Clinical Case Reports

Brazilian Journal of Case Reports

The Contribution of Facilitation Techniques to Proximal Head Control as an Influencing Factor of Postural Control in a Peripheral Vestibular Injury: a Case Report

João Carlos Martins Felício 1, 2*

[1] *Physiotherapist in Hospital Particular do Algarve – São Camilo Unit, Portimão, Algarve, Portugal.*
[2]*Invited Adjunct Teacher at the Algarve University, Health School (Physiotherapy Department), Faro, Portugal.*

**Corresponding author: João Carlos Martins Felício. Hospital Particular do Algarve. Av. S. João de Deus - Parque de Saúde da Misericordia de Portimão, Portimão. Zip Code: 8500-508, Portugal. E-mail: jcfelicio@ualg.pt.*

Research Ethics Committee Approval (if necessary): We declare that the patient approved the study by signing an informed consent form and the study followed the ethical guidelines established by the Declaration of Helsinki.

Received on: Jun 26, 2022. Accepted on: Jul 25, 2022. Available online: Jul 31, 2022.

Abstract

The Vestibular injury associated with the Peripheral Nervous System is a pathology that causes various alterations in individuals by the absence of afferent information. It mainly affects the orientation of the head and its relationship to the trunk of the body, influencing the individual's stability by a deficit in balance and coordination. In this context a 69-year-old female subject who had undergone surgery to remove a Schwannoma from the right VIII cranial nerve or Vestibular Schwannoma, with changes in head position and postural control in seated and bipedal positions and also in gait pattern, was evaluated. After a 10-week intervention program (1-hour sessions 2 to 3 times a week) which facilitation techniques based on the Bobath Concept were used, there was a considerable improvement in the subject's motor and functional status. The subject acquired the cervical rectification strategies necessary for better head alignment, better postural control, and a consequently greater autonomy in walking and daily activities.

Keywords: Facilitation techniques; Head orientation; Vestibular Schwannoma.

Introduction

The head position associated with the control of the trunk takes on a particular importance in gaining distal stability, promoting a larger selectivity of both movement and functionality within and outside of the limits of each individual's base of support. This contribution fundamentally results from the vestibular system's function in direct relation with the retinal stabilization process, with the readaptation to postural adjustments, and with the

ISSN: 2763-583X. doi: 10.52600/2763-583X.bjcr.2022.2.3.113-129.

gravitational orientation. When an injury occurs involving the vestibular system, the afferent information coming from this same system is altered, thus influencing the normal movement integration process, the reaction time, and the harmony of the sensorimotor control [1], resulting in a postural instability, disturbance in the ocular movement and complaints of dizziness [2].

Nowadays, the major expression of a vestibular injury associated with the Peripheral Nervous System (PNS) is better known as the Vestibular Schwannoma. These are benign and from an unknown origin, and more frequently diagnosed in the female sex in the age group of 50 years [3]. Additionally, since it is a quite rare pathology in the context of clinical practice in Physiotherapy it became relevant to include it in a study.

Given this context, an intervention plan was evaluated and formulated for a patient of the female sex with a Peripheral Vestibular Injury as a result from a Vestibular Schwannoma (schwann cell neoplasm of the VII cranial nerve). The patient underwent surgery for its removal, accompanied by the Department of Physical Medicine and Rehabilitation of the Hospital Particular do Algarve – Alvor Unit (outpatient regimen).

The main purpose of the present study was to observe the contribution of facilitation techniques (commonly used on central nervous injuries) in the correction of postural sequelae associated with a peripheral vestibular affliction, while equally reflecting on the importance of proximal orientation of the head within the body schema's organization, as well as the corresponding functional demonstration.

Case report

A 69-year-old female patient underwent surgery for the complete removal of a benign Schwannoma of the 8th right cranial nerve (confirmed by MRI), and the anatomical preservation of the facial nerve was not possible.

Her family support was provided by her husband (the main caregiver) who always accompanied the entire Rehabilitation process. The patient lived on the third floor of a building without an elevator. Her hobby was dancing. Regarding the patient's expectations, she hoped to recover as fast as possible even stating that she would like to regain her face, have balance and walk again.

The objective evaluation of the patient was essentially based on three key components for the regular movement and postural control: strategies in relation with the environment, functional level, and sensorimotor coordination.

At the time of the initial assessment the patient was moving by CR (driven by a third-party), thus being completely dependent. The patient showed a limited relation with the base of support (either laying or sitting down), negatively influencing the alternation between decubitus.

A cervical fixation pattern to the right, as well as the trunk (relationship between the head and the superior trunk was compromised), a hyperactivity of the right side with the constant support of the right upper limb on the table (sitting) and an asymmetrical weight transfer (with a greater reference to the right side). The sitting position showed a reduced motor activity on the left side (difficulty in crossing the midline), with a pelvic girdle in a posterior tilt, with no response for alignment (Figures 1A to 1D).

The preparation and follow-up Anticipatory Postural Adjustments were absent, which led to a difficulty in shifting the centre of gravity to the left side.

