

FEBRUARY 2026

Dear IPNFA®Members, Dear Friends

We present the next IPNFA® Newsletter prepared by the Research Committee. Below you will find the newest articles approved by the members of our committee. You can find also information about newest events in the field of our PNF. Please enjoy it

Our annual meeting took place in October 2025, this time in Budapest, Hungary. For our two Senior Instructors, Bettina Lang and Dominiek Beckers, it was an opportunity to say goodbye. Your contribution to the development of the PNF concept and the IPNFA organization is invaluable. Thank you.



We received and reviewed one research article from Leandro Giacometti Da Silva for a Research committee award

Acute effects of different proprioceptive neuromuscular facilitation stabilisation techniques on the balance of elderly women

J Bodyw Mov Ther. 2023 Jul:35:342-347. doi: 10.1016/j.jbmt.2023.04.054. Epub 2023 Apr 19.

Congratulations !!!!



We would also like to draw your attention to the upcoming conference of GCMAS (Gait & Clinical Movement Analysis Society) in Phoenix Arizona USA. We believe that for the clinicians involved in the study of human gait, this meeting seems to be a very interesting event.



Registration for the 2026 GCMAS Meeting, which will be held June 9th – June 13th at Creighton University Health Sciences Campus in Phoenix, AZ, is now available at the sites below.

More information on accommodations, tutorials, or other conference information can be found on the main conference site here:

<https://na.eventscloud.com/website/87479/home/>

Registration specific information can be found here:

<https://na.eventscloud.com/website/87479/registration/>

2025 IAPNFK Executive Workshop: Preparing for a Great 2026

IAPNFK stands for the International Academy for PNF Korea. Our group is led by President Byung-ki, Lee who is an IPNFA ® Advanced Instructor. Other instructors include Seong-soo Hwang(IPNFA ® Advanced Instructor Jeung-hyun, Yun (IPNFA ® Basic Instructor), and Min- gyu, Lee(IPNFA ® Basic Instructor).

On December 27–28, 2025, the members of IAPNFK gathered in beautiful Gangwon-do for a year-end workshop. It was a special time to look back at our work in 2025 and plan our goals for 2026.





IAPNFK Executive discussed many important topics. First, we shared news from the 2025 IPNFA ® AGM to follow global standards. We also talked about our journal and how to register it with KCI(Korean Citation Index). This is a very important goal for our research.

There was also a great learning session. Our Academic Team Leader, Min-je Cho, presented a case study called “PNF-based treatment strategy for ataxic gait.” It was very helpful and gave us many new ideas for our work.

In the fresh air of Gangwon-do, all members had a great time talking and bonding together. This workshop made our team stronger. We are now ready to work together for a successful 2026!

IAPNFK Academic Seminar Report

The International Academy for Proprioceptive Neuromuscular Facilitation Korea (IAPNFK) recently hosted a hybrid academic seminar with approximately 30 participants joining both onsite and online. The session was led by Jeung-Hyun Yun, PT, MSc, IPNFA ® Basic Instructor and vice president of IAPNFK, who presented “Neuro-Fascial Connection: Integrating PNF and Myofascial Meridians for Arm Rehabilitation.”



The seminar explored the neurophysiological and fascial mechanisms supporting upper extremity function and emphasized clinical reasoning in functional rehabilitation. Practical demonstrations and hands-on practice allowed participants to apply PNF concepts directly to arm rehabilitation strategies.

Following the seminar, IAPNFK instructors and executive members held a meeting to discuss future educational initiatives and collaboration within the association. The event highlighted the continued development of evidence-based PNF education in Korea.

The effects of visual skills training on cognitive and executive functions in stroke patients: a systematic review with meta-analysis

Marc Niering, Johanna Seifert

PMCID: PMC10967170 PMID: 38532485

J Neuroeng Rehabil. 2024 Mar 26;21:41. doi: 10.1186/s12984-024-01338-5

Abstract:

The visual system and associated skills are of particular importance in stroke rehabilitation. The process of neuroplasticity involved in restoring cognitive function during this period is mainly based on anatomical and physiological mechanisms. However, there is little evidence-based knowledge about the effects of visual skills training that could be used to improve therapeutic outcomes in cognitive rehabilitation. A computerized systematic literature search was conducted in the PubMed, Medline, and Web of Science databases from 1 January 1960 to 11 February 2024. 1,787 articles were identified, of which 24 articles were used for the calculation of weighted standardized mean differences (SMD) after screening and eligibility verification. The findings revealed moderate effects for global cognitive function (SMD = 0.62) and activities of daily living (SMD = 0.55) as well as small effects for executive function (SMD = 0.20) – all in favor of the intervention group. The analyses indicate that the results may not be entirely robust, and should therefore be treated with caution when applied in practice. Visual skills training shows positive effects in improving cognitive and executive functions, especially in combination with high cognitive load and in an early phase of rehabilitation. An improvement in activities of daily living can also be observed with this type of intervention. The high heterogeneity of the studies and different treatment conditions require the identification of a relationship between certain visual skills and executive functions in future research.

Supplementary Information

The online version contains supplementary material available at 10.1186/s12984-024-01338-5.

Keywords: Visual skills, Cognitive function, Executive function, Stroke rehabilitation

Effects of Visual Feedback on Walking Speed for Stroke Patients: Single-case Design Efecto de la retroalimentación visual sobre la velocidad de la marcha después de un accidente cerebrovascular: diseño de caso único

Karen Gizeth Castro-Medina

Revista de Investigación e Innovación en Ciencias de la Salud · Volume 5, Number 1, 2023 ·
<https://doi.org/10.46634/riics.153>

Abstract

Introduction. Gait recovery is one of the main goals in post-stroke rehabilitation. Based on the principles of motor learning, new strategies have been developed in neurorehabilitation based on repetitive, task-oriented practice, and feedback. The latter has proven to be one of the most critical variables for training, because it is easy to obtain and manipulate. However, there are still no conclusive studies to identify the real effect of this variable and its influence on recovery and functional gait performance. **Objective.** To determine the effect of visual feedback on gait speed after stroke in adults with subacute and chronic stages.

