Cervicogenic dizziness

The effect of manual therapy and deep neck flexor training

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ABSTRACT

Background and purpose

Cervicogenic dizziness is a feeling of disequilibrium caused by disturbed sensory input from the proprioceptors of the neck. Manual therapy is a common treatment for cervicogenic dizziness. Deep neck flexor training has been indicated to be an effective treatment in reducing dizziness. The purpose of this study was to explore the efficacy of manual therapy in conjunction with deep neck flexor training on cervicogenic dizziness.

Method

Single subject experimental withdrawal design (A-B-A) was used. One patient was included. The intervention consisted of manual therapy and training of the deep neck flexors. The primary outcome measure, intensity of dizziness was measured with a Visual Analog Scale. The intensity of neck pain was measured with a Numeric Pain Rating Scale. The impact of dizziness on daily life was evaluated by the Dizziness Handicap Inventory. Active cervical range of motion was measured with a cervical goniometer and a pressure sensor was used to estimate the activity and endurance of the deep neck flexors.

Results

There was a tendency for the intensity of dizziness and self-perceived disability due to dizziness to decrease at the end of the treatment period. The treatment did not have a clinical effect on neck pain, active cervical range of motion or on the activity and endurance of the deep neck flexor muscles. It was difficult to interpret the results due to an unstable baseline.

Conclusion

The results indicate that manual therapy may be an effective treatment in reducing intensity of dizziness and self-perceived disability due to dizziness. These results are in accordance with previous studies. Due to the study's low internal and external validity more research is needed before concluding on the effects of this treatment on cervicogenic dizziness.

Keywords: Single subject experimental design, cervicogenic dizziness, manual therapy, deep neck flexion training.

SAMMENDRAG

Bakgrunn og hensikt

Cervicogenic svimmelhet innebærer en følelse av ubalanse som er forårsaket av forstyrrelser i afferent input fra proprioceptorer i nakken. Manuellterapi er en vanlig behandling for cervicogenic svimmelhet. Trening av dype nakke fleksor musklene er også antydet som effektive behandling i å redusere svimmelhet. Hensikten med denne studien var å undersøke effekten av manuellterapi og trening av dype nakke fleksor musklene på cervicogenic svimmelhet.

Metode

Det ble benyttet et Singel Subject Experimental Withdrawal Design (A-B-A). En forsøksperson ble inkludert. Intervensjonen bestod av manuellterapi og trening av de dype nakke fleksor musklene. Primær utfallsmål, intensitet av svimmelhet ble målt med Visual Analog Scale. Nakkesmerter ble målt med Numeric Pain Rating Scale. Konsekvensen av svimmelhet på funksjon i dagliglivet ble evaluert med Dizziness Handicap Inventory. Aktivt bevegelsesutslag i nakke ble målt med en cervical goniometer og en trykksensor ble brukt til å estimere aktivitet og utholdenhet av de dype nakke fleksor musklene.

Resultat

Det var en tendens til at intensiteten av svimmelhet og selvopplevd funksjonshemming på grunn av svimmelhet ble redusert i løpet av behandlingsperioden. Behandlingen hadde ikke klinsk betydning på nakkesmerter, aktiv nakke bevegelsesutslag, eller på aktivtitet og utholdenhet av de dype nakke fleksor musklene. Det var vanskeligt å tolke resultatene ettersom baselinemålingene var ustabile.

Konklusjon

Resultatene indikerer at manuellterapi kan være en adekvat behandlingsform for å redusere smerteintensitet og selvopplevd funksjonshemming på grunn av svimmelhet. Resultatene er i samsvar med tidligere studier. På grunn av studiens lave interne og eksterne validitet er mer forskning nødvendig før vi konkluderer på effekten av denne behandlingen ved cervicogenic svimmelhet.

Nøkkelord: Single subject experimental design, cervicogenic svimmelhet, manuellterapi, dype nakke fleksjon trening.

1. INTRODUCTION

The background for my choice of topic is that I have always found dizziness an interesting topic but at the same time a very challenging one. I have been overwhelmed by all the differential diagnoses the therapist has to make before the appropriate treatment can be initiated. As a student of manual therapy I have a special interest in dizziness that may have originated from the cervical spine.

1.1. Dizziness

Dizziness refers to various abnormal sensations that are related to spatial perception and stability. It is an imprecise term and has been sub-classified into vertigo, pre-syncope, disequilibrium and other dizziness (Sloane et al., 2001), with vertigo being the most common (40-50%) (Heikkila, 2004). Clear definition and classification into subgroups is important, both in relation to research and in association with differential diagnosis as various disease entities may cause dizziness (Sloane et al., 2001). Vertigo, described as a spinning or rotating sensation of oneself or of the surroundings, suggests an imbalance within the vestibular system (Baloh, 1998), although it may also be caused by psychological states, such as panic disorders (Simon et al., 1998). Pre-syncope, a feeling of light-headedness, is episodic and results usually from diffuse temporary cerebral ischemia (Sloane et al., 2001). Disequilibrium is, according to Sloane (2001), a sense of imbalance that generally involves the legs and trunk without a sensation in the head. Other types of dizziness are often caused by psychological disturbances and are generally present much of the time. However, many patients cannot place their symptoms in one category.

Dizziness has been found to be one of the most common complaints in medicine, with prevalence ranging from 1.8% in young adults to more than 30% in the elderly (Sloane et al., 2001, Yardley, 1998 #37). Further, it seems to be more common in women than in men (Sloane et al., 2001). Although life-threatening illnesses are rare in patients with dizziness and the prognosis is generally benign (Sloane et al., 2001), it is often a disabling disorder associated with a significant degree of personal and occupational disability (Yardley et al., 1998).

1.2. Cervicogenic dizziness

Cervicogenic dizziness was first described by Ryan and Cope (1955) who used the term "cervical vertigo" to refer to a combination of neck disorders with vertigo. The term cervical vertigo may however be misleading as most patients suggested to suffer from cervical vertigo do not experience vertigo, but a feeling of disequilibrium (Brandt & Bronstein, 2001; Heikkila, 2004). Furman and Cass (1996) have described cervicogenic dizziness as a non-specific sensation of altered orientation in space and disequilibrium which originates from abnormal afferent activity from the neck. The diagnosis of cervicogenic dizziness is dependent upon correlating symptoms of imbalance and dizziness with neck pain (Wrisley et al., 2000). However, many patients who suffer from vertigo based on vestibular disorders complain about cervical pain and tender muscles secondary to their vertigo. It is therefore necessary to exclude other vestibular disorders based on history, examination and vestibular function tests before making the diagnosis (Heikkila, 2004). The incidence of cervicogenic dizziness has been reported in a Turkish study to be 7.5% of all dizziness with many patients having more than one diagnosis for their dizziness (Ardic et al., 2006).

2. THEORY

2.1. Underlying mechanism for cervicogenic dizziness

Cervicogenic dizziness has been a controversial entity since early in the 20th century. Three hypotheses have been proposed to explain the underlying mechanism: the neurovascular hypothesis, the vascular hypothesis and the somatosensory input hypothesis (Heikkila, 2004). The somatosensory input hypothesis is in accordance with the definition by Furman and Cass (1996) while the other two are based on vascular components. This study will be based on the somatosensory input hypothesis.

2.1.1. Neurovascular hypothesis

The neurovascular hypothesis, also named Barré-Lieou syndrome or posterior cervical sympathetic syndrome, was described by Jean-Alexander Barré in 1926 and in 1928 by Yong-Choen Lieou (Foster & Jabbour, 2007). The hypothesis was based on the assumption that cervical spine disease and degenerative changes in the cervical column could cause

mechanical irritation or compression of the sympathetic plexus surrounding the vertebral arteries. Further, this irritation could produce reflexive vasoconstriction in the vertebrobasilar system and thus cause symptomatic ischemia including dizziness (Heikkila, 2004; Foster & Jabbour, 2007). This hypothesis has however been discredited as studies have shown that sympathetic stimulation has little effect on the normal auto-regulation of cerebral blood flow (Heikkila, 2004; Foster & Jabbour, 2007).

2.1.2. Vascular hypothesis

According to the vascular hypothesis, a compression of the vertebral artery can cause episodic ischemia of the brain stem or inner ear leading to vertigo (Heikkila, 2004). Vertebrobasilar insufficiency resulting from mechanical occlusion of the vertebral artery, also named Bow hunter's syndrome, is a rare vascular phenomenon (Fleming et al., 2013; Zaidi et al., 2014). The occlusion leading to the insufficiency may be caused by degenerative changes in the cervical spine (Strek et al., 1998), an instability at the occipitocervical junction (Safain et al., 2014), and less commonly by an anomalous course of the vertebral artery, which makes it susceptible to compression by the scalenus anterior and the deep cervical fascia or by a hypertrophied ligament of the scalenus anterior and the longus colli (Dadsetan & Skerhut, 1990). Arteriosclerotic vascular disease may also lead to compromised cerebrovascular circulation and is according to Heikkila (2004) the main reason for vertebrobasilar insufficiency.

As insufficiency in the vertebrobasilar artery system can result in altered blood flow to the vestibulocochlear system, occlusion of the vertebral arteries may cause various symptoms, including dizziness, vertigo, nystagmus, nausea, vomiting and loss of consciousness (Strek et al., 1998; Zaidi et al., 2014). The symptoms vary widely and are dependent on the amount of compensatory blood flow (Zaidi et al., 2014). Dizziness due to vertebrobasilar insufficiency is generally related to cervical movements, especially in rotation and extension (Fleming et al., 2013; Safain et al., 2014), it is generally abrupt in onset and of short duration but symptoms may persist when there is an infarction in the affected vascular territory (Zaidi et al., 2014).

