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The Effect of Visual Feedback on Balance Rehabilitation in People with Impaired Ankle Instability: A Systematic Review and Meta-Analysis

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ADMINISTRATIVE INFORMATION

Support - No.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 15 June 2024 and was last updated on 15 June 2024.

INTRODUCTION

Review question / Objective Aim: The aim of this systematic review and meta-analysis was to(1) comprehensively assess the possible effects of visual feedback on balance exercise in a population with ankle instability;(2) Quantify the effects of visual feedback on balance in a population with ankle instability.

Rationale Background: Ankle instability is a common sequela of ankle injuries that can affect balance performance and daily life, so visual feedback is often utilized in rehabilitation to enhance training. However, there are inconsistencies in the scientific literature regarding the effect size of visual feedback and the best way to provide visual feedback.

Condition being studied Ankle sprains are one of the common skeletal injury events associated with sports, accounting for approximately 15% of all sports injuries[1]. Impacts on ankle structures and proprioceptive systems, with recurrent ankle sprains, mechanical laxity and perceived instability (usually described as a feeling of the ankle joint "giving way")[2].Lack of attention to rehabilitation after ankle sprains in many patients leads to a high rate of injury recurrence and raises the probability of developing ankle dysfunction, including functional ankle instability (FAI) and chronic ankle instability (CAI)[3,4].Ankle instability not only leads to impaired ligament fiber integrity and broken joint movement patterns[5,6], but also decreased balance and dorsiflexion range of motion in impaired individuals[1,7]. The above effects may increase the risk of tripping, falling or re-spraining the ankle, with long-term adverse effects on quality of life and ability to perform activities of daily living, making rehabilitative exercises necessary for those with ankle instability[8].

For conventional clinical diagnostic and surgical treatments, past research have found that their effectiveness and patient satisfaction may be low[9].Given the available treatments, emphasis has been placed on prevention of ankle injuries and rehabilitation of ankle instability[10,11]. Researchers continue to explore effective and cost-effective rehabilitation methods, including stability-based balance exercises, strength training, neurofeedback training, and multimodal training. These methods have been found to be effective in improving balance and postural control in patients with ankle injuries and positively affecting the recovery of ankle functional mobility[12–15].

METHODS

Search strategy A systematic search of the Cochrane Central Register of Controlled Trials, MEDLINE, Web of Science, and PubMed databases was conducted by the first author in April 2024 according to the PERSiST guidelines[28].Depending on the search design of the different databases, searches were conducted using "ALL Fields" in Pubmed and MEDLINE; "Topic" in Web of science; and "ALL TEXT" in the Cochrane Central Register of Controlled Trials.

Participant or population People with Impaired Ankle Instability.

Intervention Providing Visual Feedback in Balance Rehabilitation.

Comparator Does not provide visual feedback in balance rehabilitation.

Study designs to be included Studies comparing visual feedback exercise therapy interventions with conventional exercise control therapies, cluster randomized trials, and randomized crossover studies were included.

Eligibility criteria All duplicate studies were excluded by the first author, and titles and abstracts of all remaining studies were independently screened for relevance by two researchers. (C.W. and L.S.)Disagreements were resolved by discussion or by another researcher(J.L.), and the full text was finally assessed for eligibility.Inclusion of articles must comply with the following criteria:(1) Original research studies;(2) Research conducted on or likely to benefit the population with ankle instability;(3) Full text written in English;(4) Involves enhanced visual feedback of some type;(5) Involves improvement of balance indicators or balance functions;(6) Studies comparing visual feedback exercise therapy interventions with conventional exercise control therapies, cluster randomized trials, and randomized crossover studies were included. Literature that did not fulfill the above criteria was excluded . At the same time, "forwards searching" and " backwards searching" are applied according to the criteria to make up for the missing documents.

Information sources Data analysis of images in text was performed using PlotDigitizer in the face of missing experimental data, and authors were asked to provide it via email when missing data in text was encountered .A systematic search of the Cochrane Central Register of Controlled Trials, MEDLINE, Web of Science, and PubMed databases was conducted by the first author in April 2024 according to the PERSiST guidelines.

Main outcome(s) Visual feedback improves balance rehabilitation effects. Improvement of static balance, dynamic balance, and balance perception during balance exercise. The provision of visual feedback simultaneously increased subjective motivation to train and increased satisfaction and enjoyment of rehabilitation training. The results demonstrated that visual feedback improved the Foot and Ankle Ability Measure by approximately 17% (g=2.42,95%CI=0.72-4.12,I2[total]=0%).Also by providing visual feedback during the training cycle, the star excursion balance test(SEBT) may be positively affected (g=4.83,95%CI=3.09-6.56, I2[total]=21%). Also the biodex system's performance on measures of balance will be highly improved(g=0.14,95%CI=0.01-0.28,I2[total]=24%).

