Effect of Vestibular Rehabilitation on Dizziness and Balance Disorders in Traumatic Brain Injury Patients: A Systematic 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 a week 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.


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 response. 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 sources:
The three electronic databases PubMed, Cochrane library and Google scholar were searched.
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 col-
lected records, first by title then by abstract and
finally by full text, using the following inclusion
criteria: (1) Design: Randomized control trials
published 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 interven-
tion. (5) Outcome: Dizziness measured by: Dizz-
iness Handicap Inventory (DHI) and The Rivermead
Post-concussion Symptoms Questionnaire (RPQ3)
and Balance measured by: Videonystagmography,
Berg Balance Scale (BBS) and Balance error Scor-
ing 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 elim-
nated as duplicates, 846 were eliminated because
d 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].

Quality assessment:
The PEDro scale was used to assess the meth-
odological 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;

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 vesti-
bular rehabilitation therapybut there is heterogeneity
in outcomes measurements.

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

<table>
<thead>
<tr>
<th>Study</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Total score (0:10)</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naguib et al., 2014</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>5</td>
<td>Fair</td>
</tr>
<tr>
<td>Cuthbert et al., 2014</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>8</td>
<td>Good</td>
</tr>
<tr>
<td>Jafarzadeh et al., 2018</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>4</td>
<td>Fair</td>
</tr>
<tr>
<td>Kleffelgaard et al., 2019</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>7</td>
<td>Good</td>
</tr>
<tr>
<td>Soberg et al., 2021</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>7</td>
<td>Good</td>
</tr>
</tbody>
</table>
Main results
- Patients with head injuries who underwent vestibular therapy right away (with or without the addition of betahistine dihydrochloride) recovered faster than those who only received betahistine dihydrochloride.
- Both groups demonstrated improved static balance over the course of the study, with no significant differences between groups.

Outcome (measure)
- Balance (Videonystagmography)
- Balance (Berg Balance Scale (BBS))

Selection criteria
- From the time of the accident until they were admitted for rehabilitation, patients had been continuously hospitalised.
- Were able to give permission within 21 days of admission
- Occurred within 6 months of the injury.
- Obtained a minimum Berg Balance Scale score of 15
- Were successful in finishing a 10-minute test utilising the readily available VR gaming device (the Nintendo Wii).
- Vertigo and dizziness brought on by head trauma within the previous six months.
- No neck, cervical, oculocerebellar, or cognitive issues were found during the neurologic and otologic evaluations.
- A Glasgow coma score of at least 9. (10).
- Variations that show a vestibular anomaly on cervical Vestibular Evoked Myogenic Potential (cVEMP) or Dynamic Posturography.

Table (2): Summary of included studies.

<table>
<thead>
<tr>
<th>Author (Year)</th>
<th>Subjects number (M/F)</th>
<th>Selection criteria</th>
<th>Intervention</th>
<th>Protocol</th>
<th>Outcome (measure)</th>
<th>Main results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naguib et al., 2014</td>
<td>Age range 60 (43/17) (20:50)</td>
<td>- Patients had not previously complained of otologic or other causes of balance difficulties, nor had they used any sedatives or tranquilizers.</td>
<td>- G I beta-histidine dihydrochloride</td>
<td>- Beta-histidine dihydrochloride tablets 48 mg/d</td>
<td>- Balance (Videonystagmography)</td>
<td>- Patients with head injuries who underwent vestibular therapy right away (with or without the addition of beta-histidine dihydrochloride) recovered faster than those who only received beta-histidine dihydrochloride.</td>
</tr>
<tr>
<td>Cuthbert et al., 2014</td>
<td>20 (13/7) 18 y or more</td>
<td>- From the time of the accident until they were admitted for rehabilitation, patients had been continuously hospitalised.</td>
<td>- G I: Virtual Reality Therapy (VRT)</td>
<td>- Training four times per week for a total of four weeks</td>
<td>- Balance (Berg Balance Scale (BBS))</td>
<td>- Both groups demonstrated improved static balance over the course of the study, with no significant differences between groups.</td>
</tr>
<tr>
<td>Jafarzadeh et al., 2018</td>
<td>20 (NR) 18:60</td>
<td>- Vertigo and dizziness brought on by head trauma within the previous six months.</td>
<td>- G I medical therapy (Betaserc) and Vestibular rehabilitation</td>
<td>- Training for four weeks.</td>
<td>- Dizziness (unsteadiness) (Dizziness Handicap Inventory DHI )</td>
<td>- No significant difference between the two groups in the total score and subtests at the beginning of the program</td>
</tr>
</tbody>
</table>
Main results

- 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.
- The DHI outcome showed no significant between-group differences at the second follow-up.
- At the two follow-ups, there were no significant between-group differences in the other outcomes (RPQ3 and BESS).