2.1.3. Somatosensory input hypothesis

Several observations have proposed a possible pathophysiological mechanism which comprises that the symptoms in cervicogenic dizziness are due to a disturbed sensory input from the proprioceptors of the neck leading to a sensory mismatch between cervical, visual and vestibular inputs (Brandt & Bronstein, 2001; Heikkila, 2004).

The receptors for proprioception in the neck include the muscle spindles that are present in high density in the deep intervertebral muscles, especially in the suboccipital region (Kulkarni et al., 2001). Deep muscles of the cervical spine have greater concentrations of mechanoreceptors in areas adjacent to joints than in their more superficial areas (Richmond & Bakker, 1982). Further, it has been shown that the longus colli has a higher density of muscle spindles than the multifidus in cervical segments C5-C7 (Boyd-Clark et al., 2002). Mechanoreceptive and nociceptive nerve endings in cervical facet joint capsules are also important for proprioception and pain sensation (McLain, 1994). The sensory input from the proprioceptors participates in perceptual functions and reflex responses, thereby interacting with signals of the vestibular and visual system to stabilize the eyes, the head and posture (Brandt & Bronstein, 2001). It has been proposed that neck pain can lead to the changed firing characteristics of cervical proprioceptive receptors and that the appropriate treatment for cervicogenic dizziness should be the same as for cervical pain (Brandt & Bronstein, 2001).

2.2. The causes of cervicogenic dizziness

Cervicogenic dizziness can be caused by traumatic, degenerative, inflammatory or mechanical problems in the cervical spine (Wrisley et al., 2000; Reid & Rivett, 2005). Whiplash injury is an example of a traumatic problem that commonly leads to dizziness. It is estimated that 0.1% of the population will experience whiplash injury every year, with 12-40% having persistent problems (Barnsley et al., 1994). Dizziness and unsteadiness are experienced by 40-70% of those having persistent problems (Rubin et al., 1995). There can be several causes for dizziness in these patients, including, among others, cervicogenic factors (Treleaven et al., 2003) and peripheral vestibular pathology (Toglia, 1976; Oosterveld et al., 1991). Medication and anxiety are other factors that one must consider when trying to chart the problem (Ferrari & Russell, 1999). Determining the exact cause for dizziness in whiplash patients, as in other patients, is therefore difficult.

2.3. Physical findings in patients with cervicogenic dizziness

Cervicogenic dizziness is a diagnosis of exclusion as no specific diagnostic criteria or laboratory tests are available to confirm the diagnosis. Several studies have been conducted with the aim to determine what characterizes patients with cervicogenic dizziness and to describe tests with diagnostic value.

2.3.1. Oculomotor findings

A neck torsion test has been used to detect cervicogenic dizziness, with nystagmus or dizziness with this test being interpreted as cervicogenic (Vidal & Huijbregts, 2007). However, according to Norre (1987), neck torsion nystagmus appears to be a "normal" cervico-ocular reflex that is only present in 50% of the subjects. Enhanced cervical proprioceptive input as well as reduced vestibular input favour its appearance. The diagnostic accuracy of this test is therefore questionable as 50% of subjects without cervical pathology have been tested positive for nystagmus (Vidal & Huijbregts, 2007).

Tjell and Rosenhall (1998) conducted a study aimed to determine how the Smooth pursuit neck torsion test (SPNT) is affected by various diseases associated with disturbance in balance. They looked at the difference in SPNT in whiplash patients with and without dizziness, compared to a control group that included patients with vertigo of central nervous system origin, patients with Meniere's disease and healthy individuals. The results indicate that SPNT is useful for diagnosing cervicogenic dizziness, at least in patients with whiplash having symptoms of dizziness. Neck torsion had no effect in patients in the control group in opposition to patients with whiplash with dizziness and to a lesser extent in patients with whiplash without dizziness. However, the test may not differentiate between patients with whiplash with dizziness and patients with whiplash without dizziness.

2.3.2. Postural control

Patients with dizziness of suspected cervical origin are characterized by impaired postural performance, at least when compared to healthy individuals (Karlberg et al., 1996b). Further, it has been suggested that posturography can distinguish patients with suspected cervicogenic dizziness from patients with other causes of vertigo as Karlberg et al. (1996a) showed

disturbed postural control in patients with cervical vertigo to differ from that in patients with recent vestibular neuritis.

Treleaven et al. (2005) used computerized posturography, as a measure of balance during the Clinical Test for Sensory Interaction in Balance, to assess balance responses in subjects with whiplash associated disorders. The results determined that balance is disturbed in persons with persistent whiplash compared to healthy individuals, with subjects complaining of dizziness found to have greater balance deficits than those not complaining of dizziness. Current pain levels at the time of testing seemed to influence balance responses in subjects experiencing dizziness but were not seen to influence balance in subjects without dizziness. These findings could not be attributed to age, medication, compensation status or anxiety at the time of testing, in contrast to previous opinion (Ferrari & Russell, 1999).

2.3.3. Cervical kinesthesia

Revel et al. (1991) introduced an active relocation test for evaluating cervical kinesthesia. This test assesses the ability to perceive both the position and the movement of the head relative to the trunk. Involving information from the vestibular system and from the cervical proprioceptive apparatus, a number of experimental arguments suggest a primarily cervical proprioceptive role (Mergner et al., 1983). Several studies using this test have found diminished cervical kinesthesia in chronic neck pain patients (Revel et al., 1991) and in whiplash patients (Heikkila & Astrom, 1996; Heikkila & Wenngren, 1998). Further, patients with suspected cervicogenic dizziness have been shown to be significantly less precise than healthy control group during this test (Heikkila et al., 2000). However, these findings are controversial as several researches show little evidence of impaired cervical kinesthesia in patients with chronic neck pain of non-traumatic origin (Rix & Bagust, 2001; Palmgren et al., 2009).

Malmstrom et al. (2013) have shown that an experimentally introduced unilateral cervical pain affects the ability to perform a head on trunk reposition. They concluded that this probably reflected a pain-associated distortion of cervical proprioception. In the study four of eleven subjects also reported disturbed balance or dizziness, which may suggest an association between cervical pain and dizziness, at least in some subjects. The reason why some people experience dizziness in relation to neck pain while others do not is unclear but the authors proposed that sensitivity due to cervical disturbances might differ between individuals.

2.3.4. Musculoskeletal findings

Malstrom et al. (2007) explored musculoskeletal findings in twenty-two patients with cervicogenic dizziness and how these findings related to neck pain and dizziness. A structured physical examination was conducted before and after physiotherapy guided by the musculoskeletal findings. At baseline, bilateral muscle tenderness, especially in the dorsal neck muscles, was reported by the majority of patients. Tightness was most common in trapezius and suboccipital muscles. Zygapophyseal joint tenderness was found at all cervical levels but surprisingly no patient was considered to have segmental hypomobility in the cervical spine though side difference occurred frequently. Cervical range of motion was equal to or larger than expected age and gender matched values, however, the cervical-thoracic region was often hypomobile. Most patients had imbalance in postural alignment and dynamic stabilization capacity was reduced. After the physiotherapy treatment a reduction in neck pain and dizziness was observed. There was a significant reduction in tenderness in dorsal neck muscles and zygapophyseal joint pain was reduced in the middle and lower cervical spine. However, no single muscle or zygapophyseal joint tenderness reduction was found to correlate with dizziness relief. Neither could reduction of dizziness be correlated to neck pain reduction.

2.4. Research related to the intervention

It has been suggested that the treatment for cervicogenic dizziness should be the same as for neck pain (Brandt & Bronstein, 2001). It is therefore interesting to look at some of the treatment modalities that are commonly used in the treatment of chronic neck pain and cervicogenic dizziness and see what modalities have been shown to be beneficial. As chronic neck pain is a complex phenomenon only the aspects that are relevant for this study will be discussed.

2.4.1. Manual therapy

According to the International Federation of Orthopaedic Manipulative Physical Therapists (IFOMT), manual therapy techniques are *"skilled hand movements intended to produce any or all of the following effects: improve tissue extensibility; increase range of motion of the joint complex; mobilize or manipulate soft tissues and joints; induce relaxation; change muscle function; modulate pain; and reduce soft tissue swelling, inflammation or movement*

restriction" (Beeton et al., 2010). Manual therapy has been practiced in different forms for centuries and is a commonly used treatment for neck pain. Systematic reviews have shown that mobilization and/or manipulation when used with exercise have beneficial effects on chronic mechanical neck pain. However, mobilization and/or manipulation alone have not been shown to be beneficial, and when compared to one another, neither is superior (Gross et al., 2004; Gross et al., 2007).

Manual therapy intervention has been regarded as an effective treatment for cervicogenic dizziness although the evidence that support this belief is limited. Two systematic reviews regarding the role of manual therapy in the treatment of cervicogenic dizziness have been published (Reid & Rivett, 2005; Lystad et al., 2011). Both these reviews used the Maastricht-Amsterdam criteria to assess the methodological quality of the studies included. The review by Reid and Rivett (2005) included nine studies, with only one randomized control trial (RCT). The methodological quality of these studies and statistical information were poor. The results indicated limited evidence to support the use of manual therapy in the treatment of cervicogenic dizziness. The review by Lystad et al. (2011) included five RCTs and eight prospective, non-controlled cohort studies. The methodological quality of these studies was generally poor to moderate, with only one RCT found to be of good methodological quality. The results suggested moderate evidence to support the use of manual therapy for cervicogenic dizziness. Despite the low quality of the studies included in these two reviews, there was a consistent trend in the findings. All studies, except one, reported improvement in dizziness and associated symptoms following the treatment. The treatment in the studies consisted of cervical spine manipulation, mobilization and manipulation, and manipulation combined with other interventions such as electrotherapy, soft tissue therapy, home training programs and use of collars.

