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Pilot Study

Integration of a neurodynamic approach into the treatment of dysarthria for patients with idiopathic Parkinson's disease: A pilot study

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ABSTRACT

Purpose: Differences between standard dysarthria treatment and the same treatment with the integration of neurodynamic techniques tailored to the severity of dysarthria in patients with Parkinson's disease were examined.
Method: In total, 10 subjects with idiopathic Parkinson's disease and rigid–hypokinetic dysarthria were enrolled in this quasi-randomized, controlled, single-blind, pre–post study. In each of 12 therapy sessions the control group (n = 5) received standard dysarthria treatment (usual care), while the intervention group (n = 5) received the same treatment with the addition of integrated neurodynamic treatment (special care).
Results: There was no significant difference between the two groups for either the pre-test ($p = 0.739$) or the post-test ($p = 0.156$) results. However, significant differences between the pre-test and post-test results within each group (intervention group $p = 0.001$; control group $p = 0.003$) were found.
Conclusions: The significant differences in the pre–post comparison within the groups may indicate a high probability of a positive effect of standard dysarthria treatment on the severity of dysarthria. In between-group comparisons, the study results indicated no evidence of a significant difference between standard dysarthria treatment with or without neurodynamics. Due to the small sample size, the effectiveness of the integration of neurodynamics into speech therapy cannot be definitively concluded for now. In order to be able to have generalized applicability, future studies with larger numbers of participants are required.

1. Introduction

Neurodynamics is commonly utilized in the physiotherapeutic domain for diagnosis and treatment of neuromusculoskeletal dysfunctions and pain (Butler, 2006; Shacklock, 2008). The basis for neurodynamics is the premise that there is a reciprocal relationship and influence between the biomechanics and the physiology of the nervous system, which in turn have an impact on musculoskeletal functions (Shacklock, 2008). The term 'biomechanics of the nervous system' refers to the natural disposition of the nervous system to move itself. This ability is necessary to withstand the mechanical forces generated by everyday physiological movements (Butler, 1995; Nee and Butler, 2006; Shacklock, 2008). The nervous system must be able to carry out three mechanical functions successfully in order to fulfill normal movement: it needs to be compressible, able to slide relative to its surrounding structures, and be able to resist tension. All three mechanical functions interact interdependently, triggered by a complex sequence of events, including, for example, the movement of joints and movements that increase 2 points of the nervous system. Likewise, the mechanical functions of the nervous system are activated by movements of the mechanical interface, such as adjacent structures of the nervous system (e.g. muscles, ligaments, bones, blood vessels). As mentioned above, these mechanisms of the nervous system are directly interdependent with its physiology (Coppieters and Butler, 2008). Accordingly, pathomechanical changes of peripheral neural tissue, which may be due to, for example, a neurological disorder, result in pathophysiological responses, which in turn have an

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impact on the appropriate target tissue (Rolf, 2006). Correspondingly, it is assumed that recovery of the nerve leads to an improvement in the neurophysiological processes (Butler, 2006). This relation and mutual interaction of the mechanics and physiology (or the pathomechanics and pathophysiology) of the nervous system are used both therapeutically and diagnostically in the concept of neurodynamics. Thus, mechanical treatment of the nervous system, such as in a trophic disorder of peripheral nerve connective tissue, can be used to improve its physiology (Shacklock, 2008). Just as in physiotherapy, neuromusculoskeletal dysfunctions are treated in speech therapy, such as dysarthria, dysphagia, dysphonia, and facial paresis. From a clinical perspective, it can be assumed that it is possible to integrate neurodynamic treatment techniques effectively into speech therapy. Subjectively, clear changes are observable within a short time with the use of neurodynamic techniques in speech therapy treatment of dysarthria, dysphagia, dysphonia, and facial paresis. To assess the viability of this new approach in speech and language therapy, a small testing group was used to perform a pilot study of the integration of neurodynamic techniques in dysarthria treatment for patients with idiopathic Parkinson's disease. Given the small sample size in this initial study, generalizations of the study results are limited. On the other hand, it is possible to adjust the sample size in a possibly subsequent large-scale study by estimating the variance in this pilot study.

