VISUAL BIOFEEDBACK BALANCE CONTROL TRAINING VS. KINESIOLOGY TAPING IN PATIENTS SUFFERING FROM SCIATICA

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Abstract

Low Back Pain (LBP) is commonly classified as civilization disease. Many authors assume that about 80% of the population over forty have at least one major episode of pain in the lumbar area. Many of those patients demonstrate lumbosacral radicular symptoms. Sciatica usually develop as a result of a disc-root conflict and can disturb patients posture and balance. The objective of this study was to assess the effect of the visual biofeedback balance control training in patients suffering from sciatica on posture and balance. This was a randomized clinical study with control group, single-blind. Sixty suffering from sciatica patients (54% females) in the age between 20 and 83 met the inclusion and exclusion criteria. In the experimental group (VBF) in addition to comprehensive rehabilitation, visual feedback balance training was used. In the control group (KT) except comprehensive rehabilitation the kinesiology taping was applied within the lumbar region. For outcome measure center of foot pressure deflection, execution time, Bohannon's standing one-leg test, distribution of limb loads, Functional Ambulatory Category, Timed Up and Go, lumbar spine mobility, Laségue symptom, neurological symptom examination and the Visual Analog Scale has been used. In results: visual feedback balance control training using the balance platform had a statistically significant impact on execution time, standing on one leg, spine mobility, gait, coordination and pain. Dynamic kinesiotaping had a statistically significant effect on COP sway, balance, gait, coordination and pain. Feedback balance control training was more beneficial than dynamic kinesiotaping, although not statistically significant. In the VBF group no statistically significant effects on COP sway and distribution of limb loads has been observed. No effects of gender, side of sciatica (left/right) nor BMI has been observed. Statistically significant effect of visual feedback balance control training was observed in both groups in the age below 55. No side effects have been noticed.

Keywords*:* balance disorders, kinesiology taping, lumbar discopathy, Low Back Pain, LBP, lumbar radiculopathy, postural control, sciatica, Visual Biofeedback

Introduction

Low Back Pain (LBP) is commonly recognized as civilization disease (Bae et al. 2013; Opara et al. 2006). Many of those patients demonstrate lumbosacral radicular symptoms (Furman & Johnson 2019). About 90% of sciatica is due to a spinal disc herniation pressing on L4 or L5 lumbar or S1 sacral nerve root. Sciatica usually is a symptom of lumbo-sacral radiculopathy, characterized by pain radiating down the leg from the lower back, outside, or front of the leg along the course of the affected nerves (Konstantinou & Dunn 2008). Lower limb pain occurring in the sciatica causes reflex sparing of the limb and less pressure on the ground on this side.

Sciatica is typically diagnosed by physical examination and neuroimagination. The most applied diagnostic test is the Lasègue's sign, which is considered positive if pain in the distribution of the sciatic nerve is reproduced with passive flexion of the straight leg between 30 and 70 degrees. Neuroimaging modalities such as computerized tomography or magnetic resonance imaging can help with the diagnosis of lumbar disc herniation. As for treatment there is no one medication regimen used to treat sciatica. Commonly used arenon-steroidal anti-inflammatory drugs (NSAIDs), some people believe in alternative medicine. Only few (2-3%) patients need surgery – if sciatica is caused by a herniated disc, a discectomy has tentative evidence of benefit in the short term (Gibson &Waddell 2007).

As well LBP as sciatica can disturb patients posture and balance (Della Volpe et al.2006; Henry et al. 2006; Lafond et al 2009). The type of training in posture and balance disorders is determined by a physiotherapist and depend on its nature and severity (Arienti et al. 2019). Usually these are many types of exercise (gait, balance, co-ordination and functional tasks; strengthening exercise; 3D exercise and multiple exercise types). Till now there is still insufficient evidence supporting general physical activity, computerized balance programs or vibration plates.

The effects of posture and balance training can be measured by more varied means, but typical quantitative outcomes are centre of pressure (COP), postural sway, and static/dynamic balance, which are measured by the subject's ability to maintain a set body position while undergoing some type of instability (Willigenburg et al. 2013].