A recent RCT by Reid et al. (2014b) compared the effectiveness of Mulligan sustained natural apophyseal glides (SNAGs) and Maitland mobilization for cervicogenic dizziness. Previously, Reid et al. (2008) showed short-term evidence for treatment of cervicogenic dizziness with SNAGs. In the current study both SNAGs and Maitland mobilizations provided reductions in intensity and frequency of chronic cervicogenic dizziness, both immediately and at 12 weeks follow-up.

Generally, the underlying mechanism for beneficial effects of manual therapy is not fully understood. Previously, the effects were thought to be local or segmental, as the techniques should affect tissue lubrication or correct joint subluxation (Paris, 1979). It was also proposed that manual therapy might produce pain relief by activating the spinal component of the gate control mechanism (Schmid et al., 2008). In recent years, the focus has been on neurophysiological effects of manual therapy (Pickar, 2002; Schmid et al., 2008). Studies have indicated that spinal manipulation stimulates proprioceptive, primary afferent neurons from paraspinal tissues (Pickar, 2002). In addition, it is indicated that spinal manual therapy can induce neurophysiological effects by activation of the descending pain inhibitory mechanisms projecting from the periaqueductal grey to nuclei in the ventrolateral medulla to the spinal cord. This activation produces an immediate hypoalgestic effect, which is specific to mechanical nociception (Wright, 1995). According to a systematic review by Schmid (2008), compelling evidence indicates that cervical mobilization triggers concurrent activation of pain modulatory and sympathetic nervous system effects, which suggests that brain regions are involved.

It is hypothesized that the underlying mechanism for the effect of manual therapy on cervicogenic dizziness is due to stimulation of cervical proprioceptors in both joints and muscles. This stimulation normalizes disturbances to the afferent input and thereby reduces the sensory mismatch between the proprioception, the vestibular and the visual systems (Reid et al., 2008; Kristjansson & Treleaven, 2009).

2.4.2. Cervical motor control

Cervical motor control is one component that has been shown to be altered in patients with neck pain, with these patients showing increased activation of the superficial cervical muscles (Falla et al., 2004a; Jull et al., 2004a) and a reduced activation of the deep cervical muscles (Falla et al., 2004c; Jun & Kim, 2013). Further, a delay in neck muscle activity observed in chronic neck pain patients associated with rapid, unilateral arm movement, indicates a change in the feed-forward response (Falla et al., 2004b). It is likely that these changes in activation of the superficial and deep cervical flexors occur early after the onset of pain (Sterling et al., 2003; Cagnie et al., 2011). A study by O'Leary (2011) revealed a positive relationship between pain intensity and superficial muscle activity in individuals with chronic mechanical

neck pain. However, the association was only modest, which indicates that multiple factors contribute to alter motor function in this group.

It has been suggested that manual therapy intervention may have a positive effect on cervical motor control. Sterling et al. (2001) showed that activity in the superficial neck muscles decreased at the lower levels of a staged cranio-cervical flexion test following grade III posterior-anterior mobilization applied over the articular pillar of C5/C6. The author indicated that the intervention resulted in facilitation of the deep neck flexor muscles with a decreased need for co-activation of the superficial neck flexors. However, these results could not be reproduced in healthy subjects (Soon et al., 2010) and a systematic review from 2008 (Schmid et al.) indicates limited evidence to support the effect of passive accessory mobilization on motor function. These findings must however be questioned as a more recent study by Jesus-Moraleida (2011) supports the findings from Sterling et al. (2001). By using ultrasonographic analysis, Jesus-Moreleida showed that a single cervical Maitland's posterior-anterior central mobilization technique appeared to modulate neck muscle function by increasing the recruitment of deep muscles and reducing that of superficial muscles in patients with chronic neck pain. Therefore, the effects of manual therapy on cervical motor control remain uncertain.

A low load training of the deep neck flexor (DNF) is another treatment modality that can affect cervical motor control. This includes a specific training of m. longus capitis and m. longus colli with the aim to increase the activation of the deep cervical flexor muscles and improve isometric endurance (Jull et al., 2008). Jull et al. (2009) showed that this training enhanced the pattern of deep and superficial muscle activity in the cranio-cervical flexion test. These findings were supported by findings from Falla et al. (2012), which indicated that specific training of the DNF is effective in reducing neck pain and improving the activation of these muscles in women with chronic neck pain. In addition, a case control study showed that 12 weeks' training of the DNF reduced neck pain and dizziness in a patient with chronic neck pain and dizziness that began after immobilization (Thoomes-de Graaf & Schmitt, 2012).

A recent study by Lluch et al. (2014) compared the immediate effects of exercise versus mobilization intervention on motor control of the cervical spine, cervical range of motion and pain in patients with chronic idiopathic neck pain. Reduced pain was seen in both groups, which confirms former findings that both passive and active intervention lead to immediate

relief of pain. However, improved motor control of the cervical spine was only seen in the exercise group, which indicates that specific active training is essential to improve motor control of the cervical spine.

The question remains whether mobilization intervention in addition to specific training will be more effective in improving motor control than specific training alone, and further, whether this intervention will have a beneficial effect on cervicogenic dizziness.

3. PURPOSE AND HYPOTHESIS

3.1. Purpose

Manual therapy is an intervention commonly used in the management of neck pain and cervicogenic dizziness. DNF training has been shown to be an effective treatment in reducing pain in women with chronic neck pain. Moreover, there are indications that this kind of training might be effective in reducing dizziness. It has been proposed that the treatment of cervicogenic dizziness should be the same as for cervical pain. The purpose of this study is therefore to explore the efficacy of manual therapy in conjunction with DNF training on dizziness in patients with chronic dizziness of suspected cervical origin.

3.2. Hypothesis

Based on this background my hypothesis is that manual therapy combined with DNF training is an effective treatment for reducing dizziness in patients with chronic dizziness of suspected cervical origin.

3.3. The research question

Is manual therapy combined with DNF training an effective treatment for reducing dizziness in patients with chronic dizziness of suspected cervical origin?

4. METHODS

4.1. Choice of research design

Single subject experimental design (SSED) was used in this study to test the hypothesis. This design was selected because the time to conduct the study was limited. A randomized controlled trial (RCT) would have been the optimal choice of research design as it is considered to be the gold standard for evaluating intervention effects in research. The time limitations, however, made it difficult to conduct an RCT with enough power to get meaningful results.

SSED is conducted prospectively and includes controlled manipulation of an independent variable (Carter et al., 2011b). It is generally quasi-experimental research, lacking randomization and control group. A withdrawal design (A-B-A), which consists of an extended baseline phase (A), a treatment phase (B) and withdrawal of treatment phase (A), was used. In the baseline phase three measurements were obtained to document the patient's status in terms of dizziness, neck pain, cervical range of motion (ROM) and DNF activity and endurance before initiation of treatment. After the baseline was recorded, an experimental manipulation in the form of manual therapy and DNF training was introduced. As the treatment was initiated a change in status was expected. The measurement was continued in the treatment phase, in every other treatment session, to try to differentiate between a normal fluctuation in the patient's status and real change due to the intervention (Carter et al., 2011b). After cessation of the treatment two measurements were obtained during a three-week period to see how the treatment was working. In this study it was expected that the effects of the treatment would be maintained to a certain degree in the follow-up. The patient served as her own control as the pattern of change during the treatment phase was compared to the pattern established during the baseline and after cessation of treatment (Carter et al., 2011b).

Following single-subject methods, the study was based on a certain theory and patient selection was purposive, that is the patients included in the study were considered to have a specific need for the treatment and the treatment could be administered according to their needs (Carter et al., 2011b). As a conclusion was drawn from the comparison of repeated measurements, it was extremely important to use measurement tools with recorded reliability and validity (Carter et al., 2011b). Subjective phenomena, dizziness and neck pain, were measured with standardized rating scales (Visual Analog Scale, Numeric Pain Rating Scale)

and the impact of dizziness on daily life was evaluated with a questionnaire (Dizziness Handicap Inventory). A cervical goniometer was used to gain a standardized measurement of active cervical ROM and a pressure sensor was used to estimate the activity and endurance of the DNF. These measurement tools were chosen as they represent each of the three key components of The World Health Organization (WHO) International Classification of Functioning, Disability and Health (ICF) (2001) (Figure 11). The three key components of the ICF, body function and structures, activities and participation, are related to and interact with the health condition and environmental and personal factors (Cieza & Stucki, 2008). In this study, the intensity of dizziness and neck pain represents body function and the cervical ROM and the activity and endurance of the DNF muscles represent body structure. The Dizziness Handicap Inventory questionnaire describes both activities and participation. Further, it involves questions about emotions that represent personal factors.