Methodology. Single-case, multiple baseline, non-concurrent randomized, and four-participant design. Gait velocity was assessed by determining differences in level, trend, data stability, and nonoverlapping data using visual analysis based on technical documentation for single-case designs from the What Works Clearinghouse.

Results. Four participants ranging in age from 19 to 73 years were included in the study. The change in level for all participants demonstrated an increase in gait velocity values after the introduction of the intervention (mean: 0.76 m/s). Visual trend analysis estimated acceleration for the intervention line for three participants. The data in the baseline and intervention phase met the stability criterion measured with the two standard deviation band method (mean: 0.05 m/s); patterns of change demonstrated immediate effect with gradual improvement during the intervention for participants 1, 3, and 4. The percentage of nonoverlapping data showed effectiveness of the intervention for three of the participants (PND >91.67%).

Conclusions. The findings presented in this study represent a scientific contribution that supports the relevance of the use and application of motor learning principles for the development of new strategies in motor rehabilitation. However, this study constitutes a first step towards more robust studies that include replication of the phases in the study and follow-up evaluation to determine the permanence of long-term effects.

Keywords:

Stroke; feedback; walking speed; rehabilitation; robotics; single-case study; physical therapy; gait disorders, neurologic; haptic technology.

Multisensory integration, brain plasticity and optogenetics in visual rehabilitation

Martina Lucchesi, José Fernando Maya-Vetencourt, Dario Rusciano

Front Neurol. 2025 Jul 10;16:1590305. doi: 10.3389/fneur.2025.1590305

PMCID: PMC12288684 PMID: 40708952

Abstract:

Multisensory integration enables the brain to integrate information from different sensory modalities while enhancing perception. This principle relies on phenomena of neuroplasticity (i.e., the ability of neuronal networks in the brain to adapt to changing environmental conditions) and is crucial for visual rehabilitation, particularly in hemianopia and retinal degeneration. Here we review emerging experimental approaches and their translational potential for vision recovery in visually impaired patients. Rehabilitation strategies incorporating multisensory training, optogenetics, and pharmacological interventions have demonstrated to be instrumental in restoring visual function by leveraging plasticity of inputs from different sensory modalities. Emerging technologies such as virtual reality and auditory–visual stimulation further optimize neural reorganization. Future research should focus on refining these interventions to enhance sensory compensation and recovery. Understanding the role of multisensory ganglion cells and retinal circuits may unlock new strategies for improving visual function in visually impaired individuals.

Keywords: multisensory areas, brain plasticity, visual rehabilitation, optogenetics, cross-modality

The effect of visual feedback on balance rehabilitation in people with impaired ankle instability: a systematic review and meta-analysis

Chuan qiu shui Wang, Kun Wang, Liang Sun, Shi qi Liu, Jiong Luo

BMC Sports Sci Med Rehabil. 2025 Apr 10;17:77. doi: 10.1186/s13102-024-01041-x

PMCID: PMC11984011 PMID: 40211335

Abstract:

Background

Ankle instability is a consequence of ankle injuries that can impair balance and affect an individual's ability to perform activities of daily living. Consequently, visual feedback is frequently employed in rehabilitation to enhance training outcomes. However, inconsistencies exist in the scientific literature regarding the effect size of visual feedback and the optimal method of delivery.

Aim

The objective of this systematic review and meta-analysis was twofold: firstly, to conduct a comprehensive assessment of the potential impact of visual feedback on balance exercises for individuals with ankle instability; secondly, to quantify the effects of visual feedback on balance in this population.

Methods

A total of 10 studies were included in this systematic review and meta-analysis. The review was conducted in accordance with the PERSiST (Implementing Prisma in Exercise, Rehabilitation, Sport Medicine, and Sports Science) guidance. The research was conducted using four databases and was required to be written in English. Additionally, the studies had to involve the provision of visual feedback during balanced rehabilitation.

Results

The provision of visual feedback has been demonstrated to enhance the efficacy of rehabilitation programs designed to improve balance. Improvement in static, dynamic, and perceptual balance during balance training. The provision of visual feedback was found to simultaneously increase the subjects' subjective motivation to train and their satisfaction and enjoyment of the rehabilitation training. The results demonstrated that visual feedback improved the Foot and Ankle Ability Measure by approximately 17% (MD = 2.42, 95%CI = 0.72 to 4.12, I^2 [total] = 0%). Additionally, the provision of visual feedback during the training cycle may positively affect the star excursion balance test (SEBT) (MD = 4.83, 95%CI = 3.09 to 6.56, I^2 [total] = 21%).

Moreover, the Biodex system is expected to demonstrate notable improvements in measures of balance (MD = 0.14, 95% CI = 0.01 to 0.28, I^2 [total] = 24%).

Conclusion

The provision of visual feedback in the context of balance rehabilitation has been demonstrated to facilitate beneficial adaptations to balance in individuals presenting with ankle instability. The research included in our analysis demonstrates the positive impact of visual feedback, with nearly all results exhibiting superior outcomes relative to those observed in the absence of visual feedback. Visual feedback can be employed as an “additive” or alternative to conventional rehabilitation for individuals with ankle instability.

Supplementary Information

The online version contains supplementary material available at [10.1186/s13102-024-01041-x](https://doi.org/10.1186/s13102-024-01041-x).