### Table (2): Count.

<table>
<thead>
<tr>
<th>Author (Year)</th>
<th>Subjects number (M/F)</th>
<th>Selection criteria</th>
<th>Intervention</th>
<th>Protocol</th>
<th>Outcome (measure)</th>
<th>Main results</th>
</tr>
</thead>
</table>
| Kleffelgaard et al., 2019 | 65 (20/45) (16:60) | - Patients with traumatic brain injury reported mild, moderate, or severe feelings of dizziness on the Rivermead Post-Concussion Symptoms Questionnaire  
- Had a positive Romberg's test | - GI vestibular rehabilitation therapy (VRT)  
- GII no treatment | - Training twice weekly for eight weeks | - Dizziness (Dizziness Handicap Inventory DHI) and (The Rivermead Post-concussion Symptoms Questionnaire (RPQ3))  
- Balance (Balance Error 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.  
- The DHI outcome showed no significant between-group differences at the second follow-up.  
- 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  
- Had a positive Romberg's test  
- Had a score on the DHI >15 points. | - GI vestibular rehabilitation therapy (VRT)  
- GII usual treatment | - VRT 16 sessions over eight weeks | - Dizziness (The Rivermead Post-concussion Symptoms Questionnaire (RPQ3)) | - No significant between-group differences in the RPQ3 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).](image)

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).](image)

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 betahistine-dihydrochloride, since the mean recovery time in patients receiving solely betahistine was 62.1 days (SD 20.8 days). That was markedly (\( p<0.05 \)) longer than the 37.6 days (SD 18.2 days) for individuals who only got early vestibular rehabilitation or the 34.4 days (\( p<0.05 \)) for those who received both treatments (SD 14.0 days).

Cuthbert et al., (2014) demonstrated 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) demonstrated 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 Video-nystagmography, 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 Kleffelgaard 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 Video-nystagmography with twenty patients in each group and demonstrated that early vestibular rehabilitation with the concomitant use of betahistine Dihydrochloride 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.

Kleffelgaard 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:

The author(s) received no financial support for their search.
References


تأخير إعادة تأهيل دهليز الأذن للدوار واضطرابات التوازن في مرضى إصابات الرأس: دراسة منهجية

خلفية البحث: إصابات الرأس عبارة عن تغيير في وظائف الدماغ، أو وجود ألم آخر على مرضي الدماغ بسبب قوة خارجية، وهي سبب شائع لإعادة طويلة المدى في الوظائف الجسدية والعقلية والسلوكية والاجتماعية في الشباب.

الهدف: تهدف هذه الدراسة المرجعية إلى عمل تقييم لدراسة السابقة وتقييم تأثير إعادة تأهيل دهليز الأذن للدوار واضطرابات التوازن في مرضى إصابات الرأس.

المراجع الأخرى وتتضمن الدراسات المختارة الدراسات العشوائية فقط طبقاً لمعايير الاشتغال المختارة.

طرق البحث: بواسطة استخدام البيانات الإلكترونية التالية: PubMed Cochrane library, Google scholar

النتائج: قبض على خمسة دراسات 20 مريضاً تراواحت مدة العلاج لهم من مرتين إلى أربعة مرات أسبوعياً لمدة تراوحت بين أربعة وثمانية أسابيع. جميع الدراسات المرجعية أشارت إلى أن هناك تأثير إيجابي في النتائج التي تم قياسها قد تتضمن تأثير دهليز الأذن. استخدم التحليل الإحصائي في هذه الدراسة في ثلاثة دراسات، التحليل الوصفي في ثلاثة دراسات. إعادة تأهيل دهليز الأذن ليس له تأثير هامًا في علاج الدوار واضطرابات التوازن.

الاستنتاج: هذه الدراسة أظهرت أن إعادة تأهيل دهليز الأذن هو علاج آمن ومفيد، يسعف الشفاء ولكن ليس لديه تأثير يقفع العلاج التقليدي على الدوار واضطرابات التوازن في مرضى إصابات الرأس. هذا الدليل يعتمد على عدد محدود من التجارب السريرية وهناك حاجة إلى المزيد من التجارب السريرية عالية الجودة لدعم هذا الدليل.