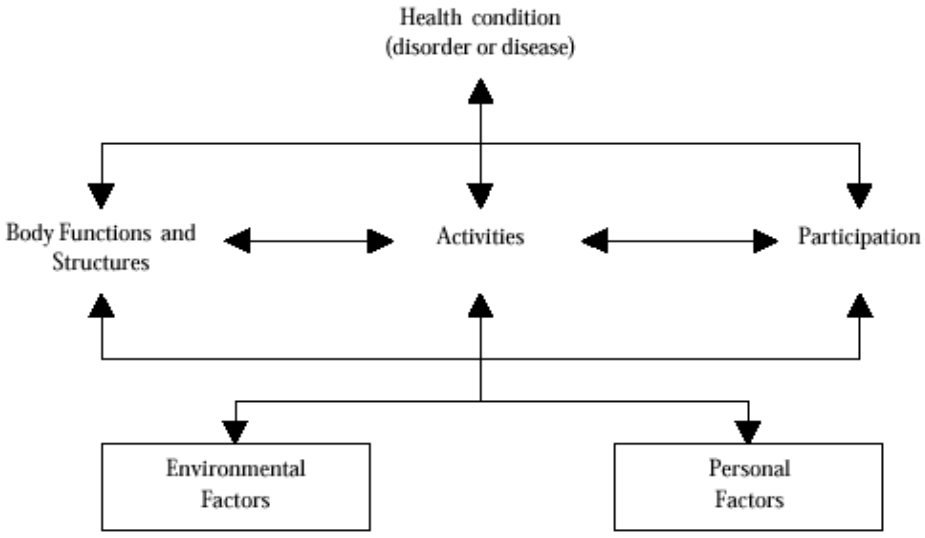

Figure 1. International classification of functioning, disability and health (WHO, 2001).

4.2. Patient selection

The participants were selected from the patients who contacted the institute at which I have a practice, between March and September 2014. The sample was therefore one of convenience, which means that it involves the use of readily available participants (Carter et al., 2011b). The therapists working at the institute were informed about the study and asked to refer patients who might fulfill the inclusion criteria for physical examination. It was estimated that 2-4 patients would participate in the study.

Inclusion/exclusion criteria

Cervicogenic dizziness is a diagnosis of exclusion due to a lack of reliable clinical tests to confirm the diagnosis. The inclusion/exclusion criteria is the first step in distinguishing between those with cervicogenic dizziness and those who suffer from dizziness or vertigo from other causes. I chose to use similar inclusion/exclusion criteria (Table 1) as have been used in other studies regarding cervicogenic dizziness (Reid et al., 2008; Reid et al., 2014b).

Table 1. Inclusion/exclusion criteria.

Inclusion criteria:
• Concurrent neck pain and dizziness for more than three months (chronic). • Dizziness related to either movement or position of the cervical spine, or dizziness occurring with a stiff or painful neck. • Age 18-60.
Exclusion criteria:
• History of central nervous system disease, vestibular disorders or ear disease. • Contraindications for manipulation such as osteoporosis, cervical spine infection, cancer, active inflammatory joint disease, arteriosclerotic disease and pregnancy. • Psychiatric disease. • Medicine that can cause dizziness.

When a patient met the inclusion criteria a detailed history was taken and various tests were performed to eliminate other causes of dizziness. Guidelines from Wrisley et al. (2000) and Vidal and Huijbregts (2007) were followed regarding the history and physical examination (Appendix A). This study was based on the somatosensory input hypothesis, thus, patients were excluded if they showed signs of vertebrobasilar insufficiency.

To enter the study the participants had to meet all the inclusion criteria but were excluded if they met any of the exclusion criteria or if the history or examination indicated that the dizziness was not cervicogenic.

4.3. Variables and data collection

The data collection was conducted at the institute at which I have a practice, between March and June 2014. Quantitative data was collected both from questionnaires and physical tests. The primary outcome of this study was the intensity of dizziness. Disability caused by dizziness, intensity of neck pain, cervical ROM and DNF function were secondary outcomes. Both primary and secondary outcomes were measured repeatedly. Three measurements were conducted with 3 days apart to get the baseline. In the treatment phase, measurements were expected to be conducted once a week, at the beginning of a treatment appointment. As a follow-up, measurements were conducted one and three weeks after the last treatment. Due to uncontrollable factors it was not possible to follow this plan exactly.

Information from the data collection was labeled with an ID number and stored on a computer that was locked with a password and located at the institute.

4.3.1. Intensity of dizziness

The intensity of the dizziness was evaluated with a 100 mm horizontal Visual Analogue Scale (VAS), ranging from no dizziness (zero mm) to dizziness of maximal intensity (100 mm) (Appendix B). The patient reported an average value over the last 3 days. VAS has been used in previous studies to evaluate the intensity of dizziness (Heikkila et al., 2000; Reid et al., 2008). A change of VAS dizziness scores of 20 mm following treatment have been considered to indicate clinically meaningful differences (Reid et al., 2008).

4.3.2. Dizziness Handicap Inventory

The Dizziness Handicap Inventory (DHI) was used to evaluate the impact of dizziness on the patients' everyday life (Jacobson & Newman, 1990) (Appendix B). The 25-item DHI was developed to evaluate the self-perceived disability imposed by vestibular system disease. It is composed of seven physical, nine functional and nine emotional questions. The total score ranges from 0 to 100, with a higher score indicating more self-perceived handicap. Mild handicap is indicated with a total score of 0-30, moderate handicap with a total score of 31-60 and a total score of 61-100 indicates severe handicap (Whitney et al., 2004).

This inventory has demonstrated good internal consistency reliability (Jacobson & Newman, 1990). The validity of the DHI was indicated as higher scores were associated with a higher

frequency of dizziness episodes (Jacobson & Newman, 1990). Although this inventory was originally developed with respect to dizziness caused by vestibular system disease it has been used for persons with dizziness from other origins (Treleaven et al., 2005) and as a measurement for treatment outcome in studies involving cervicogenic dizziness (Reid et al., 2008; Reid et al., 2014b). DHI has been translated and adapted to several languages including Norwegian. The Norwegian translation has shown satisfactory internal consistency of the total score and an excellent ability to discriminate between patients with and without disability (Tamber et al., 2009). A change in the DHI scores of 11 units following treatment has been shown to indicate minimally important change (Tamber et al., 2009).

4.3.3. The intensity of neck pain

The intensity of the neck pain was evaluated using an 11-point Numeric Pain Rating Scale (NPRS), ranging from 0 = "no neck pain" to 10 = "neck pain as bad as it can be" (Appendix B). The patient reported an average value over the last 3 days. The NPRS has been shown to exhibit acceptable reliability in patients with neck pain (Cleland et al., 2008). A clinically meaningful difference in a broad population of patients with various musculoskeletal conditions has been identified to be 2 points (Farrar et al., 2001).

4.3.4. Cervical range of motion

Measurement of cervical active range of motion into flexion, extension, lateral flexion and rotation were done using a cervical range of motion instrument (CROM). The CROM instrument was used as it has shown good to high intratester reliability and a good concurrent validity (Williams et al., 2010). The measurements were done according to a CROM procedural manual that comes with the instrument and the mean from three measurements for each movement was used. The minimal detectable change for each direction has been shown to be between five and ten degrees (Fletcher & Bandy, 2008).

4.3.5. Craniocervical flexion test

A craniocervical flexion test (C-CFT) was performed to evaluate the activation and isometric endurance of the DNF, the longus capitis and colli (Jull et al., 2008). An inflatable pressure sensor was used and the test was performed according to a clinical protocol (Jull et al., 2008).

This is a clinical test and provides only an indirect measure of performance. However, studies have verified the construct validity of this test in a laboratory setting (Falla et al., 2003; Falla et al., 2006). This test has also shown high interrater reliability in asymptomatic subjects (Arumugam et al., 2011).

4.4 Intervention

An experienced manual therapist performed the intervention. The intervention was based on a clinical examination which included evaluation of active and passive function, segmental mobility and palpation. A manual examination was performed to test segmental mobility and detect the presence or absence of a cervical facet joint dysfunction. This examination has not been considered reliable, although results of studies are contradictory, and was therefore not used as a measurement outcome (Pool et al., 2004; Schneider et al., 2013).

The intervention was in the form of manual therapy and training of the DNF muscles. The manual therapy treatment included mobilization techniques based on Maitland principles (Banks & Maitland, 2005) and manipulation, applied to segments with decreased mobility. The training began with re-education of the craniocervical flexion movement when needed. When the patient could perform the cranio-cervical flexion movement correctly, training of the holding capacity of the DNF began (Jull et al., 2004b). The patient was instructed to practice the exercise at home, at least twice per day. Each patient should receive 8 treatments over 4 weeks.

4.5. Data analysis

To analyze the data for the patients the scores are shown graphically. The two standard deviation band analyses were used to determine whether there was a significant difference between baseline and intervention scores. In this technique the mean and standard deviation (SD) for the baseline scores are calculated and a 2-SD band is plotted around the baseline and intervention phases (Carter et al., 2011b). In the literature, it is indicated that when two successive points fall outside of the 2-SD band, a statistically significant ($\alpha = 0.05$) difference is detected between the baseline and intervention points (Carter et al., 2011b). If at least 2 scores in the intervention phase fall outside the 2-SD band the intervention is considered to be significantly effective. Microsoft Excel for Windows 7 was used in the data analysis.

4.6. Ethical considerations

This study was conducted in accordance with the ethical principles specified in the declaration of Helsinki (World Medical Association, 2013 clarification). Participation in the study was voluntary and the patients could at any time withdraw from it. All patient information was anonymous and names will not be made public in any documents. Informed consent was obtained from all patients (Appendix C). It was not necessary to apply for approval from the Regional Ethics Committee (REC) as the purpose of this study was considered to be to ensure the quality of a daily clinical practice rather than to gain new knowledge.