Keywords: Augmented Feedback, Balance Exercise, Virtual Reality, The Star Excursion Test, Visualization

Effects of stabilizing reversal technique and vestibular rehabilitation exercise on dizziness and balance ability in patients with vestibular neuritis

An observational study

Beomryong Kim, Everett Lohman, JongEun Yim

Editor: Gopal Nambi

Medicine (Baltimore). 2022 Jan 28;101(4):e28740.

doi: 10.1097/MD.00000000000028740

PMCID: PMC8797558 PMID: 35089249

Abstract:

Vestibular neuritis is a common disease of peripheral dizziness. Studies have shown that vestibular rehabilitation exercise (VRE) and proprioceptive neuromuscular facilitation (PNF) are effective to treat the symptoms of vestibular neuritis. However, the effect of VRE and PNF on the balance ability and dizziness in this patient cohort remains unclear.

The aim of our observational study was to determine the changes in dizziness and balance ability of patients with vestibular neuritis who participated in the VRE program with stabilizing reversal technique (SRT).

The reporting of this study conforms to the STROBE statement. Ten men and women aged ≥ 20 years who were diagnosed with vestibular neuritis were included. Patients performed VRE with SRT for 4 weeks with assistance from a therapist. VRE without SRT can also be performed at home. Dizziness was evaluated using the dizziness handicap inventory (DHI) and visual analog scale (VAS). Balance ability was assessed using the Berg's balance scale (BBS) and timed up and go test (TUG). At pre- and post-exercise, paired t test was performed to compare the within-group differences.

After the program, DHI (45.40 ± 6.74 to 21.00 ± 7.07), VAS (5.90 ± 1.20 to 2.80 ± 0.92), BBS (45.10 ± 2.77 to 52.70 ± 1.83), and TUG (15.29 ± 1.13 to 12.06 ± 1.61) scores improved significantly in the VRE program group ($P = .05$).

The VRE program combined with SRT was effective in reducing dizziness and increasing balance ability in patients with vestibular neuritis.

Keywords: balance ability, dizziness, stabilizing reversal technique, vestibular neuritis, vestibular rehabilitation

Vestibular rehabilitation therapy on balance and gait in patients after stroke: a systematic review and meta-analysis

Lijiao Meng, Qiu Liang, Jianrong Yuan, Siyi Li, Yanlei Ge, Jingyi Yang, Raymond C C Tsang, Quan Wei

BMC Med. 2023 Aug 25;21:322. doi: 10.1186/s12916-023-03029-9

PMCID: PMC10464347 PMID: 37626339

Abstract:

Background

There is limited evidence to support the use of vestibular rehabilitation therapy (VRT) on improving balance and gait in patients after stroke. This systematic review aimed to evaluate the effects of VRT in addition to usual rehabilitation compared with usual rehabilitation on improving balance and gait for patients after stroke.

Methods

This review followed the Preferred Reporting Items for Systematic reviews and Meta-Analysis statement guidelines. Ten electronic databases were searched up to 1 June 2023 without restrictions in language and publication status. The PEDro scale and the Grading of Recommendations Assessment Development, and Evaluation were used to evaluate the risk of bias and the certainty of evidence. The meta-analysis was conducted with Review Manager 5.3.

Results

Fifteen randomised controlled trials with 769 participants were included. PEDro scale was used to assess the risk of bias with a mean score of 5.9 (0.7). VRT was effective in improving balance for patients after stroke (SMD = 0.59, 95% CI (0.40, 0.78), $p < 0.00001$), particularly for patients after stroke that occurred within 6 months (SMD = 0.56, 95% CI (0.33, 0.79), $p < 0.00001$) with moderate certainty of evidence. Subgroup analysis showed that VRT provided as gaze stability exercises combined with swivel chair training (SMD = 0.85, 95% CI (0.48, 1.22), $p < 0.00001$) and head movements (SMD = 0.75, 95% CI (0.43, 1.07), $p < 0.00001$) could significantly improve balance. Four-week VRT had better effect on balance improvement (SMD = 0.64, 95% CI (0.40, 0.89), $p < 0.00001$) than the less than 4-week VRT. The pooled mean difference of values of Timed Up-and-Go test showed that VRT could significantly improve gait function for patients after stroke (MD = -4.32, 95% CI (-6.65, -1.99), $p = 0.0003$), particularly for patients after stroke that occurred within 6 months (MD = -3.92, 95% CI (-6.83, -1.00), $p = 0.008$) with moderate certainty of evidence.

Conclusions

There is moderate certainty of evidence supporting the positive effect of VRT in improving balance and gait of patients after stroke.

Trial registration

PROSPERO CRD42023434304

Supplementary Information

The online version contains supplementary material available at [10.1186/s12916-023-03029-9](https://doi.org/10.1186/s12916-023-03029-9).

Keywords: Vestibular rehabilitation, Stroke, Balance, Gait, Systematic review, Meta-analysis

Effectiveness of vestibular rehabilitation on postural balance in Parkinson's disease: a systematic review and meta-analysis of randomized controlled trials

Carla Marineli Saraiva do Amaral, Samuel Brito de Almeida, Renata Parente de Almeida, Simony Lira do Nascimento, Rodrigo Mariano Ribeiro, Pedro Braga-Neto

BMC Neurol. 2024 May 14;24(1):161. doi: 10.1186/s12883-024-03649-5.

PMID: 38745275 PMCID: PMC11092171 DOI: 10.1186/s12883-024-03649-5

Abstract:

Introduction: Postural balance impairment can affect the quality of life of patients with Parkinson's disease. Previous studies have described connections of the vestibular system with postural functions, suggesting a potential participation of the basal ganglia in receiving vestibular stimuli. This systematic review aims to summarize the evidence on the effectiveness of vestibular rehabilitation on postural balance in patients with Parkinson's disease.