The aim of this study was to assess the effect of the visual biofeedback balance control training in patients suffering from sciatica on posture and balance comparing to kinesiology taping.

Material and methods

The study protocol has been approved by the Bioethics Committee. Sixty suffering since 6-24 month from sciatica patients (54% females) in the age between 20 and 83 (mean 54) met the inclusion and exclusion criteria (Table 1).According to Quebec Task Force Classification all patients fulfilled criteria QTF 3 i.e. LBP with radiation to the limb below the knee, QTF 4 = LBP with radiation to the limb with neurological symptoms, QTF 6 = spinal root compression confirmed by imaging techniques such as CT or MRI, QTF 9 – surgery in the lumbosacral segment of spine for over 6 months (Atlaset al. 1996). From 60 involved patients 24 had spinal surgery.

In the experimental group VBF) in addition to comprehensive inpatient rehabilitation (about 3 hours per day) which took three weeks (six days per week), visual biofeedback balance training was used. In the control group (KT) except comprehensive rehabilitation the kinesiology taping was applied within the lumbar L1-L5 region.

Table1. Study demographics.

		Experimental group		Control group	
		n	%	n	%
Gender	Females	16	27%	16	27%
	Men	14	23%	14	23%
Age (years)		36-80		20-83	
Mean age (mean±SD)		55,2±13		53,9±14,65	
Body lenght (mean±SD) cm		169,17±7,18		170,10±19,59	
Body mass (mean±SD)		80,37±15,42		79,53	
BMI (average)		28,08		27,49	

As for outcome measures: center of foot pressure (COP), execution time (coincidence with moving point, i.e. virtual stimulus, during 30 seconds probe), distribution of limb loads, Bohannon's standing one-leg test, Functional Ambulatory Category (FAC), Timed Up and Go (TUG), lumbar spine mobility (Schober), Lasègue`s sign, neurological symptoms examination and the Visual Analog Scale (VAS) has been used (Bohannon 1994; Holden et al. 1984; Podsiadło& Richardson 1991).

Results

Results are presented in tables 2-4. VBF balance control training had a statistically significant impact on execution time, standing on one leg, spine mobility, gait, coordination and pain. Dynamic kinesiotaping had a statistically significant negative effect on COP sway and positive impact on balance, gait, coordination and pain. Feedback balance control training had a more beneficial than dynamic kinesiotaping, although not statistically significant. In the VBF group no statistically significant effects on COP sway and distribution of limb loads has been observed. No effects of gender, side of sciatica (left/right) nor BMI has been observed. The main parameter having a statistically significant effect on impact of visual feedback balance control training was age below 55, which was also observed in the control group. No side effects as well of VBF and KT has been noticed.

Table 2. The COP sway (centimeters) and coincidence with moving point (virtual stimulus) during 30 seconds probe (%).

Parameter	Intervention group			Control group		
	Before intervention	After intervention	P value	Before intervention	After intervention	P value
COP sway (cm) Eyes open	216.19	229.31	0.14	175.53	216.96	**0.001**
Execution time (%)	18.93	36.93	**0.00001**	16.37	30.50	**0.00002**

Table 3. Distribution of limb loads and standing time on one leg (eyes open).

Parameter	Intervention group			Control group		
	Before intervention	After intervention	P value	Before intervention	After intervention	P value
Limb load distribution L/R leg (%)	L:49.97 R:50.03	L:49.40 R:50.60	0.21	L:49.93 R:50.07	L:50 R:50	0.69
Standing time (s) on left leg	6.04	9.62	**0.000002**	8.48	12.92	**0.000002**
Standing time (s) on right leg	6.49	10.75	**0.000002**	8.53	13.16	**0.000003**

Table 4. Changes of lumbar spine mobility (Schober), Laségue`s sign, Functional Ambulatory Category (FAC), Timed Up and Go test (TUG) and VAS after intervention.