Functionally, the patient exhibited difficulty in the automatic recruitment of the left hemitrunk thus compromising the beginning of the motor task in a normal movement pattern, neglected the left side due to a hyperactivation of the right side favouring the orientation of the motor task exclusively to that same side.

Reduced selective movement in the left hemibody associated with compensatory strategies with the right hemibody, with no capacity for bimanual tasks and for a functional reach with the left upper limb. Difficulty with undertaking the bipedal position (inactivity of the anterior trunk muscles and a decreased extensor response). The patient required moderate help with horizontal ambulation (related to alterations to the gait pattern).

Procedures

The qualitative evaluation measures used were based on the clinical practice model of the Bobath concept4, which is congruent with the model of the International Classification of Functioning, and with Disability and Health (ICF), where the essential components of the analysis of the movement for the motor task were addressed, considering not only the completion of the task and necessary help, but also the cause of its performance [4].

Regarding the quantitative measures, several diverse assessment instruments were used: Berg Balance Scale (BBS), Functional Independence Measure (FIM) and BESTest (Balance Assessment - Systems Testing), for the risk of a fall and for the functional restriction associated to this clinical condition. Beside these instruments, a postural analysis was undertaken through photography using the editing software program Kinovea, comparing the images of the initial evaluation with the final ones.

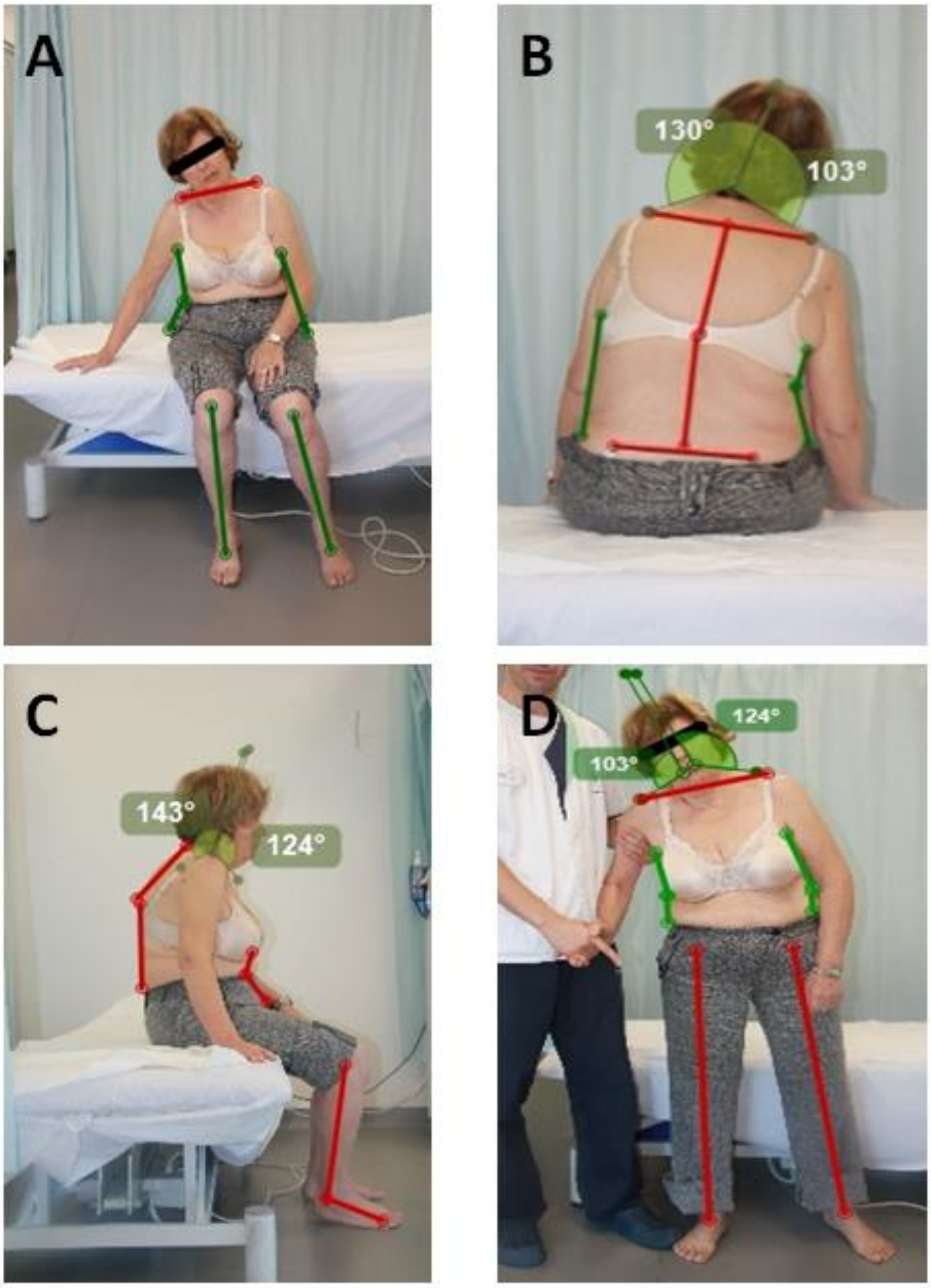

Figure 1. A. Postural Analysis in the anterior view in initial assessment (according to the computer software *Kinovea*). B. Postural Analysis in the posterior view in initial assessment (according to the computer software *Kinovea*). C. Postural Analysis in the profile view in initial assessment (according to the computer software *Kinovea*). D.