Methods: A systematic review was conducted using the electronic databases: PubMed, Embase, Scopus and PEDro. The study selection was independently conducted by two reviewers, and disagreements were evaluated by a third reviewer. The included studies had no restrictions on publication dates or languages and the last update occurred in July 2023.

Results: From the 485 studies found in the searches, only 3 studies were deemed eligible for the systematic review involving a total of 130 participants. The Berg Balance Scale was described as the tool for evaluation of postural balance in all studies. The meta-analysis showed statistically significant results in favor of vestibular rehabilitation (MD = 5.35; 95% CI = 2.39, 8.31; $P < 0.001$), regardless of the stage of Parkinson's disease. Although the effect size was suggested as a useful functional gain, the analysis was done with caution, as it only included 3 randomized controlled trials. The risk of bias using the RoB-2 was considered as being of "some concern" in all studies. Furthermore, the quality of the evidence based on the Grading of Recommendations Assessment Development and Evaluation system, produced by pooling the included studies was considered very low.

Conclusion: Compared to other interventions, vestibular rehabilitation has potential to assist the postural balance of patients with Parkinson's disease. However, the very low quality of the evidence demonstrates uncertainty about the impact of this clinical practice. More robust studies are needed to confirm the benefits of this therapy in patients with Parkinson's disease. This study was prospectively registered in PROSPERO: CRD42020210185.

Keywords: Balance dysfunction; Movement disorder; Parkinson's disease; Rehabilitation; Vestibular disease.

Vestibular Rehabilitation Improves Gait Quality and Activities of Daily Living in People with Severe Traumatic Brain Injury:

A Randomized Clinical Trial

Marco Tramontano, Valeria Belluscio, Elena Bergamini, Giulia Allevi, Sara De Angelis, Giorgia Verdecchia, Rita Formisano, Giuseppe Vannozzi and Maria Gabriella Buzzi

Sensors 2022, 22(21), 8553; <https://doi.org/10.3390/s22218553>

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Published: 6 November 2022

(This article belongs to the Collection Sensors for Gait, Human Movement Analysis, and Health Monitoring)

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Abstract:

Neurorehabilitation research in patients with traumatic brain injury (TBI) showed how vestibular rehabilitation (VR) treatments positively affect concussion-related symptoms, but no studies have been carried out in patients with severe TBI (sTBI) during post-acute intensive neurorehabilitation. We aimed at testing this effect by combining sensor-based gait analysis and clinical scales assessment. We hypothesized that integrating VR in post-acute neurorehabilitation training might improve gait quality and activity of daily living (ADL) in sTBI patients. A two-arm, single-blind randomized controlled trial with 8 weeks of follow-up was performed including thirty sTBI inpatients that underwent an 8-week rehabilitation program including either a VR or a conventional program. Gait quality parameters were obtained using body-mounted magneto-inertial sensors during instrumented linear and curvilinear walking tests. A 4X2 mixed model ANOVA was used to investigate session-group interactions and main effects. Patients undergoing VR exhibited improvements in ADL, showing early improvements in clinical scores. Sensor-based assessment of curvilinear pathways highlighted significant VR-related improvements in gait smoothness over time ($p < 0.05$), whereas both treatments exhibited distinct improvements in gait quality. Integrating VR in conventional neurorehabilitation is a suitable strategy to improve gait smoothness and ADL in sTBI patients. Instrumented protocols are further promoted as an additional measure to quantify the efficacy of neurorehabilitation treatments.

Keywords: inertial sensors; wearables; movement analysis; biomechanics; neurorehabilitation; sTBI; balance; locomotion; smoothness; RCT

Verbal Feedback Enhances Motor Learning During Post-Stroke Gait Retraining

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PMCID: PMC7969478 NIHMSID: NIHMS1625461 PMID: 32942960

The publisher's version of this article is available at Top Stroke Rehabil

Abstract:

Background: Fast treadmill walking combined with functional electrical stimulation to the ankle muscles (FastFES) is a well-studied gait training intervention that improves post-stroke walking function. Although individualized verbal feedback is commonly incorporated during clinical gait training, and a variable practice structure is posited to enhance motor learning, the influence of these 2 factors on motor learning during locomotor training interventions such as FastFES is poorly understood.

Objectives: To determine if the addition of individualized verbal feedback or variable practice to FastFES training enhances motor learning of targeted gait patterns.

Methods: Nine individuals with post-stroke hemiparesis completed a crossover study comprising exposure to 3 dose-matched types of gait training with >3 weeks between training sessions: (1) FastFES (FF), comprising five 6-minute bouts of training with intermittent FES, (2) FF with addition of individualized verbal instructions and faded feedback delivered by a physical therapist (FF+PT), (3) FF with variable gait speed and timing of FES (FF+Var). Gait biomechanics data were collected before (Pre), immediately after (Post), and 24-hours following each type of training (Retention). Within-session and retention change scores of 3 targeted gait variables were calculated to assess locomotor learning.

Results: FF+PT resulted in larger improvements within-session and at retention in trailing limb angle, and a trend for larger improvements in paretic leg pushoff compared to FF; whereas FF+Var failed to show greater learning of biomechanical gait variables compared to FF (control).

Conclusions: Addition of individualized verbal feedback (FF+PT) to a single session of standardized gait training may enhance both within- and across-session learning of targeted gait variables in people post-stroke, and merits more investigation.