Assessment tools used in this study were judged as reliable and valid by former studies. The intervention was similar to treatments that have been shown to be effective for this group of patients (Malmstrom et al., 2007; Reid et al., 2008; Reid et al., 2014b). It was based on individual findings and tailored to the needs of each patient as has been recommended in previous studies (Malmstrom et al., 2007). It was therefore expected that the patients would benefit from participating in the study. The risk of suffering and injury was considered to be minimal in this study.

When a patient was included in the study the treatment was delayed 10 days due to the repeated measurements required at the baseline phase. However, the patients were recruited to the study as soon as they contacted the clinic and could therefore skip the waiting list that is normally 2-4 weeks long.

There was no conflict of interest regarding this study.

5. RESULTS

5.1. Participants

Five patients were referred in the study period. One was excluded based on severe anxiety, one was excluded as his symptoms were consistent with Benign Paroxysmal Positional Vertigo (BPPV) and one was excluded as he was not interested in participation. Two patients were included in the study, but one was excluded after initiation of the treatment as she was suffering from an underlying anxiety that was not revealed in the inclusion process. As the treatment began she was experiencing increased anxiety in conjunction with the treatment.

Patient A

Patient A was a 31-year-old woman, single and had no children. She holds a bachelor's degree. She had a full-time job at a large laundry, a job that that she found physically demanding. She was unhappy with the job situation and was experiencing bullying from her colleagues and supervisor. She experienced that her symptoms were, to a certain degree, related to stress and the work situation.

Her primary complaints were neck pain, dizziness and headache. Current symptoms started gradually over six months ago. She was experiencing dizziness in conjunction with movement of the neck, especially with rotation and extension. She described her dizziness as an imbalance rather than rotational. She had experienced similar symptoms for a few years and received manual therapy and chiropractic treatment that relieved the symptoms to a certain extent.

During the physical examination I evaluated the active movements of the neck to be decreased in extension and rotation to the right, with increased pain at end-range, especially in these movement directions. Neurological examination was without significant remarks. Compression increased her neck pain and a Spurling's test caused increased localized pain at the cervical-thoracic junctions on the right side. Segmental mobility tests revealed hypomobility at the upper cervical spine (C0-C2) and decreased mobility at the cervical-thoracic junctions and in the upper thoracic region.

She was included in the study as she fulfilled the inclusion criteria and did not meet any of the exclusion criteria. Further, history and examination indicated that the dizziness was cervicogenic.

Initially, the treatment period was supposed to last 4 weeks and each patient should receive treatment two times per week. However, patient A received one treatment in the first and second week each, then, due to sickness and an Easter break, the third treatment was in week four and the fourth treatment in week six. After that the patient received 2 treatments in the next two weeks, 8 treatments in total (Table 2).

Table 2.

Timing and number of measurements and treatment sessions for Patient A.

Date	**25/3**	**28/3**	**1/4**	**7/4**	**25/4**	**8/5**	**13/5**	**16/5**	**21/5**	**23/5**	**30/5**	**11/6**
Baseline measurements	x	x	x									
Treatment measurements					x	x		x		x		
Follow-up measurements											x	x
Treatment			x	x	x	x	x	x	x	x		

5.2. Intensity of dizziness

The intensity of dizziness increased in the baseline period from 77 mm to 100 mm (maximum intensity) (Figure 2). The intensity was 75 mm at the beginning of the treatment period and increased to 95 mm at the second measurement in this period. Thereafter, it started to decrease and the intensity had decreased to 63 mm at the end of this period. In the follow-up period the intensity increased slightly (up to 72 mm). Only the last measurement in the treatment period was outside the 2-SD band, which is not enough to indicate a significant difference. However, the first measurement in the follow-up period was outside the 2-SD band. Further, the difference between these two measurements and the mean of baseline measurements (88.3 mm) was clinically meaningful.

Figure 2. Intensity of dizziness on a Visual Analogue Scale during the baseline period, treatment period and follow-up. The mean of the baseline data is shown and 2-SD band is plotted.

5.3. Self-perceived disability

In the baseline period the patient reported severe handicap (score 61-100) from her dizziness (Figure 3). During the treatment period the patient reported severe to moderate handicap (31-60) and she reported moderate handicap in the follow-up. The last two measurements in the treatment period and both measurements at follow-up fell outside the 2-SD limit, which indicates that the decrease is statistically significant. However, only the last measurement in the treatment period (score 38) was considered to have reached a clinically meaningful difference compared to the mean of baseline measurements (score 62).

Figure 3. Self-perceived disability caused by dizziness shown in DHI score during the baseline period, treatment period and follow-up. The mean of the baseline data is shown and 2-SD band is plotted.

5.4. Intensity of neck pain

The intensity of neck pain increased in the baseline period from eight to ten (Figure 4). The intensity varied in the treatment period with only the last measurement being outside of the 2-SD band. The decrease is therefore not statistically significant even though the difference between the last measurement in the treatment period and the mean of the baseline measurements is clinically significant. This decrease was not maintained during follow-up.

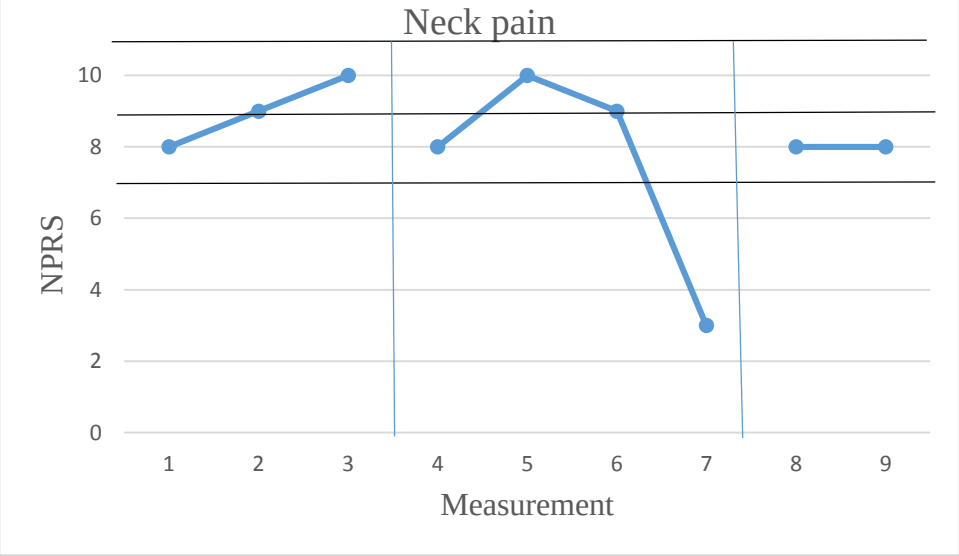

Figure 4. Intensity of neck pain on a Numeric Pain Rating Scale during the baseline period, the treatment period and follow-up. The mean of the baseline data is shown and 2-SD band is plotted.

5.5. Cervical range of motion

The cervical range of motion (CROM) responses to intervention are shown in figures 5 to 10. The CROM decreased in the baseline period for all the movements except rotation to the left. Only two measurements were obtained in the treatment period, one at the beginning and one at the end. The intervention did not influence the CROM as only one point, for rotation to the left (Figure 9), was outside the 2-SD band. However, that point falls below the 2 SD-band, which indicates a decrease in active CROM in the treatment period.

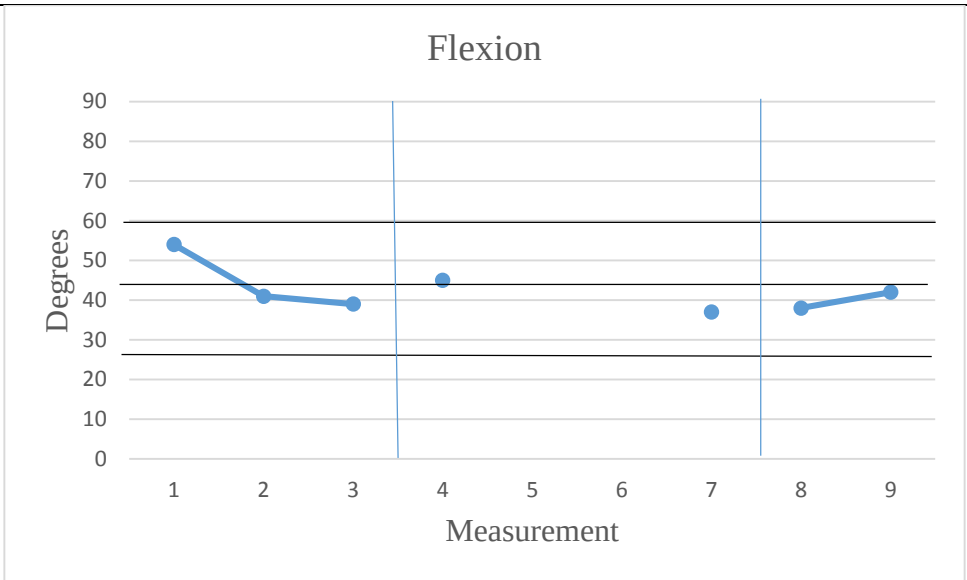

Figure 5. Cervical range of motion in flexion during the baseline period, the treatment period and follow-up. The mean of the baseline data is shown and 2-SD band is plotted. Normative value 47.3° +/- 9.5° (Youdas et al., 1992).