Postural Analysis in the bipedal position in initial assessment (according to the computer software *Kinovea*).

From the qualitative evaluation performed, the patient showed the main issues to be: a fixation pattern of the head in a slight flexion and a right lateral inclination; an inability to recruit motor activity in the left hemitrunk caused by a greater demand on the right hemibody, which lead to a lack of dynamic trunk interaction and to a poor automatic postural response; difficulty in acquiring the bipedal position from a sitting position due to an inability to flex the trunk and secure it in an asymmetrical position, thus making a normal gait pattern impossible.

All these aspects had a great influence on the patient's functionality regarding the alternation of decubitus in bed, in the acquisition of the sitting position, from that same position to the bipedal position, and consequently in the execution of a functional and automatic gait.

To this effect, a Physiotherapy program was implemented during a period of 10 weeks with three weekly sessions of one hour, in which the following goals were proposed:

1. Improve cervical motor recruitment capacity in different directions, changing the angle of lateral inclination to the right in the posterior view and the angle of flexion in the profile view (quantified by the Kinovea software through photography). This would allow the patient to improve the relationship between the head and the trunk and ease the performance of different functional activities in bed and against gravity.
2. Acquire a good postural control in the sitting position, due to a greater activation of the left hemibody and reduction of hyperactivity on the right resulting, according to the Kinovea software, in a correct alignment of the trunk (going from a score of 0/4 to 4/4 on item 3 according to BBS). This is necessary for the functionality of the upper limbs, for an independence on the execution of Self-Care (score of 6/7 in all the parameters according to FIM), and for an independent transition from sitting position to bipedal position (score 3 on number 9 of section III according to BESTest).
3. Re-educate the gait pattern towards automation (score 6/7 according to FIM) so that the patient, in the span of 10 weeks,

could walk again without the help of others.

The intervention in this patient was based on an individual and personalized problem-solving approach, considering the principles of normal movement present in Bobath's concept (facilitation of necessary structures for selective, harmonious, and normal movement) [5] and at a later stage in task-oriented functional exercises (after the patient gains more independence) (Figure 2).