At the time of the pilot study, two Meta-studies from the Cochrane Library (Herd et al., 2012a, 2012b) indicate that there are altogether nine randomized controlled trials available on speech therapies for patients with Parkinson's disease and dysarthria. In one Meta study Herd et al. (2012a) compared the efficacy of speech and language therapy (SLT) versus placebo or no intervention for speech and voice problems in patients with Parkinson's disease (Johnson and Pring, 1990; Ramig et al., 2001; Robertson and Thomson, 1984). In the other Meta-study (Herd et al., 2012b) they compared the efficacy and effectiveness of novel SLT techniques versus a standard SLT approach to treat Parkinsonian speech problems (Scott and Caird, 1983; Ramig et al., 1995; Lowit et al., 2010; Halpern et al., 2007; Constantinescu et al., 2011; Healy, 2002). In two of these nine studies, no statistical data analysis was carried out (Healy, 2002; Scott and Caird, 1983). Only one study showed no significant results to refute the null hypothesis (Lowit et al., 2010), whereas the remaining studies achieved significant improvements in at least a portion of their outcomes. All studies had rather small sample sizes (total sample size ranged from 10 to 45). Four of the nine studies (Constantinescu et al., 2011; Halpern et al., 2007; Ramig et al., 2001, 1995) investigated the Lee Silverman Voice Treatment (LSVT). The guidelines of the German Neurological Society note that there is an extensive body of data indicating significant improvements in dysarthric disorders with the use of LSVT speech therapy exercises (Diener, 2012). However, there are no studies on the effectiveness of neurodynamics in speech therapy.

The orthopedic literature contains a number of scientific studies covering all areas of neurodynamics, some of which have a large sample size. Quality criteria for neurodynamic tests, such as the straight leg raise (SLR), the slump test, the upper limb neurodynamic test (ULNT), and nerve palpation were identified in various studies (Capra et al., 2011; Carla et al., 2010; Majlesi et al., 2008; Rabin et al., 2007; Vanti et al., 2011; Walsh and Hall, 2009). Likewise, there are studies on the effectiveness of neural mobilization to treat orthopedic conditions such as carpal tunnel syndrome and a herniated disc (De-la-Llave-Rincon et al., 2012; Heebner and Roddey, 2008; Nee et al., 2013; Oskay et al., 2010; Villafañe et al., 2011). A number of studies have scientifically investigated the influence of neurodynamic techniques on the biomechanics and physiology of the nervous system (Beneciuk et al., 2009; Breig, 1960, 1978; Brown et al., 2011), as well as the effects of sensitized neurodynamic components on individual neurodynamic tests or muscle activity (Boyd et al., 2009; Lohkamp and Small, 2011; Nee et al., 2010). Thus, there are several studies providing evidence of the effectiveness of neurodynamics for diagnosis and treatment in orthopedics.

Fewer scientific studies exist on neurodynamics in the neurology literature. Altered muscle activity and sensitivity in the upper extremities are the primary topics in published studies on neurology in the context of treatment with ULNT (Castilho et al., 2012; Cha et al., 2012; Godoi et al., 2010; Wolny et al., 2010). Only one neurological study has been conducted on mobilization of the cervical spine (Villafañe et al., 2012). Currently, no published clinical studies exist on neurodynamic diagnosis and treatment of the torso or lower limbs of patients with central nervous system lesions. In the studies conducted so far, stroke was by far the most common underlying neurological disorder of the patients. Only one study references a patient with Alzheimer's disease being diagnosed and treated (Villafañe et al., 2012) and one case study is published on the treatment of dysfunction and pain effected by a peripheral neurogenic cause in the temporomandibular region (Geerse and Piekartz von, 2015). There are no studies about other neurological or neurodegenerative diseases in relation to neurodynamics. In addition, the sample sizes in the existing studies are low (ranging from $n = 1$ to $n = 32$). Based on this summary of evidence-based neurodynamics in neurology, there is a need for clinical trials of neurodynamic diagnosis and treatment in patients with neurological disorders.

Because there are no studies on the use of neurodynamics in the field of speech therapy up to now and there has only been a small number of studies on the treatment of dysarthria in Parkinson's disease or on the use of neurodynamics in the field of neurology, a pilot study on the integration of neurodynamic techniques in the treatment of dysarthria in patients with Parkinson's disease was carried out. The aim of the study was to identify any differences in the severity of dysarthria between a group of patients with Parkinson's disease given standard dysarthria treatment alone and another group given the same treatment with the integration of neurodynamic techniques. In addition, a first insight into the viability of the integration of neurodynamics into speech therapy should be provided.

The rationale for the integration of neurodynamics into standard treatment is, that it may directly affect the peripheral nervous system, resulting in improved efficiency of the region treated. After a short neural mobilization, the clinician observes an obvious improvement in speech motor skills, e.g. a clearer speaking voice. With the improved speech skills, the subsequent speech therapy exercises can be carried out in a more intensive and more effective manner. Therefore, a speech therapy treatment with the integration of neurodynamic techniques may lead to better results than the same treatment without neurodynamics.

2. Method

2.1. Study design

The total sample of 10 patients with Parkinson's disease was quasi-randomized into an intervention group (IG) and a control group (CG). The CG received standard dysarthria treatment (usual care) alone, while the IG received the same standard dysarthria treatment with integrated neurodynamic therapy (special care). The additional inclusion of a control group that received no treatment was not possible for operational reasons. Based on the pre–post study design, a standardized dysarthria diagnostic test,

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