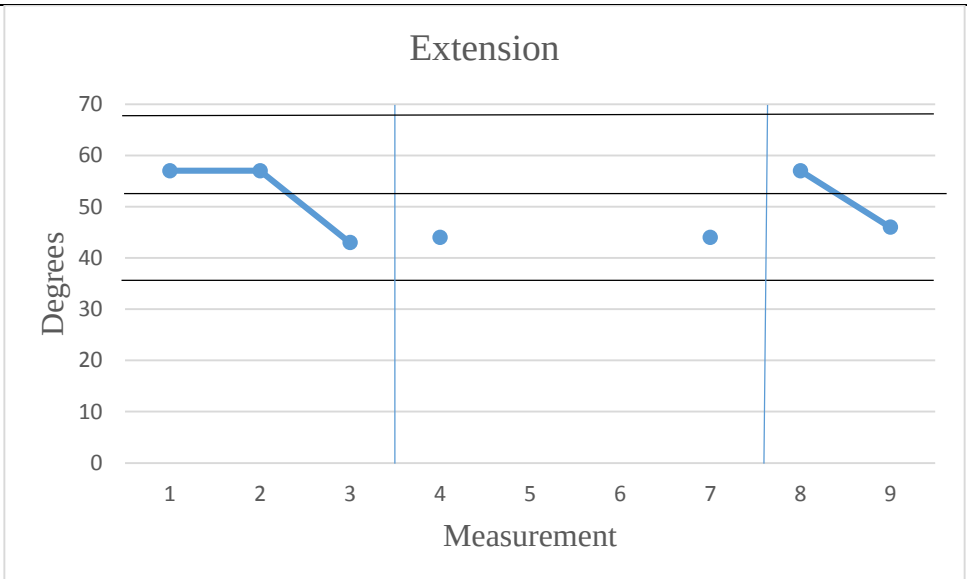

Figure 6. Cervical range of motion in extension during the baseline period, the treatment period and follow-up. The mean of the baseline data is shown and 2-SD band is plotted. Normative value 78° +/- 13.8° (Youdas et al., 1992).

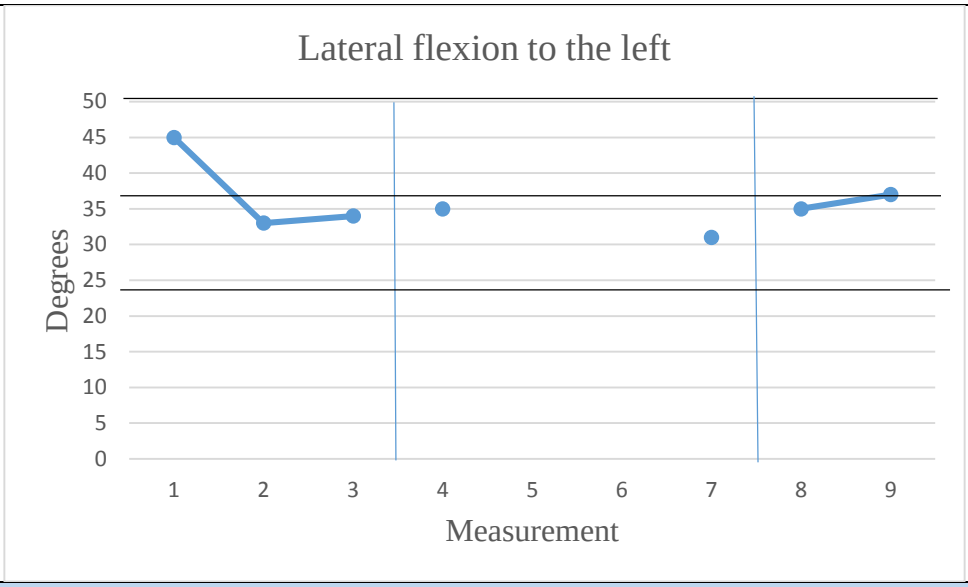

Figure 7. Cervical range of motion in lateral flexion to the left during the baseline period, the treatment period and follow-up. The mean of the baseline data is shown and 2-SD band is plotted. Normative value 43.6° +/- 7.9° (Youdas et al., 1992).

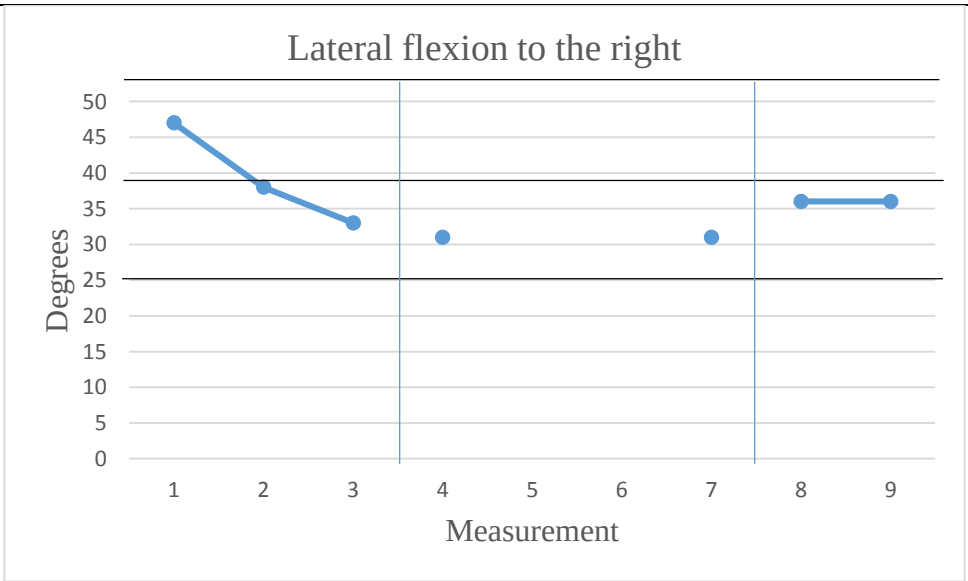

Figure 8. Cervical range of motion in lateral flexion to the right during the baseline period, the treatment period and follow-up. The mean of the baseline data is shown and 2-SD band is plotted. Normative value 46.5° +/- 8.4° (Youdas et al., 1992).

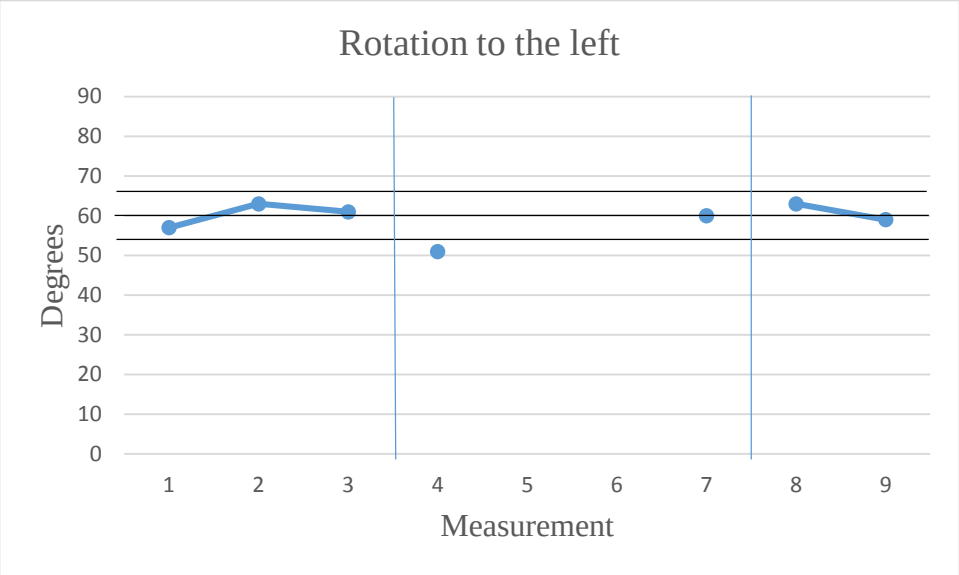

Figure 9. Cervical range of motion in rotation to the left during the baseline period, the treatment period and follow-up. The mean of the baseline data is shown and 2-SD band is plotted. Normative value 65.9° +/- 8.1° (Youdas et al., 1992).

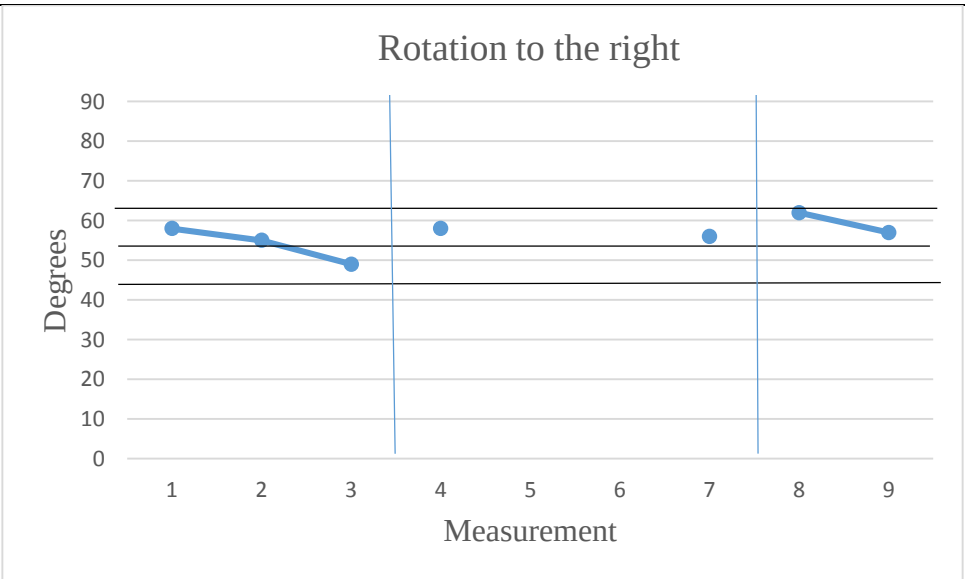

Figure 10. Cervical range of motion in rotation to the right during the baseline period, the treatment period and follow-up. The mean of the baseline data is shown and 2-SD band is plotted. Normative value 71.7° +/- 5.7° (Youdas et al., 1992).