Keywords: verbal instructions, walking, rehabilitation, variable practice, cerebrovascular accident, gait propulsion

Verbal augmented feedback in the rehabilitation of lower extremity musculoskeletal dysfunctions: a systematic review

Marianne Storberget, Linn Helen J Grødahl, Suzanne Snodgrass, Paulette van Vliet, Nicola Heneghan

BMJ Open Sport Exerc Med. 2017 Sep 21;3(1):e000256. doi: 10.1136/bmjsem-2017-000256

PMCID: PMC5623330 PMID: 29018544

Abstract:

Background: Verbal augmented feedback (VAF) is commonly used in physiotherapy rehabilitation of individuals with lower extremity musculoskeletal dysfunction or to induce motor learning for injury prevention. Its effectiveness for acquisition, retention and transfer of learning of new skills in this population is unknown.

Objectives: First, to investigate the effect of VAF for rehabilitation and prevention of lower extremity musculoskeletal dysfunction. Second, to determine its effect on motor learning and the stages of acquisition, retention and transfer in this population.

Design: Systematic review designed in accordance with the Centre for Reviews and Dissemination and reported in line with Preferred Reporting Items for Systematic Review and Meta-analysis.

Method: MEDLINE, Embase, PubMed and five additional databases were searched to identify primary studies with a focus on VAF for prevention and rehabilitation of lower extremity musculoskeletal dysfunction. One reviewer screened the titles and abstracts. Two reviewers retrieved full text articles for final inclusion. The first reviewer extracted data, whereas the second reviewer audited. Two reviewers independently assessed risk of bias and quality of evidence using Cochrane Collaboration's tool and Grading of Recommendations Assessment, Development and Evaluation, respectively.

Results: Six studies were included, with a total sample of 304 participants. Participants included patients with lateral ankle sprain (n=76), postoperative ACL reconstruction (n=16) and healthy individuals in injury prevention (n=212). All six studies included acquisition, whereas retention was found in five studies. Only one study examined transfer of the achieved motor learning (n=36). VAF was found to be effective for improving lower extremity biomechanics and postural control with moderate evidence from five studies.

Conclusion: VAF should be considered in the rehabilitation of lower extremity musculoskeletal dysfunctions. However, it cannot be unequivocally confirmed that VAF is effective in this population, owing to study heterogeneity and a lack of high-quality evidence. Nevertheless, positive effects on lower extremity biomechanics and postural control have been identified. This suggests that further research into this topic is warranted where an investigation of long-term effects of interventions is required. All stages (acquisition, retention and transfer) should be evaluated.

Keywords: verbal augmented feedback, motor learning, musculoskeletal dysfunction, lower extremity, injury prevention

Exploring Physiotherapists' Use of Motor Learning Strategies in Gait-Based Interventions for Children with Cerebral Palsy

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PMCID: PMC6864228 NIHMSID: NIHMS1050434 PMID: 31154883

The publisher's version of this article is available at Phys Occup Ther Pediatr

Abstract:

Aim: This study investigated physiotherapists' experiences using motor learning strategies (MLS) in gait-based interventions for children with cerebral palsy (CP). The objectives were to explore how child characteristics, physiotherapist decision-making, and treatment approach influenced intentional MLS use.

Methods: Semi-structured interviews were conducted with eight physiotherapists who provided gym- and/or Lokomat-based treatment to children with CP. Interviews were analyzed using directed content analysis and a modified constant comparison method.

Results: Three themes described their experiences: (1) MLS use is driven by the unique aspects of the child, physiotherapist, and intervention; (2) The use and description of motor learning content varies among physiotherapists; and (3) The Lokomat is “the same but different.” Child characteristics were at the forefront of MLS selection in both interventions. The terminology used to describe MLS use varied considerably among therapists. They used similar clinical decision-making in gym-and Lokomat-based interventions.

Conclusions: Conscious reflection on the factors affecting MLS use could facilitate related clinical decision-making in physiotherapy interventions for children with CP. Increased awareness of MLS and use of a structured framework for reporting MLS are required to promote intentional MLS use and generate CP-specific evidence-based MLS research.

Keywords: Cerebral palsy, clinical decision-making, motor learning, motor learning strategies, physiotherapy

Proprioceptive Neuromuscular Facilitation for the Upper Extremity and Scapula: Review and Update on Rehabilitation of Shoulder Pathology

Michael Higgins, Carolyn Greer

Int J Sports Phys Ther. 2025 Sep 2;20(9):1407–1419. doi: 10.26603/001c.143176

PMCID: PMC12404573 PMID: 40904708

Abstract:

Proprioceptive Neuromuscular Facilitation (PNF) has deep roots in neurological rehabilitation for the treatment of neuromuscular disorders that has carried over into musculoskeletal rehabilitation and human performance. There are two major aspects of PNF in musculoskeletal practice, stretching and strengthening, but this commentary only addresses the effects of strengthening. Techniques that do not incorporate all the original principles and guidelines as described in the literature are often miscategorized as PNF. The purpose of this clinical update/commentary is to review the essential principles, guidelines, and techniques for the effective utilization of PNF strengthening exercises for the upper extremity highlighting the importance of regaining/maintaining the synergist relationship between the glenohumeral joint and scapula. It will also provide recommended sequencing, exercise parameters, and present evidence of the effectiveness of incorporating PNF patterns into the rehabilitation programs for upper extremity pathologies. # Level of Evidence 5

Keywords: PNF, scapula, shoulder pathology

Impact of Neurophysiological Facilitation (Pnf Strech) of Pectoralis Major and Minor Muscle: A Noval Approach to Improve Pulmonary Function in Copd Patient

Sakshi Tiwari, Sumedha Rabra

E-ISSN: 2582-2160 International Journal for Multidisciplinary Research (IJFMR): IJFMR250238496 Volume 7, Issue 2, March-April 2025

Abstract:

Background: Chronic Obstructive Pulmonary Disease (COPD) is a progressive respiratory condition characterized by airflow limitation, leading to reduced pulmonary function and impaired quality of life. Effective rehabilitation strategies to enhance respiratory function and muscle strength are critical in managing COPD symptoms. Proprioceptive Neuromuscular Facilitation (PNF) stretching techniques have been widely used in physiotherapy for improving flexibility, muscle strength, and neuromuscular function. Among various muscle groups, targeting the pectoralis major and minor muscles through PNF techniques may play a significant role in enhancing respiratory mechanics and pulmonary function in COPD patients. **Objective:** This systematic review aims to evaluate the impact of PNF stretching on the pectoralis major and minor muscles as a novel approach to improving pulmonary function in individuals with COPD.