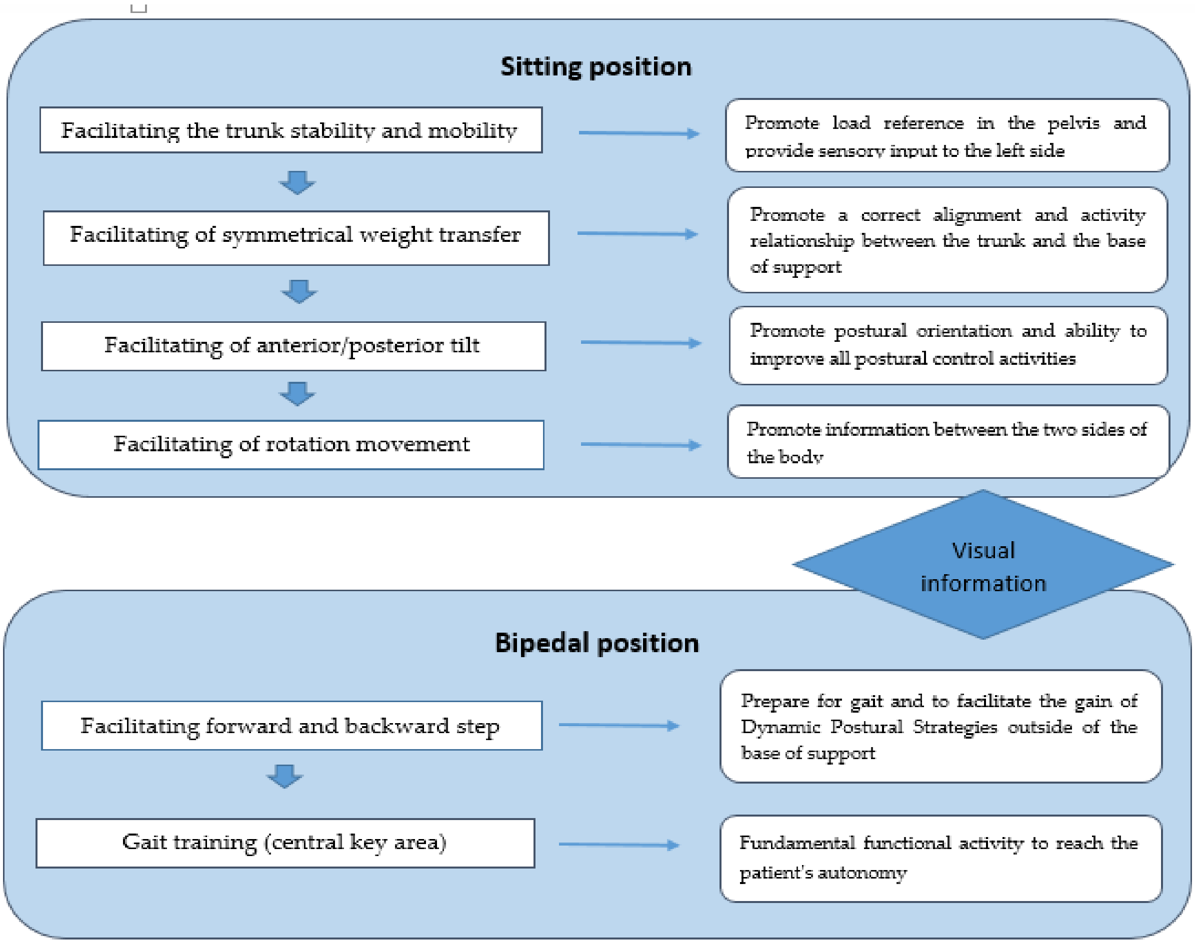

Figure 2. Flowchart of type of strategies used in Intervention Plan of Physiotherapy (first in sitting position and then in bipedal position).

All these intervention strategies wanted to contribute to reactivating Dynamic Postural Strategies (DPS) necessary for the work outside the base of support in all directions, progressively releasing the right hemitrunk, and consequently activating the left hemitrunk. This strategy was important to recognize the different bases of support (necessary for the transition from sitting to bipedal), enhancing sensorimotor input, and promoting the task repetition. After gaining mobility/stability of the trunk, cervical dynamics was introduced, promoting the selective movement between the head and the upper trunk.

The posterior tilt takes on a particular importance, being considered one of the main components for transition from sitting to a bipedal position (prerequisite for carrying out the march), promoting a better acceptance of the support base which then results in a greater recruitment of the activity of the lower limbs [7].

Once again, these strategies were fundamental for functional independence in bed and the experience of different body positions, essentially in bed rolls and preparing the patient to acquire a sitting position from the dorsal decubitus with as little help as possible as a way of stimulating contralateral activity.

The visual information during the task allowed the patient to improve her sensory level and the postural control response in different positions of the body. This variation is important in a peripheral vestibular injury in which the vision is, in fact, an influencing element in the postural orientation of the head and its relationship with the trunk.

Results

From the qualitative point of view, the patient achieved complete independence in the alternation of decubitus in bed, with the acquisition of a sitting position with an adequate and effective motor recruitment being visible. She revealed an improvement in postural control and, consequently, a more effective response of the trunk to the demand of gravity.

However, what was most important was verifying a better alignment of the head in relation to the upper trunk, positively influencing the gain of Cervical Rectification Strategies (CRS). These postural changes led to a symmetrical weight transfer and a better acceptance of the load on the left side, showing a greater voluntary motor recruitment of the left hemitrunk and less of the right hemitrunk (Figures 3A to 3D).

From the functional point of view, the patient gained the ability to safely perform activities outside her base of support (functional reach with the left upper limb and bimanual tasks), additionally acquiring an independent gait that manifested in a considerable improvement in her quality of life.

Regarding the specific proposed goals, the patient showed a better postural alignment of the head, which was confirmed by the change of the lateral inclination angle to the right on the posterior view and the flexion angle on the profile view. This allowed the patient an improvement of the cervical mobility as well as the gain of CRS.