5.6. Activation and endurance of DNF

A stable baseline was observed for activation and endurance of the DNF (Figure 11 and 12). As there was no variation in the baseline period the SD was zero and it was not possible to draw the 2-SD band. Only two measurements were conducted in the treatment period, one at the beginning and one at the end of the period.

The treatment did not influence the activation of the DNF as the activity was the same throughout the whole period (Figure 11).

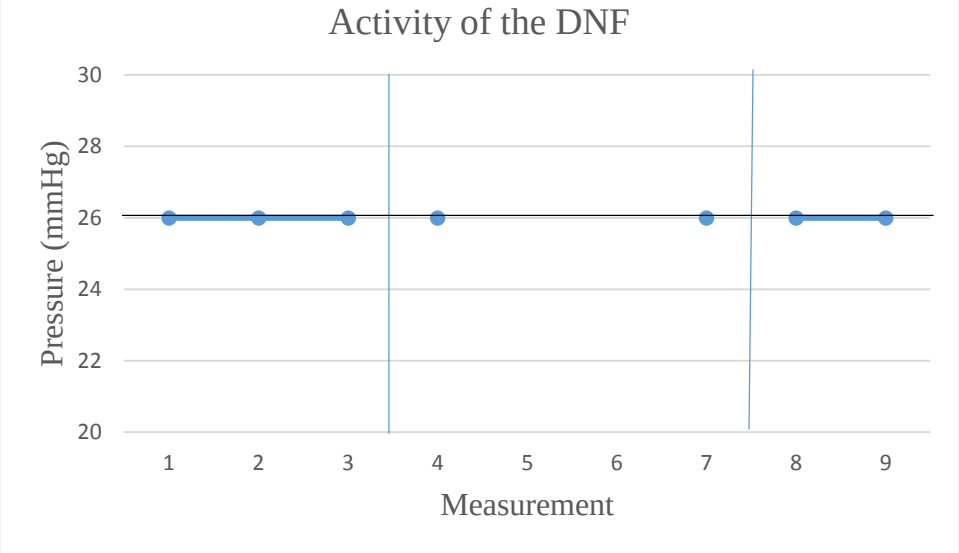

Figure 11. Activity of the DNF during the baseline period, the treatment period and follow-up. The mean of the baseline data is shown.

The endurance of the DNF had increased in the last measurement from 24 mmHg to 26 mmHg (Figure 12). In the follow-up period the activation was the same as in the baseline period.

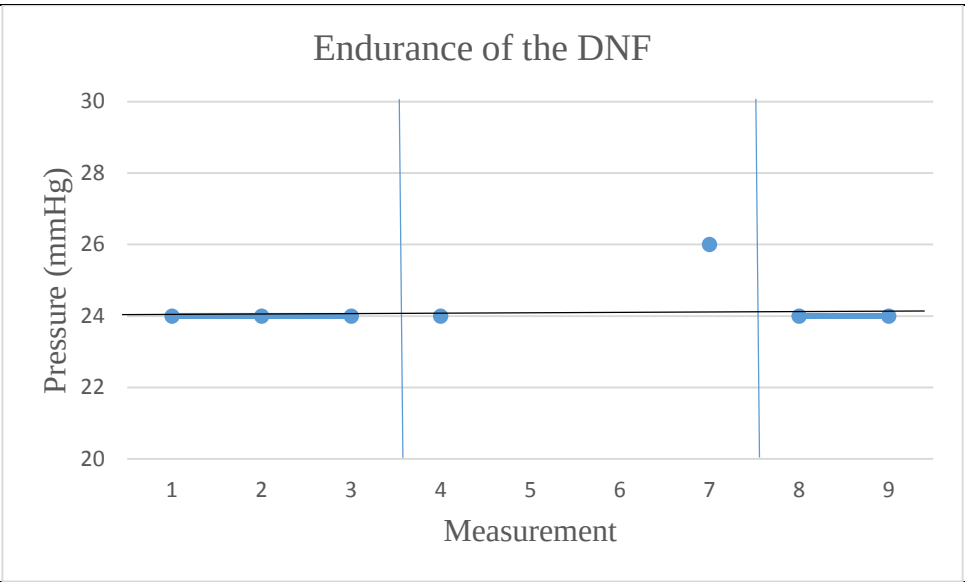

Figure 12. Endurance of the DNF during the baseline period, the treatment period and follow-up. The mean of the baseline data is shown.

6. DISCUSSION

6.1. Summary of the results

Patient A was experiencing increased dizziness and neck pain during the baseline period, which makes it difficult to interpret the results. However, the self-perceived disability was more stable during the baseline period even though it increased in the last measurement. Active CROM decreased during the baseline period, with the exception of rotation to the left, which increased. A stable baseline was observed for the activity and endurance of the DNF.

Considering this unstable baseline and the patient's problem at her workplace, it is obvious that one must be cautious when interpreting the results. With that said, there seemed to be a tendency for the intensity of dizziness and self-perceived disability to decrease in the later part of the treatment period with the decrease in intensity being clinically but not statistically significant and the decrease in self-perceived disability being statistically but not clinically significant. The neck pain was considerably less during the last measurement in the treatment period with the decrease being clinically significant. However, the decrease was not statistically significant nor maintained at follow-up. On the other hand, the treatment did not seem to have an effect on active CROM or on the activity of the DNF muscles. The

endurance of the DNF muscles increased in the last measurement of the treatment period, but was back to baseline during the follow-up.

6.2. Methodological considerations

6.2.1. Research design

In a SSED the extended baseline assessment is used to provide a picture of how the patient is currently performing. Three data points are typically considered the minimum necessary to determine the patient's pattern or trend. However, three data points may be insufficient to determine the patient's pattern of performance variation (Carter et al., 2011b). In this study it would had been optimal to use more than three data points to see whether the increasing and decreasing trends observed were stable or whether the increasing/decreasing period of a frequently shifting (unstable) condition was captured. It has been proposed that one should change the study's phases when the data is stable or a pattern has emerged (Carter et al., 2011b). However, there are limits to how often a patient can arrive for appointments that just involve measurement and how long he or she is willing to wait for the initiation of treatment. The time frame for this master thesis study was also limited, which decreased the time available for baseline measurements. The choice of how many baseline measurements were conducted was therefore based on ethical and practical reasons.

6.2.2. Patient selection

Initially it was estimated that 2-4 patients would participate in the study. Unfortunately, only one of five possible participants was considered to have dizziness of cervicogenic origin. Even though dizziness has been found to be one of the most common complaints in medicine the incidence of cervicogenic dizziness has been reported to be just 7.5% of all types of dizziness (Ardic et al., 2006). The rate is therefore relatively low, which can explain why only one patient could be included during the study's limited timeframe. Due to this, it would have been wise to send a letter to the general practitioners in the area asking for referral or to place an advertisement in the local newspaper. Karlberg et al. (1996b) included only 17 patients out of 65 referrals from general practitioners during a 39-month period. However, Reid et al. (2014b), with recruitment strategies consisting of media releases, advertisements in local newspapers and letters to general practitioners and neurologists, were able to include 86 patients out of 683 during a 20-month period.

6.2.3. Selection of outcome measures

The measuring instruments used in this study are similar to the instruments used in other intervention studies concerning cervicogenic dizziness (Reid et al., 2008; Reid et al., 2014b). The instruments have been found to be sensitive enough to capture clinically and statistically significant changes in patients with dizziness. Therefore, it is reasonable to believe that the measurements are sensitive to changes in this study as well.

When selecting the measuring instruments an effort was made to select instruments representing the three key components of the ICF model (Figure 1). However, the contextual factors (environmental and personal factors) that represent the complete background of the individual's life were not addressed systematically (WHO, 2001). These factors may have an impact on the individual's health-related state (WHO, 2001). Given the known complexity of dizziness and neck pain, screening tools that are able to give insight into these factors and to capture possible yellow flags should have been used. The presence of yellow flags is a risk factor for developing long term pain and prolonged disability (Kendall et al., 1997) and might therefore influence the treatment outcome. Possible yellow flags in my study could have been psychosocial problems at work, fear-avoidance and catastrophic thinking. These components were partly captured in the history, but using a standardized questionnaire could have given more valid results.

6.2.4. Internal and external validity

The validity of a study refers to the degree to which the study measures what it claims to measure. Internal validity is the extent to which the results of a study demonstrate that a causal relationship exists between the independent and dependent variables (Carter et al., 2011a). Actual threats to the internal validity in this study include history or events in the patient's life, unrelated to the study, which can influence the study's outcome (Carter et al., 2011a). This study was conducted in a relatively short period of time, which should reduce the changes of such external factors. However, Patient A was experiencing bullying at her workplace and was having discussions with her supervisor regarding the situation at work. She experienced the whole situation as very stressful, which could have a great influence on her symptoms and thereby the measurement outcomes. Another actual threat in this study is the regression to the mean, which means that extreme scores tend to get closer to the average as time passes regardless of the treatment received (Carter et al., 2011a). Patient A had

extreme scores on intensity of both dizziness and neck pain during the baseline period and in the treatment period.