Methods: A comprehensive search of relevant databases (PubMed, Scopus, Cochrane Library, etc.) was conducted for studies published between 2000 and 2024. Studies assessing the effects of PNF stretching specifically targeting the pectoralis major and minor muscles in COPD patients, with a focus on pulmonary outcomes such as Forced Expiratory Volume (FEV1), Forced Vital Capacity (FVC), peak expiratory flow (PEF), and oxygen saturation, were included. Both randomized controlled trials and observational studies were considered for review.

Results: Initial findings suggest that PNF stretching of the pectoralis muscles may contribute to improved thoracic mobility, enhanced diaphragm function, and reduced respiratory muscle fatigue in COPD patients. Additionally, a number of studies demonstrated a positive impact on pulmonary function parameters such as FEV1, FVC, and oxygen saturation levels. The PNF technique was found to improve postural alignment, chest expansion, and muscle flexibility, indirectly contributing to better respiratory function.

Conclusion: PNF stretching of the pectoralis major and minor muscles shows promise as a novel approach in pulmonary rehabilitation for COPD patients. This review highlights the potential benefits of incorporating PNF techniques into standard COPD management, suggesting improvements in pulmonary function and overall respiratory performance. However, further large-scale randomized controlled trials are needed to conclusively establish its effectiveness and long-term benefits for COPD rehabilitation.

Keywords: Chronic Obstructive Pulmonary Disease, Proprioceptive Neuromuscular Facilitation, Pectoralis Major, Pectoralis Minor, Pulmonary Function, Respiratory Rehabilitation.

Effect of Joint Traction and Approximation on H- Reflex in Normal Subjects

Camy Anilkumar Bhagat, Paras Abhisinh Bhura

January 2014 Indian Journal of Physiotherapy and Occupational Therapy - An International Journal
8(3):20

DOI:10.5958/0973-5674.2014.00349.9

Abstract:

Introduction: Proprioceptive sensation (kinaesthesia and/or joint position sense), one of the most important somatosensory modalities, is known to play an important role in body balance and motor control. Joint traction and approximation are two proprioceptive stimuli applied at the joint. Studies reveal that an unidentified set of muscle afferent fibres and cutaneous receptors both contribute to the sense of movement and position. The Hoffmann reflex (H- reflex), an electrically evoked monosynaptic reflex, is a measure of the final common pathway, or the motor output.

Objective : To find out the effect of traction and approximation on H-reflex.

Method: Study performed on 20 normal subjects both males and females taken from the city Anand under the age group of 19-26 years. This is an experimental study, which is performed in the clinic of physiotherapy. The subject was made to lie prone comfortably on a plinth. The tibial nerve was stimulated at the popliteal fossa using 1 ms pulse and then finds H- latency and amplitude of H wave. The subject was made to stand on the wooden board with same electrode arrangement to approximate the articular surfaces of the knee joint. The procedure was repeated to find H- latency, and amplitude of H- wave. The subject was made to sit on the stool with same electrode arrangement and right leg hanging freely off the stool. A 2 kg weight was tied at the ankle to distract the knee joint. The procedure was repeated to find H- latency, and amplitude of H- wave.

Results : There is significant difference in H-reflex latency and amplitude in prone, joint traction and approximation.

Conclusion: There is significant change in latency with proprioceptive input.

Keywords: Joint Traction, Approximation, H-Reflex, Proprioception, Knee Joint

Demonstrating the Irridation and Reinforcement Effects of Proprioceptive Neuromuscular Facilitation Technics

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Abstract:

Pupose of the study is demonstrate the irradiation and reinforcement principle of the proprioceptive neuromuscular facilitation (PNF) technique, which was expected to occur through the use of body segments together. Volunteers aged between 18 and 30 who did not have any orthopedic or neurological problems that could affect handgrip strength were included in the study. Using a hand dynamometer (Jamar), dominant-side handgrip strength was evaluated via two different methods, expressed as control and experimental. The control group measurement was done as a standard unilateral handgrip strength test and the experimental one included bilateral handgrip strength. Three consecutive repetitive measurements were taken for both control and experimental methods, and the average values were compared with the dependent t-test. Fifty-four individuals participated in the study. Sixteen (29.6%) of the participants were male and 38 (70.4%) were female, and the dominant side was the right for all participants. The means of hangrip strength was 27.08 ± 8.67 kg for control measurement and 29.08 ± 8.89 kg. for experimental measurement. The experimental handgrip strength was significantly higher than the control ($p < 0.001$). As a result of the study, we can the grip strength obtained by bilateral activity is more than that of unilateral activity; therefore, it supports the PNF irradiation effect principle. In addition, this information highlights the bilateral treatment approach in training programs for strengthening weak muscles and increasing skills in motor activity.