Additional outcome(s) For the foot and ankle ability measure, a stronger effect was found for the visual training group (g=2.42,95%CI=0.72-4.12, I2[total]=0%).Among them, visual feedback training was found to have a strong benefit for FAAM-ADL(g=2.58,95%CI= 0.72-4.43,p=0.007)and no effect for FAAM-SPROTS(p=0.44).For the balance data measured by the Biodex Balance system, a stronger effect was found for the visual training group(g=0.14,95%CI=0.01-0.28,I2[total]=24%). Significant effects were demonstrated in dynamic balance tests (g=0,35, 95%CI=0.11-0.60, p=0.005).There was no significant effect in the static balance test (g=0.07,95%CI=-0.08-0.22, p=0.34). For the star excursion balance test, a stronger effect was found for the visual training group (g=4.83, 95%CI=3.09-6.56, I2[total]=21%).More significant are the Posterior-medial (g=6.41, 95%CI=2.68-10.15, p=0.0008),Posterior-lateral (g=6.85, 95%CI=1.18-12.53,p=0.02)and Lateral (g=7.42, 95%CI=0.49-14.35, p=0.04) directions.

Data management To analyze benefits, we calculated effect sizes in individual studies as standardized differences in means, allowing combining and comparing various outcomes assessed in individual trials.Meta-analysis was performed using Review Manager 5.4.1, and combined effect sizes were reported using 95 % confidence intervals and 95 % prediction intervals. 95 % confidence intervals that do not cross zero indicate statisticalsignificance.In order to compare the effects of visual feedback on balance ability, pre- and post-performance changes in the feedback and control groups were utilized. The mean of the M(change) was calculated as: M(post)-M(pre). Before and after standard deviations (SD change) were calculated using recognized formulas (Cochrane handbook for systematic reviews of interventions)[32]. The included studies did not report correlation values, so r = 0.5 was used for the correlation coefficient. When data expressed as standard deviation + standard error (SE) were encountered, The Cochrane Handbook calculation tool was applied to convert SE to SD. Meta-analysis of the transformed data was performed using the random effects model, and sensitivity analysis was performed when I2 was >50% to investigate potential sources of heterogeneity. When outlier effects were found in the data, it was investigated whether the heterogeneity found after removing the outlier effects was acceptable. If heterogeneity is acceptable, models without outlier effects are retained.

Quality assessment / Risk of bias analysis The Cochrane Risk Assessment Tool was used to assess the risk of bias for included articles.The assessment was performed independently by two reviewers(C.W. and L.S.).Disagreements were resolved via consensus or by a third reviewer(J.L.)if necessary.

Strategy of data synthesis In order to compare the effects of visual feedback on balance ability, pre- and post-performance changes in the feedback and control groups were utilized. The mean of the M(change) was calculated as: M(post)-M(pre). Before and after standard deviations (SD change) were calculated using recognized formulas (Cochrane handbook for systematic reviews of interventions)[32]. The included studies did not report correlation values, so r = 0.5 was used for the correlation coefficient. When data expressed as standard deviation + standard error (SE) were encountered, The Cochrane Handbook calculation tool was applied to convert SE to SD. Meta-analysis of the transformed data was performed using the random effects model, and sensitivity analysis was performed when I2 was >50% to investigate potential sources of heterogeneity. When outlier effects were found in the data, it was investigated whether the heterogeneity found after removing the outlier effects was acceptable. If heterogeneity is acceptable, models without outlier effects are retained.

Subgroup analysis For the subgroup analysis of SEBT metrics we analyzed all 8 directions. The final results are shown in Figure 5.For the star excursion balance test, a stronger effect was found for the visual training group (g=4.83, 95%CI=3.09-6.56, I2[total]=21%). More significant are the Posterior-medial (g=6.41, 95%CI=2.68-10.15, p=0.0008),Posterior-lateral(g=6.85,95%CI=1.18-12.53,p=0.02)and Lateral (g=7.42,95%CI=0.49-14.35,p=0.04) directions.

Sensitivity analysis Sensitivity analysis using Revman 5.4 funnel plots, see Supplementary Material.

Language restriction No.

Country(ies) involved China.

Keywords Augmented Feedback, balance exercise, virtual reality, the star excursion test, visualisation.

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