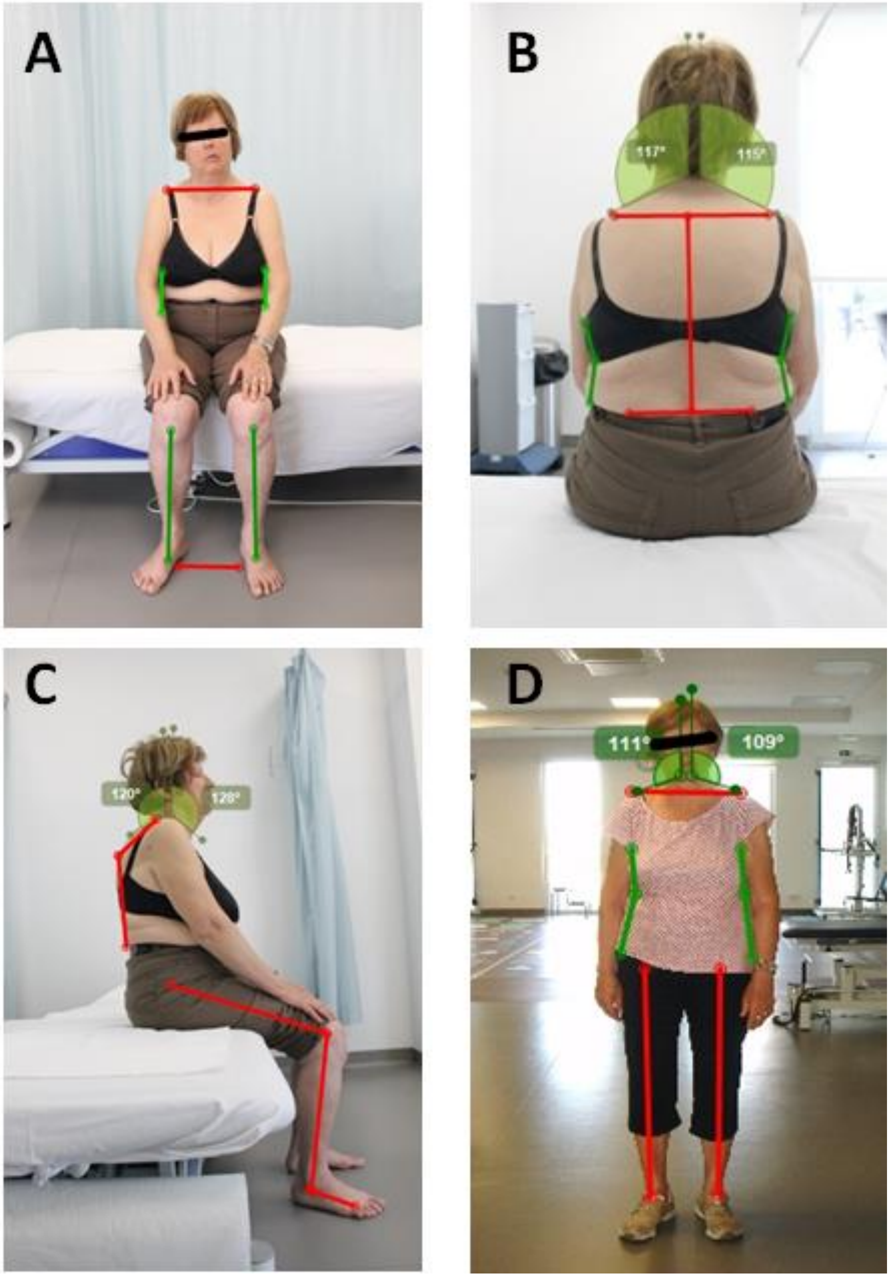

Figure 3. A. Postural Analysis in the anterior view in final assessment (according to the computer software *Kinovea*). In final assessment, the patient shows a better head and trunk alignment; a decrease in the activity of the right hemibody and a greater activation of the left hemibody was observed, promoting symmetry in the weight transfer, greater acceptance of the support base and, consequently, the sitting position with effective postural control without support from the upper limbs. Also noticeable is the better alignment of the lower limbs with a good support from both feet, thus

facilitating the transition to the bipedal position. B. Postural Analysis in the posterior view in final assessment (according to the computer software *Kinovea*). In final assessment the improvement in postural control in the sitting position is noticeable, with a symmetrical weight transfer (higher load reference on the left). C. Postural Analysis in the profile view in final assessment (according to the computer software *Kinovea*). These images show an improvement in cervical mobility, revealing an increase in the anterior flexion angle (124° to 128°), as well as a more visible extensor response of the trunk. Sitting position without support of the right upper limb on the table. Correct support of the right foot on the ground. D. Postural Analysis in the bipedal position (according to the computer software *Kinovea*). In the final assessment a better alignment of the head and trunk is noticeable, with a symmetrical weight distribution. No need for third-party support in the bipedal position.

Furthermore, the patient equally showed gains in postural control, presenting a bigger activation of the left hemitrunk and a decrease of hyperactivity on the right (a score of 4/4 in item 3, according to BBS), fundamental for the performance of self-care, in which it was possible to achieve a modified independence according to the FIM scale (all parameters with a score of 6/7, except bathing with a score of 5/7, since the patient needed supervision during the task), and in the transition from the sitting position to the bipedal position (a score of 2/4 in number 9 of section III, according to BESTest).

This last proposed goal couldn't be achieved (with a score of 3/4) since the bipedal position was reached on the first try with the assistance of the upper limbs. Functionally, the patient was able to achieve modified independence during gait according to the FIM scale (a score of 6/7). All these quantitative changes are shown in the next table, where values of the initial and final assessment were compared (Table I).

Table 1. Instruments for measuring. Comparison between the scores of the first and last assessments (including the scores regarding in the proposed goals).

Instruments for measuring (specific goals)	First Assessment	Final Assessment
Berg Balance Scale	Total Score: 7/56	Total Score: 41/56
	Seating without support Item 3: 0/4	**Seating without support** Item 3: 4/4 (goal achieved)
BESTest	Total Score: 2/108 (1,85%/100%)	Total Score: 68/108 (62,9%/100%)

	Seating for bipedal Item 9 (section III): 0/3	**Seating for bipedal** Item 9 (section III): 2/3 (Proposed goal was 3/3, not achieved)
Functional Independence Measure	Total Score: 77/126	Total Score: 112/126
	Self-Care: 16/42 **Gait**: 3/7	Self-Care: 35/42 (all parameters with 6/7, except the bath with 5/7) **Gait**: 6/7 (goal achieved)
Kinovea Software	Change in head and trunk alignment (inclination to the right side). Posterior view: right lateral inclination (103º). Profile view: cervical flexion (124º).	Better head and trunk alignment (postural stability with symmetrical weight transfer). Posterior view: right lateral inclination (angulation changed to 115º). Profile view: cervical flexion (angulation changed to 128º)

Discussion

According to the literature, the reference to the importance of Physiotherapy during the postoperative period of a Vestibular Schwannoma in terms of facial nerve recovery, vestibular function [8, 9] and benefits for postural control [2], is unanimous.