Keywords: Exercise Therapy, Handgrip Strength, Physiotherapy, Rehabilitation

Effectiveness of Low-Frequency Stimulation in Proprioceptive Neuromuscular Facilitation Techniques for Post Ankle Sprain Balance and Proprioception in Adults: A Randomized Controlled Trial

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Abstract:

Stretching is an important part of post ankle sprain rehabilitation, as well as an effective exercise for improving general ankle-joint performance. But the combination of stretching alongside low-frequency stimulation has not yet been extensively studied. Therefore, the purpose of the present randomized controlled trial was to compare the combined effects of low-frequency transcutaneous electrical nerve stimulation (TENS) with proprioceptive neuromuscular facilitation (PNF) on strength, balance, and proprioception among individuals with post ankle sprain. Sixty male subjects with lateral ankle sprain were selected and randomly allocated to three groups: group 1, group 2, and the control group (CG). Subjects in group 1 received the PNF stretching technique combined with TENS. TENS stimulation was provided using two electrodes placed 5 cm apart directly on the triceps sural muscle of the affected leg and a biphasic current with a symmetrical waveform at 50 Hz for 15 seconds, tuned for a 3-second ramp up time and a 30-second rest time with a 250-microsecond pulse duration was given with PNF stretching. Subjects in group 2 received the PNF stretching technique alone. Both group 1 and group 2 received these treatments for 4 weeks (4 days/week); follow-up assessments were administered in the third and fifth weeks. CG received no treatment; outcome measures alone were assessed. Outcome measures comprised pain, balance, flexibility, proprioception, range of motion, muscle strength, and functional limitation. A mixed-model ANOVA showed significant interaction (time and group) and the time effect for all the outcome measures ($p \leq 0.05$). Group 1 (PNF-TENS) showed significant improvement for all the outcome variables compared to the other groups. The present study showed PNF stretching combined with TENS for the triceps sural muscle to trigger muscle contraction during the muscle contraction phase of the PNF stretch, compared against PNF stretching alone, produced significant improvements in ankle function for post ankle sprain subjects.

Keywords: -

Immediate Effects of Abdominal Hypopressive Technique Versus PNF Stretching in Shortened Hamstring Syndrome: A Pilot Randomized Controlled Trial

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ABSTRACT:

Background and Purpose: Short Hamstring Syndrome (SHS) is described as a deficit of extensibility of this musculature. In contrast to Proprioceptive Neuromuscular Facilitation (PNF), which is widely used in these cases, the abdominal hypopressive technique (AHT) is presented as a possible method to improve flexibility. The primary aim of this trial was to assess the feasibility and acceptability of a single-session AHT program versus PNF stretching in adults with SHS, while the secondary, exploratory aim was to estimate their immediate effects on hamstring flexibility to inform the design and sample size of a future definitive trial.

Methods: A pilot randomized controlled trial of a single treatment session was designed, with a pre- and post-treatment evaluation to assess the effects of both techniques on flexibility. 19 subjects were randomized into an AHT group and a PNF stretching group. The Straight Leg Raise and Toe Touch tests assessed changes after treatment. Paired samples t-tests and independent samples t-tests were used to statistically analyze changes within and between groups, respectively.

Results: Significant improvements were observed in both groups on all tests pre- and post-intervention. However, no significant differences were found between the groups following the intervention.

Discussion: Both AHT and PNF techniques produced immediate improvements in hamstring flexibility in adults with shortened hamstring syndrome. However, these findings are exploratory, and, given the pilot nature of the trial, no conclusions can be drawn regarding the superiority of one method over the other.

Keywords: exercise, hamstrings, hypopressive abdominals, proprioceptive neuromuscular facilitation

Foam Rolling vs. Proprioceptive Neuromuscular Facilitation Stretching in the Hamstring Flexibility of Amateur Athletes: Control Trials

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Editors: Paul B Tchounwou, Subas Neupane

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Abstract:

Background: the use of stretching techniques in the sports world is frequent and common thanks to their many effects. One of the main benefits of stretching is an increased range of motion (ROM). Recently, the use of a foam roller has spread in sports practice due to benefits that are similar to those of shoes observed in stretching. The objective of the following study was to compare the results of proprioceptive neuromuscular facilitation stretching (PNF) with foam rolling (FR). **Methods:** The design of the study was a single-blind, randomized controlled trial (clinicaltrial.gov NCT05134883), and the participants were 80 healthy young athletes. The range of motion was evaluated with a modified sit-and-reach test before, during (at 30 s), and at the end of the intervention (at 2 min). The subject's discomfort sensation was measured using the Borg scale. Effect sizes were calculated using Cohen's d coefficient. Volunteers were randomized into the PNF group or FR group. **Results:** the differences were statistically significant ($p < 0.001$) during the intervention in favor of PNF group. The differences at the end of intervention showed that the PNF group had a greater increase in flexibility, with this difference being statically significant ($p < 0.001$). The sensation of perceived exertion with PNF at the end of the intervention was similarly classified as moderate for both groups. **Conclusion:** Despite the fact that the use of FR is spreading in the field of sports and rehabilitation, the results of the present study suggest that the gain in flexibility in the hamstrings is greater if PNF-type stretches are used instead of FR.

Keywords: extensibility, healthy adults, ROM, muscle stretching, hamstring muscles, strength, flexibility, fascia, myofascial rolling

Anterior Cruciate Ligament Reconstruction Rehabilitation as a Complex Adaptive Process: From Control–Chaos to Actionable Return-to-Sport Decisions

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Editors: Alvaro N Gurovich, Shashwati Geed

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Abstract:

Rehabilitation after anterior cruciate ligament reconstruction cannot be reduced to a linear, time-based sequence of protection, strength, and return to sport. Persistent asymmetries, quadriceps inhibition, and variable re-injury rates highlight that recovery is a complex adaptive process in which outcomes emerge from dynamic interactions between biological, neural, and psychological subsystems. Grounded in complexity science and chaos theory, this editorial reframes rehabilitation as the regulation of variability rather than its suppression. The Control–Chaos Continuum provides a practical structure to translate this concept into progressive exposure, where clinicians dose uncertainty as a therapeutic stimulus. Adaptive periodization replaces rigid stages with overlapping macro-blocks that respond to readiness, feedback, and context. Neuroplastic mechanisms and ecological dynamics justify the deliberate introduction of controlled “noise” to foster coordination, confidence, and resilience. Ultimately, the goal is not perfect control but stable performance under variability—the ability to function “at the edge of chaos.” This conceptual perspective articulates a clinically actionable framework—linking the Control–Chaos Continuum with adaptive periodization—to guide non-linear decision-making and safe return-to-sport.