Parameter	Intervention group			Control group		
	Before intervention	After intervention	P value	Before intervention	After intervention	P value
Schober (cm)	3.17	4.25	**0.00003**	2.85	4.28	**0.00001**
Laségue L	52.03°	67.50°	**0.000003**	53.87°	69.20°	**0.000003**
Laségue P	55.37°	69.90°	**0.000002**	55.17°	68.60°	**0.000002**
FAC	4.60	4.90	**0.01**	4.83	4.97	**0.067**
TUG sec.	14.24	11.35	**0.00003**	13.40	10.28	**0.000004**
mean VAS	5.87	3.50	**0.00001**	5.40	3.10	**0.00001**

Discussion

The human postural system operates on the basis of integrated information from three independent sources: vestibular, visual and somatosensory (Della Volpe et al. 2006). The peripheral proprioceptive system or the central processing of proprioceptive information may be altered in LBP. Balance is commonly affected by multiple factors as well in children as in adults. Main neurological diseases in which posture and balance disorders appear are as following: stroke, Traumatic Brain Injury, Sclerosis Multiplex, Parkinson`s disease, Vestibular neuronitis. Other neurological diseases less common in which balance disorders appear are: age related decline in balance function, infectious, circulatory, medullary syndrome, structural or tumors. These are also peripheral disturbances which can cause disorders of balance, i.e. leg amputation, disorders of function of hip joint, knee joint, sciatica etc. Sequel of balance disorders could be as following: dizziness or vertigo, falling, disorientation (Stel et al. 2003).

Many authors indicated that LBP can disturb postural stability and balance. Della Volpe et al. performed posturography by 12 chronic LBP patients and 12 age-matched controls. While the control of balance was comparable between the two groups across stabilized support surface conditions, chronic LBP patients oscillated much more than controls in the anterior-posterior (AP) direction in platform sway-referenced conditions. Increased sway in AP direction as postural strategy may underlie a dysfunction of the peripheral proprioceptive system or the central integration of proprioceptive information (Della Volpe et al. 2006). Based on 72 trials made in 24 healthy subjects and 26 suffering from chronic LBP standing with feet placed on separate force plates, Henry et al. stated that subjects with LBP had reduced and delayed sagittal plane center of pressure responses (P<0.01) compared to the subjects without LBP. In contrast, the sagittal plane center of mass responses was larger in magnitude (P=0.03) yet similarly delayed in onset (P=0.04) for the LBP group. Frontal plane responses did not differ between groups. Authors interpretation: subjects with LBP have altered automatic postural coordination, both in terms of magnitude and timing of responses, indicating alterations in neuromuscular control (Henry et al. 2006).

Lafond et al. analyzed the control of posture by 12 subjects with chronic LBP during prolonged unconstrained standing in comparison to 12 matched healthy adults. The center of pressure (COP) position of 12 chronic LBP subjects and 12 matched healthy controls was recorded in prolonged standing (30min) and quiet stance tasks (60s) on a force plate. Statistical analyses showed that LBP subjects produced less postural changes in the antero-posterior direction with decreased postural sway during the prolonged standing task in comparison to the healthy group - only LBP subjects were influenced by the prolonged standing task. Individuals with LBP might have altered sensory-motor function, their inability to generate responses similar to those of healthy subjects during prolonged standing may contribute to LBP persistence or an increased risk of recurrent back pain episodes (Lafond et al 2009).

In cross-sectional case-control study age-matched and gender-matched 16 chronic LBP and 16 asymptomatic participants McRae et al. assessed barefoot (1) standing, over three 40 s trials, under four posture challenging conditions (2) during gait. Primary outcome was postural stability (assessed by root mean squared error of center of pressure (CoP) displacement (CoPRMSEAP) and mean CoP velocity (CoPVELAP), both in the anteroposterior direction). There were no differences between groups in CoPRMSEAP (P=0.26), or CoPVELAP (P=0.60) for any standing condition. Authors conclusion: this study suggests that people with mild to moderate CLBP present with similar standing postural control, and parameters of gait to asymptomatic individuals. Treatments directed at influencing postural stability (e.g. standing on a wobble board) or specific parameters of gait may be an unnecessary addition to a treatment program (MacRaeet al. 2018).