Due to the proximity to the vestibulocochlear nerve, an impairment presented itself at the level of the facial nerve, and in most cases the sequelae are frequent [6], causing muscle weakness or paralysis on the side of the tumour [3]. Regarding this situation, and since there was no anatomical preservation of the nerve after surgery, the intervention essentially focused on gaze stability, postural stability, and the return to normal daily life [11] through the approach of the Bobath concept.

Dizziness was one of the symptoms reported by the patient, explained by the connection between the Labyrinth (vestibular system) and the vestibulocochlear nerve, which prevented her from moving her head, gaining CRS and DPS [9, 10], necessary for its functionality. The Labyrinth is thus a fundamental structure in the vestibular system, having the ability to transform the forces caused by the acceleration of the head and by gravity in a biological signal, inform the nervous centres about the speed of the head and its position in space, and initiate some reflexes necessary for the stability of the gaze, head, and body [12, 13].

As it was previously described, the absence or deficit in the afferent information circuit from the vestibulocochlear nerve (mainly from the vestibular portion) to the CNS through the vestibular nuclei, and from these to the Spinal Cord by descending, can cause changes in stability and postural orientation in individuals [14], issues observed in the patient during the objective examination. The vestibular nuclei (central component) are fundamental structures in the production of movement, as they not only send information to the spinal cord through the Vestibular-Spinal Tract, but also receive direct afferents from the Vestibular System involved in the control of the tone of the extensor muscles in antigravity maintenance of posture and maintenance of balance [15].

Significant alterations were also observed at the level of the cervical pattern, with difficulty for a correct alignment, head orientation and gaze stability, which is a responsibility of the medial vestibulospinal tract [1], thus confirming an alteration in the descending vestibular circuit due to the clinical situation in question, given that this tract responds to information from posture and head movements, where the axons project themselves to the spinal cord up until the cervical level, influencing the lower motoneuron that controls the neck and upper trunk.

Unlike the previous one, the lateral vestibulospinal tract responds to gravity information, facilitating the extensor musculature and inhibiting the flexor musculature, projecting ipsilaterally to all spinal levels [1,15], resulting in a postural instability with consequences for its global functionality.

This information can thus confirm the importance of the knowledge of intrinsic neuro-physiological concepts in the Physiotherapist's assessment and intervention, demonstrating the vital contribution of the vestibulospinal tract to the development of the sensory and motor system, providing important information regarding the movement of the head and its position in space, with the CNS subsequently using this information along with information from the visual and somatosensory systems to create an internal map of the position and movement of the entire body in relation to the environment [16].

The presence of compensatory strategies to overcome the effects of permanent vestibular injury [11] caused a slower recovery to postural stability. These compensatory strategies involved the neck and trunk rotation deficit, leading to a block trunk, without a dissociation of the shoulder and pelvic girdles, hence the need to provide a movement experience preparatory for the readjustment of correct postural strategies [17].

Bobath's concept is a problem-solving approach focused on the assessment and treatment of patients with alterations in function, movement and postural control [18], thus being fundamental in this rehabilitation process through the analysis of normal movement, of the selective movement for the production of a coordinated sequence and the integration of postural control in performing the task, essentially through sensory input and with constantly promoting a bigger participation from the patient [4, 19]. Additionally, its use was made possible by being an inclusive and individual concept, reinforcing the idea of non-exclusivity, with the possibility to be used in all patients regardless of age, severity of cognitive and motor deficits, and degree of functional disability [4,20], becoming a differentiating concept from the rest and forcing an individualized reasoning process.

Since the Bobath concept is more widely used in the central nervous injury it does not treat the neurological injury itself, but the consequences of this injury, once again reinforcing that this approach can then be used in numerous pathologies, including the peripheral nerve injury [4].

The evaluation carried out according to the Bobath concept made it possible to relate several components, among them the postural control (individual, task and environment), the sensorimotor level and the selective movement [21], which proved to be important elements in this patient with an influence in terms of postural orientation of the head, and in the alignment and selective movement of the trunk, changing the quality in the accomplishment of the motor task [22].

During the intervention, the gain in stability/mobility of the trunk allowed a better alignment and voluntary motor recruitment of the head and the rest of the body, thus making possible the horizontality of the gaze and the automatic motor response of the trunk. Given this progression, it was possible to introduce cervical dynamics exercises in the sitting position [4].

