatment with medicine and vestibular rehabilitation exercises can result in quicker and better therapeutic effects.

The choice of the optimum management protocol for patients who develop balance disorders following head trauma is controversial. Pharmacological therapy is used by some authors to improve the recovery process. Others feel that drugs may be counterproductive with respect to the eventual desired outcome of vestibular rehabilitation of patients especially those drugs with a vestibular suppressant action **[14]**.

*Strength of the study:*

This study depended mostly on good quality RCTs that published from 2011 to 2022. All studies used different types of vestibular rehabilitation therapy.

*Limitation:*

The limitation of the review is that the researcher could found only one study (1) that measured the secondary outcome (mobility), few numbers of RCT studies, And we can't do meta-analysis for all results.

*Conflict of interest:*

Author(s) declared no possible conflicts of interest.

*Funding:*

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# تأثير إعادة تأهيل دهليز الأذن للدوار واضطرابات التوازن فى مرضى إصابات الرأس : دراسة منهجية

خلفية البحث : إصابات الرأس عبارة عن تغيير فى وظائف الدماغ، أو وجود أدلة أخرى على مرض الدماغ بسبب قوة خارجية، وهى سبب شائع للإعاقة طويلة المدى فى الوظائف الجسدية والعقلية والسلوكية والإجتماعية فى الشباب.

الهدف : تهدف هذه الدراسة المرجعية إلى عمل تلخيص للدراسات السابقة وتقييم تأثير إعادة تأهيل دهليز الأذن للدوار واضطرابات التوازن فى مرضى إصابات الرأس.

طرق البحث : بواسطة استخدام البيانات الإلكترونية التالية : PubMed Cochrane library ,Google scholar بجانب فحص جميع قوائم المراجع الأخرى وتتضمن الدراسات المختارة الدراسات العشوائية فقط طبقاً لمعايير الاشتمال المختارة.

النتائج : وقع الاختيار على خمسة دراسات ٢٣٠ مريضاً تراوحت مدة العلاج لهم من مرتين إلى أربعة مرات أسبوعياً لمدة تراوحت بين أربعة وثمانية أسابيع. جميع الدراسات المدرجة أشارت إلى أن هناك تأثير إيجابى فى النتائج التى تم قياسها قد مت النتائج دليلاً من المستوى ١ أعلى أن إعادة تأهيل دهليز الأذن فعال فى علاج مشاكل الدوار واضطراب التوازن ى فى مرضى إصابات الرأس. استخدام التحليل الإحصائى فى هذه الدراسة فى ثلاثة دراسات، التحليل الوصفى فى ثلاثة دراسات. إعادة تأهيل دهليز الأذن ليس لها تأثير هاماً فى علاج الدوار وإضطرابات التوازن عقب إصابات الرأس.

الإستنتاج : هذه الدراسة أظهرت أن إعادة تأهيل دهليز الأذن هو علاج آمن ومفيد، يسرع الشفاء ولكن ليس لديه تأثير يفوق العلاج التقليدى على الدوار واضطرابات التوازن فى مرضى إصابات الرأس. هذا الدليل يعتمد على عدد محدود من التجارب السريرية وهناك حاجة إلى المزيد من التجارب السريرية عالية الجودة لد عم هذا الدليل.