Mok et al. tested quiet stance on supporting bases with different lengths and with different visual inputs in 24 study participants with chronic LBP and 24 matched control subjects. A task was counted as successful if balance was maintained for 70 seconds during bilateral stance and 30 seconds during unilateral stance. The hip strategy was reduced with increased visual dependence in study participants with LBP. The failure rate was more than four times that of the controls in the bilateral standing task on short base with eyes closed. Analysis of COP motion also showed that they have inability to initiate and control a hip strategy. In conclusion: the inability to control a hip strategy indicates a deficit of postural control and is hypothesized to result from altered muscle control and proprioceptive impairment (Mok et al. 2004).

Oyarzo et al. assessed postural control and static balance in 44 athletes belonging to Chilean national teams: 20 had LBP and the remaining 24 were healthy controls. Computerized platform posturography showed that athletes with LBP used significantly more energy (p< 0.0182) and had a greater displacement of the COP (p< 0.005) with open eyes to control posture than healthy athletes Oyarzo et al. 2014).

Sipko and Kuczyński investigated 32 healthy persons while 32 chronic LBP were divided into 2 subgroups, according to the reported intensity of resting pain: low and high pain levels.

The forward limit of stability (LOS) was lower in both the low pain (P < .01) and high (P < .01) subgroups than in the asymptomatic with eyes open and closed, while no differences between the low pain and high pain groups were found. Eye closure caused an increase in forward (P = .02) and backward (P = .001) COP velocity in the low pain group and forward COP velocity in the asymptomatic (P = .04) only. Conclusion: subjects with LBP had reduced forward limit of stability regardless the pain level. However, the higher level of pain was associated with slower execution of voluntary leaning tasks, with eyes closed only (Sipko & Kuczyński 2013).

Willigenburg et al. assessed trunk control by measuring COP, lumbar kinematics and trunk muscle electromyography in 20 low-back pain patients and 11 healthy individuals. Repeated measures analyses of variance indicated that the effects of proprioception disturbance and vision occlusion were similar between groups. Interestingly, LBP patients grabbed the safety rail more often, while differences between groups in sway measures were rather subtle. This suggests that LBP patients were more cautious. Furthermore, LBP patients had an about 20 degrees less flexed lumbar posture than healthy individuals, and made larger thoraco-lumbar movements in the sagittal plane (Willigenburg et al. 2013)].

Among new methods of supporting comprehensive rehabilitation in balance disorders in 21st century Visual Biofeedback (VBF) based training has been appeared. VBF is mostly popular in the treatment of balance disorders in stroke and Parkinson`s disease. There is no information in the literature about VBF in sciatica.

Alahan et al. (2017) searched databases from 2010 to 2016 about healthy adults, aged ≥65 years, with no specific disorders. Interventions were any VBF intervention with the aim of improving balance and were compared to no intervention, traditional exercises, placebo, or standard care. Of 879 articles five papers were included. The total number of participants in all the five included studies was 181, with a mean age of 74.3 years. The variation between studies in methodology, intervention protocol, and outcomes utilized made it difficult to inform a definitive statement regarding the potential application of VBF for balance training with the elderly. In conclusion: engaging elderly people living in the community in VBF training was found to be effective and could improve their balance ability (Alahan et al. 2017).

Molka et al. evaluated the effects of VBF balance training in 16 patients (mean 33 ± 8 years old) who underwent anterior cruciate ligament reconstruction in comparison to the control group consisted of 15 people aged 34 ± 4 years. In results: balance in the sagittal plane with eyes closed improved significantly after rehabilitation. The average velocity of center of foot pressure swing in both the frontal and sagittal planes with eyes closed differed significantly from those of controls. Execution time required for the two dynamic tests decreased significantly after rehabilitation and were significantly better than those in the controls. Authors conclusion: maintaining static balance with eyes closed is very challenging after anterior cruciate ligament reconstruction especially in the sagittal plane is particularly difficult. A one-month rehabilitation program partially improves static and dynamic balance (Molka et al. 2015)].