These improvements regarding the orientation and postural control in the sitting and bipedal position favoured the theory that the approach with the Bobath concept may have contributed to the functional recovery of the peripheral vestibular injury, because although some studies refer that these lesions can improve spontaneously through the CNS compensation process, some postural strategies can be inappropriately adopted, leading to compensatory movements or maladapttive postural control [11, 23], where facilitation techniques have been proven to be a possible strategy while achieving a more effective postural response, originated by a correct afferent information to the CNS [23].

The evolution of this case may have been favoured by the Neuroplasticity of the CNS, due to its ability to adapt to the asymmetries that arose from the peripheral labyrinthine system, this ability being exploited by the Bobath concept. Therefore, we can state that the intimate relationship that exists between the CNS and the PNS may be the basis for the successful application of facilitation techniques, mainly due to the mechanisms of neuronal plasticity which are capable of promoting a vestibular compensation that results from neuronal alterations active in the cerebellum and brain stem, in response to sensory conflicts produced by the vestibular pathology [11,24].

The manipulation of information can directly influence changes in the structural organization of the nervous system through spatial and temporal summation and the facilitation of pre and postsynaptic inhibition, achieved mainly through the handling, in which the physical therapist guides the movement by providing afferent inputs to optimize movement control [18].

To promote plastic changes in the NS, we also resorted to the training of the task through repetition that allowed the patient to be functional but in an optimized way, with selective, coordinated, and sequenced movements without the observation of compensatory movements, and with the maximum quality in movement reinforcing motor learning. In other words, the more frequently the task is practiced and repeated, the stronger the communication and synaptic transmission is since experience and new learning promote dendritic branching and the increase of neuronal synapses [25].

We can thus confirm through the literature that the neurophysiological explanation for the improvement in postural control may be linked to complex processes within the CNS but closely linked to the SNP [3, 14].

Vision became an important stimulus due to its influence on the head's response to the trunk's postural mechanisms, and in doing so it provided a reference for cervical rectification and orientation [26]. This way it was possible to achieve stabilization of the vestibulo-ocular reflex during head movement associated with the offer of greater stability and postural control [20] consequently improving the functional autonomy [27], since this reflex is mainly affected by the loss of peripheral vestibular function [26], influencing precision in gaze direction, the compensatory postural adjustments and, consequently, the automatic proximal control of the head [14].

Throughout the intervention, the patient always showed motivation and collaboration during the sessions and understood the tasks requested, factors that were fundamental for her rehabilitation process, emphasizing the importance of the cognitive system that benefited the patient in this entire process, thus confirming the importance that the concept of Bobath places on the different systems, not directing the referred approach solely to the neuromuscular system.

Final considerations

A peripheral vestibular lesion is a pathology that causes numerous changes in coordination and postural control, evidently influencing the overall functionality of these individuals. In this case, the importance of the automatic postural response of the trunk in the alignment and orientation of the head was notable, aspects that contributed to the stability of the gaze, promotion of anticipatory postural adjustments, stability/mobility of the trunk and, consequently, the entire global functionality (including in bed, sitting position and gait), thus showing relevant improvements in the patient's motor and functional condition.

In this patient, it was essential to start our intervention with postural control of the trunk and later with proximal control of the head, contrary to what was initially proposed, because by starting with the stability/mobility of the trunk a better stability and cervical orientation were achieved.

The intervention based on Bobath's concept through the facilitation techniques seemed to demonstrate a positive influence on the patient's functional recovery, because despite being a strategy with more evidence at the CNS level, it was revealed to be an approach to be taken into account in the recovery of a peripheral vestibular lesion, mainly due to the fundamental role of regeneration of neuronal mechanisms of the CNS and the correct afferent information from the PNS to important structures in the production and control of movement in the CNS.

Functionally, significant improvements were observed through the application of facilitation techniques based on the Bobath concept, which demonstrated an important therapeutic effectiveness in movement dysfunction, whether of peripheral or central origin, due to its particular relationship with the Nervous System.

After the end of the sessions, the patient showed great satisfaction with the goals achieved, considering her initial expectations, having mentioned the functional independence in her daily life as the most important aspect achieved within her clinical condition.

References

[1] Bankoff ADP, Bekedorf R. Bases Neurofisiológicas do Equilíbrio Corporal. Laboratório de Avaliação Postural e Eletromiografia. 2007; 106.

[2] Fransson PA, Kahlon B, Karlberg M, Lindberg S, Magnusson M, Siesjo P, Tjernstrom F. Prehab vs Rehab – presurgical treatment in vestibular schwannoma surgery enhances recovery of postural control better than postoperative rehabilitation: Retrospective case series. Journal of Vestibular Research 27 (2017) 313–325.

[3] Vestibular Schwannoma (Acoustic Neuroma) and Neurofibromatosis, National Institute on Deafness and other Communication Disorders, NIH Pub N 99-580, novembro 2015.

[4] IBITA, International Bobath Instructors Training Association; 2021 (consultado em 9 fevereiro 2021).

[5] Brock K, Eustace C, Graham JC. The Bobath Concept in Contemporany Clinical Practise. Topics in Stroke Rehabilitation/ Jan-Fev 2009. 16 (1): 57-67.