Keywords: anterior cruciate ligament reconstruction, adaptive periodization, complexity, chaos

Electromyographic activation during motor irradiation of proprioceptive neuromuscular facilitation: a scoping review

Ativação eletromiográfica durante a irradiação motora da facilitação neuromuscular proprioceptiva: uma revisão de escopo

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Abstract:

Background: This scoping review examined the effectiveness of motor irradiation in activating specific muscles in adults, using surface electromyography (EMG). The literature suggests motor irradiation, a basic procedure of Proprioceptive Neuromuscular Facilitation (PNF), can stimulate contractions in weak muscles by applying resistance to stronger ones. This could potentially reduce complications in neurological and orthopedic conditions. However, despite its widespread use in physiotherapy, there's a lack of research on the exact impact of motor irradiation on target muscle activity. **Methods:** Online databases (PubMed, Scielo, Lilacs, and Google Scholar) were used to identify papers published between 1981-2025, that utilized EMG analysis as a primary or secondary outcome variable in individual of both sexes with and without any disorders. **Results:** The search yielded 30 potentially relevant articles after removing duplicates. Of these, only nine articles met the inclusion criteria (articles in English, Spanish, or Portuguese that analyzed EMG during PNF motor irradiation). The studies analyzed EMG activity of the upper limb, trunk, and lower limb muscles during motor irradiation (flexor and extensor patterns of both upper and lower limbs). Significant differences were observed between flexor and extensor movement patterns, with specific muscles showing distinct activation profiles. The lower limb patterns evoked higher activation in homologous and contralateral muscles, while upper limb patterns seem to evoke less activation. The limited number of studies, small sample sizes, methodological issues, and the fact that a few studies have investigated upper limb muscle activity highlight the need for further research to achieve a comprehensive understanding of PNF dynamics.

Keywords: Motor activity. Isometric contraction. Rehabilitation exercise. Proprioceptive neuromuscular facilitation. Physical therapy. Electromyography. Scoping review.

Proprioceptive Neuromuscular Facilitation for the Upper Extremity and Scapula: Review and Update on Rehabilitation of Shoulder Pathology

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Int J Sports Phys Ther. 2025 Sep 2;20(9):1407–1419. doi: 10.26603/001c.143176

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Abstract:

Proprioceptive Neuromuscular Facilitation (PNF) has deep roots in neurological rehabilitation for the treatment of neuromuscular disorders that has carried over into musculoskeletal rehabilitation and human performance. There are two major aspects of PNF in musculoskeletal practice, stretching and strengthening, but this commentary only addresses the effects of strengthening. Techniques that do not incorporate all the original principles and guidelines as described in the literature are often miscategorized as PNF. The purpose of this clinical update/commentary is to review the essential principles, guidelines, and techniques for the effective utilization of PNF strengthening exercises for the upper extremity highlighting the importance of regaining/maintaining the synergist relationship between the glenohumeral joint and scapula. It will also provide recommended sequencing, exercise parameters, and present evidence of the effectiveness of incorporating PNF patterns into the rehabilitation programs for upper extremity pathologies. # Level of Evidence 5

Keywords: PNF, scapula, shoulder pathology

Verbal augmented feedback in the rehabilitation of lower extremity musculoskeletal dysfunctions: a systematic review

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ABSTRACT

Background Verbal augmented feedback (VAF) is commonly used in physiotherapy rehabilitation of individuals with lower extremity musculoskeletal dysfunction or to induce motor learning for injury prevention. Its effectiveness for acquisition, retention and transfer of learning of new skills in this population is unknown.

Objectives First, to investigate the effect of VAF for rehabilitation and prevention of lower extremity musculoskeletal dysfunction. Second, to determine its effect on motor learning and the stages of acquisition, retention and transfer in this population.

Design Systematic review designed in accordance with the Centre for Reviews and Dissemination and reported in line with Preferred Reporting Items for Systematic Review and Meta-analysis.

Method MEDLINE, Embase, PubMed and five additional databases were searched to identify primary studies with a focus on VAF for prevention and rehabilitation of lower extremity musculoskeletal dysfunction. One reviewer screened the titles and abstracts. Two reviewers retrieved full text articles for final inclusion. The first reviewer extracted data, whereas the second reviewer audited. Two reviewers independently assessed risk of bias and quality of evidence using Cochrane Collaboration's tool and Grading of Recommendations Assessment, Development and Evaluation, respectively.

Results Six studies were included, with a total sample of 304 participants. Participants included patients with

lateral ankle sprain (n=76), postoperative ACL reconstruction (n=16) and healthy individuals in injury prevention (n=212). All six studies included acquisition, whereas retention was found in five studies. Only one study examined transfer of the achieved motor learning (n=36). VAF was found to be effective for improving lower extremity biomechanics and postural control with moderate evidence from five studies.

Conclusion VAF should be considered in the rehabilitation of lower extremity musculoskeletal dysfunctions. However, it cannot be unequivocally confirmed that VAF is effective in this population, owing to study heterogeneity and a lack of high-quality evidence. Nevertheless, positive effects on lower extremity biomechanics and postural control have been identified. This suggests that further research into this topic is warranted where an investigation of long-term effects of interventions is required. All stages (acquisition, retention and transfer) should be evaluated.