Pethe-Kania et al. assessed the effect of VBF in 30patients who underwent total hip arthroplasty. Both in the study group as in control group a conventional 21-day comprehensive rehabilitation was carried out. In results: the eyes-open static posturography indicated significant improvement in the lower limb loading symmetry in 29 (97%) patients from the experimental group ($p = 0.000003$) compared to the control group, where improvement was observed in 20 (67%) patients ($p = 0.034796$). In the eyes closed examinations correction in the limb loading symmetry was evident in 23 (77%) patients from the experimental group ($p = 0.000247$) and 18 (60%) patients from the control group ($p = 0.043327$). Authors conclusions: significant improvement in the lower limb loading symmetry was observed in patients who underwent rehabilitation supplemented with VBF (Pethe-Kania et al. 2017).

Walker et al. divided 46 people who had stroke within 80 days before into three groups: two with VBF balance training and one with conventional balance therapy, all of them had also comprehensive physiotherapy. Results: all groups demonstrated marked improvement for all measures of balance ability, with the greatest improvements occurring in the period from baseline to discharge after five weeks. No between-group differences were detected in any of the outcome measures. Authors conclusion: VBF or conventional balance training in addition to regular therapy affords no added benefit when offered in the early stages of rehabilitation following stroke (Walker et al. 2000).

Zijlstra et al. has been published in 2010 results of systematic review of reports on VBF for interventions in adults older than 60 with balance and mobility disorders. Effectiveness was evaluated based on 21 studies, mostly of moderate quality. An indication for effectiveness of VBF-based training of balance in (frail) older adults was identified for postural sway, weight-shifting and reaction time in standing, and for the Berg Balance Scale. The authors stated that further appropriate studies are needed in different populations of older adults to be able to make definitive statements regarding the (long-term) added effectiveness, particularly on measures of functioning (Zijlstra et al. 2010).

We used in control group kinesio taping (KT), which has been developed in the seventies of the 20th century by Kenzo Kase. Bae et al. examined the effects of KT applied to 10 chronic LBP patients comparing to 10 controls. In the experimental group patients received KT more than 12 whereas in control group the ordinary physical therapy was applied. Anticipatory postural control was evaluated using electromyography (EMG), and movement-related cortical potential (MRCP) was assessed using electroencephalography (EEG). In results: there were significant decreases in the transversus abdominis (TrA) muscle and the external oblique muscle in both groups. There was significant difference in the TrA between the two groups. There was also a significant decrease in the MRCP of both groups. In particular, changes in the movement monitoring potential (MMP) of the experimental group were greatest at Fz, C3, Cz, and C4. In conclusion: KT applied to LBP patients reduced their pain and positively affected their anticipatory postural control and MRCP [1].

Köroğlu et al. evaluated the effect of KT on pain, functionality, mobility and endurance in chronic low back pain treatment in 60 chronic LBP patients divided into three groups. Ultrasound, hot packs, and transcutaneous electrical nerve stimulation (TENS) and therapeutic exercises were applied to each group for ten sessions during two weeks. KT was applied to the patients in the first group after each treatment session, and placebo tape was applied to the patients in the second group. Statistically significant improvement demonstrating the superiority of the taping group was observed in pain, functionality, flexibility and endurance values. Authors conclusions: KT in LBP is an easy and effective method which increases the effectiveness of the treatment significantly in a short period when applied in addition to exercise and electrotherapy methods (Köroğlu et al. 2017).

What is interesting in our research: VFB had no impact on COP sway in the intervention group but negative impact on COP in KT group. Note: in KT group before intervention COP sways were less than in the VFB group.

Conclusion

Visual biofeedback balance control training using the balance platform in patients with radiculopathy suffering from sciatica has a statistically significant impact on postural control, balance, gait, coordination and pain better than kinesiology taping.

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