[6] Vestibular Rehabilitation for Peripheral Vestibular Hypofunction: An Evidence-Based Clinical Practice Guideline. American Physical Therapy Association (Neurology Section). JNPT. Abril 2016. 40: 124-154

[7] Chen J, Fan W, Liu M. Effects of modified sit-to-stand training on balance control in hemiplegic stroke patients: A Randomized control trial. Clinical Rehabilitation. Outubro 2015; 1-10.

[8] Ciubotaru GV, Georgescu M, Mogoanta CA, Stoian S. Vestibulary rehabilitation – Election treatment method for compensating vestibular impairment. Bucareste. Rom J Morphol Embryol 2012, 53 (3):651–656.

[9] Gouveris HT, Mann W. Diagnosis and Therapy of Vestibular Schwannoma. Expert Rev, Neurother. 2009. 9 (8): 1219-1232.

[10] Bento RF, Neto VB, Pinna MH. Schwannona Vestibular: 825 casos, 25 anos de experiência. Int. Arch. Otorhinolaryngology. São Paulo, Brasil. 2012: v.16, 4: 466-475.

[11] Han BI, Kim JS, Song HS. Vestibular Rehabilitation Therapy: review of Indications, Mecanisms and Key Exercices. J Clin Neurol 2011; 7:184-196

[12] Larson S, Solan HA, Tremblay JS. Vestibular Function, Sensory Integration, and Balance Anomalies: A Brief Literature Review. State College of Optometiy SUN. 2007; 3 (1): 13-17.

[13] Cass SP, Clendaniel RA, Fife TD et al. Vestibular Rehabilitation for Peripheral Vestibular Hypofunction: An Evidence-Based Clinical Practice Guideline. American Physical Therapy Association: Neurology Section. 2016; 40: 124-154.

[14] Clark S, Cohen LG, Duncan PW, Gage FH, Selzer ME. Textbook of Neural Repair and Rehabilitation. Nova Iorque: Cambridge University Press. 2006.

[15] Tallitsch MT. The Nervous System: Sensory and Motor Tracts of the Spinal Cord. 7 ed. Nova Iorque: Pearson Education. 2012.

[16] Agrawal Y, Carey JP, Minor LB, Santina CCD, Schubert MC. Disorders of Balance and Vestibular Function in US Adults. Department of Otolaryngology–Head and Neck, 2017.

[17] Horak FB, Postural orientation and equilibrium: what do we need to know about neural control of balance to prevent falls? Neurological Sciences Institute of Oregon Health & Science University, Portland, OR, USA. Age and Ageing 2006; 35-S2: ii7–ii11.

[18] Lynch-Ellerington M, Meadows L, Raine S. Bobath Concept: Theory and Clinical Practise in Neurological Rehabilitation. Oxford: Wiley-Blackwell, 2009.

[19] Brock K, Eustace C, Graham JC. The Bobath Concept in Contemporany Clinical Practise. Topics in Stroke Rehabilitation/ Jan-Fev 2009. 16 (1): 57-67

[20] Moreira, JCF. A evolução do conceito de Bobath: Uma revisão narrativa. Porto. Universidade Fernando Pessoa, Escola Superior de Saúde, 2012.

[21] Michielsen M, Vaughan-Graham J, Holland A, Magri A, Suzuki M. The Bobath concept - a model to illustrate clinical practice. Disabil Rehabil. 2019 Aug;41(17):2080-2092.

[22] Graham, JV. The Bobath (NDT) concept in adult neurological rehabilitation: What is the state of the knowledge? A scoping review. Part I: conceptual perspectives. Journal Disability and Rehabilitation. 2015. 37(20): 1793-807.

[23] Buurke JH, Lennon S, Lyons B, Kollen BJ. The Effectiveness of the Bobath Concept in Stroke Rehabilitation What is the Evidence? American Heart Association, 2009: 89-97.

[24] Vestibular Rehabilitation for Peripheral Vestibular Hypofunction: An Evidence-Based Clinical Practice Guideline. American Physical Therapy Association (Neurology Section). JNPT. 2016. 40: 124-154.

[25] Florindo M, Pedro R. O processo de aprendizagem motora e a neuroplasticidade. Revista de Ciências da Saúde da Escola Superior de Saúde da Cruz Vermelha Salutis Sciencia, Lisboa. 2014; 6: 19-26.

[26] Santina CCD, Schubert MC, Shelhamer M. Incremental angular vestibulo-ocular reflex adaptation to active head rotation. National Institute of Heath. 2008; 191(4): 435–446.

[27] Kluding PM, Lin J, Silva LJ, Staecker H, Whitney SL. Impact of Diabetic Complications on Balance and Falls: Contribution of the Vestibular System. American Physical Therapy Association. 2016; 96 (3): 400-409.

Conflict of interest: None.

Acknowledgements: None.

Funding: None.

How to cite this article: Felício JCM. The Contribution of Facilitation Techniques to Proximal Head Control as an Influencing Factor of Postural Control in a Peripheral Vestibular Injury: a Case Report. Brazilian Journal of Case Reports. 2022 Jul-Sep;02(3):113-129.