Repeated measurements in the baseline phase are considered to serve as a control for the influence of history and regression to the mean (Carter et al., 2011a). With a stable baseline, one can assume with greater accuracy that these threats are controlled. As Patient A was experiencing increasing symptoms of dizziness and neck pain at the baseline, one must be more careful when interpreting the results. Afterwards, it can be discussed whether Patient A should have been excluded from the study based on this unstable baseline. Had more patients been included in the study, it is more likely that Patient A would have been excluded.

Repeated testing itself can result in a change in the dependent variable and can therefore be a threat to internal validity (Carter et al., 2011a). This can be the case in learning effects, when the patient's performance improves over time as he or she learns how the test works. As can the patient's performance improve when he or she becomes familiar with the testing situation. I tried to control this threat by using measure instruments that have been tested in relation to validity and are not likely to show learning effects. Further, the measure instruments have been found to be sensitive to capture significant changes. Each measurement session was carried out in the same manner and the measurements were conducted in accordance with standardized protocols which can be considered to strengthen the internal validity.

External validity is the extent to which results of the study can be generalized to other situations, other times and other people. The generalizability of an SSED is limited to individuals and depends on how well the patient's features and the intervention are matched to the study (Carter et al., 2011a). Hence the external validity of this study is limited. Another factor that can further limit the external validity of this study is that in the clinic, there is no access to neurological laboratory tests that are necessary to rule out vestibular disorders as a cause for the dizziness. However, by following the guidelines from Vidal and Huijbregts (2007) and Wrisley et al. (2000), I believe that I was as sure as I can be in a clinical setting that the cause for the dizziness was cervicogenic. Other studies have used similar exclusion criteria but following clinical examination a neurological laboratory test was performed (Karlberg et al., 1996b; Reid et al., 2008). In the study by Reid et al., (Reid et al., 2008) 25 patients out of 59 were excluded following the neurological assessment.

However, it is not reported how many were excluded after the clinical examination and how many after the laboratory tests. Knowing how many were excluded after the laboratory tests could provide further insight into how reliable my diagnosis of cervicogenic dizziness was. As the method used in my study for identifying cervicogenic dizziness has not been studied in relation to validity, the external validity of my study decreases.

On the other hand, this study is conducted in a clinical setting, which can strengthen the external validity when attempting to generalize the result to other patients in the clinic.

6.2.5. Own role as a researcher

The purpose of a quantitative research is to limit the researcher's influence on the results. In this SSED I was involved in most parts of the project, as I selected the patients, performed the testing and analysed the data. Therefore my role was to remain as neutral as possible and keep a distance from the material. I tried to remain detached from the study and the patient in order for my own expectations, values and feelings not to influence the measurement outcome. Standardized measurement tests were important in this process. My weakness in the implementation of this study was best experienced in the testing of the activity and endurance of the DNF muscles as I have received minimal training in performing this test. In order to minimize my influence on the outcome of the study, the intervention was performed by an experienced manual therapist.

6.3. Discussion of the results

The results of my study must be interpreted with caution and conclusions about causal relationships cannot be drawn based on the study's low internal validity. The tendency toward decreased dizziness and self-perceived disability at the end of the treatment period might, for example, be based on the relationship that forms between the patient and the therapist during treatment. During the treatment the patient could address the problems she was experiencing at work and get feedback about how to deal with these problems. Another factor that must be considered are natural swings in the patient's symptoms. With a baseline where all symptoms are getting worse it is difficult to say whether the decrease in symptoms is due to the treatment or to a natural recovery. It is also unfortunate how widely spread the first four treatment sessions were. As the patient began to receive two treatments per week a decrease was observed in the intensity of dizziness, self-perceived disability due to dizziness

and neck pain. Better results might have been observed if the treatment had been steadier from the beginning or if the treatment period had been longer. However, previous studies have shown positive effects of manual therapy on cervicogenic dizziness after three treatments during a two-week period (Heikkila et al., 2000), and on cervicogenic dizziness and neck pain after four to six treatments during a four-week period (Reid et al., 2008) and two to six treatments during a six-week period (Reid et al., 2014b).

6.3.1. Intensity of dizziness

There was a tendency for the intensity of dizziness to decrease at the end of the treatment period. These result are in accordance with the results of a recent study (Reid et al., 2014b) where dizziness intensity reduced immediately after manual therapy intervention, both after Maitland and Mulligan techniques, with the effects being maintained for 12 weeks. Prior to this study by Reid et al. (2014b) there was no evidence for treatment of cervicogenic dizziness with Maitland mobilization.

In my study, the treatment may have stimulated cervical proprioceptors and thereby led to decreased dizziness intensity. Normalized input from cervical nociceptors can have contributed, as there was a decrease in pain intensity at the end of the treatment period, though it is less likely since the decrease in pain intensity was not maintained. It is unlikely that the decrease in dizziness is due to improvement in cervical motor control as the treatment did not affect the DNF muscles.

It is worth noting that the patient in my study scored once 100 mm on VAS (maximal dizziness) and once 95 mm on VAS. Despite this high score my patient was able to work, drive and take care of herself, which can be hard to imagine one doing when experiencing maximal dizziness. Therefore, I suspect other psychosocial factors, such as catastrophizing, to be involved.

6.3.2. Self-perceived disability

Using the DHI showed that cervicogenic dizziness had a negative effect on functional, physical and emotional aspects of the patient's everyday life, which is in accordance with other studies (Reid et al., 2008; Reid et al., 2014b). During the treatment period self-perceived disability due to dizziness decreased from severe to moderate and this decrease was

maintained during the follow-up period. This tendency in decreased disability is in accordance with other studies (Reid et al., 2008; Reid et al., 2014b).

In the study by Reid et al. (2014b) all three groups (two intervention groups and a control group) had a reduction in DHI and pain intensity scores. Further, the DHI score were almost as well correlated with pain ratings as with dizziness ratings. Therefore, it remains unclear whether the disability was associated with dizziness or pain perceptions. Even though the DHI has been used in studies concerning cervicogenic dizziness, it was designed for use in patients with vestibular pathology, a group that is probably less affected by pain. Reid et al. (2014b) suggested that further research concerning the use of the DHI in patients with cerviogenic dizziness might be warranted.

6.3.3. Intensity of neck pain

The intensity of neck pain decreased considerably between the last two measurements during the treatment period. However, the decrease was not maintained at follow-up. The results of previous studies regarding cervicogenic dizziness and neck pain intensity have been controversial. Reid et al. (2008) observed a significant decrease in neck pain scores in the intervention group that received Mulligan mobilization compared to the control group at 12 weeks follow-up. In a more recent study by Reid et al. (2014b), a significant difference in neck pain intensity was observed for the intervention group that received Maitland mobilization. However, there was no significant difference between the intervention group that received Mulligan mobilization and the control group. Cervical and thoracic manipulation did not affect neck pain in a study by Heikkila et al. (2000) in contrast to acupuncture and NSAIDs.

Patient A reported pain intensity at eight or higher in eight out of nine appointments. Twice did she report maximal pain intensity, in the same appointments as she reported maximal dizziness. High pain intensity has been linked to catastrophizing (Tan et al., 2001) (Severeijns et al., 2001), which is defined as the tendency to magnify or exaggerate the threat or seriousness of pain sensation (Chaves & Brown, 1987). Catastrophizing has been shown to play a crucial role in the experience of chronic pain and contributes to the variance of pain intensity, pain-related disability and psychological distress (Severeijns et al., 2001). As Patient A was able to work, drive and take care of herself while experiencing maximal dizziness and neck pain, I suspect other factors than physical impairments to be involved.

However, without the appropriate screening tools I cannot say with accuracy which factors that might be.

6.3.4. Cervical range of motion

The treatment had no effect on CROM, which is in accordance with a study by Reid et al. (2014a) where Maitland mobilization and range of motion exercises had limited effect on CROM. However, surprisingly, in my study, the CROM seemed to decrease during the study period even though the decrease was not statistically significant. Several explanations for this decreased CROM are possible. When measuring CROM the patient was asked to move her head as far as she could in the specific movement direction. It was not registered whether the movement stopped because of pain, dizziness or if the physiological limits were reached. The self-reported dizziness and neck pain increased during the baseline and the CROM decreased with the exception of rotation to the left. It is therefore natural to consider that increased dizziness and pain led to a lessened ability to move. Other factors than dizziness and pain that can affect the CROM include fear-avoidance. As the patient expects or is afraid that the dizziness or pain will increase during the testing she might be less willing to move her head. Even though measuring CROM in this way has been shown to be a reliable and valid method (Williams et al., 2010), the outcome can vary based on the patient's conditions.

6.3.5. Activity and endurance of the deep neck flexors

The treatment did not affect the activity or the endurance of the deep neck flexors. These findings are not in accordance with the findings by Jull et al. (2009) and Falla et al. (2012), as they observed positive findings after 6 weeks of specific training. In the study by Falla et al. (2012), activation of the DNF muscles improved and neck pain decreased after 6 weeks of specific training. In that study, the patients exercised two times per day (for 10-20 minutes) during the 6-week period.

In a case control study by Thoomes-de Graaf & Schmitt (2012), reduced neck pain and dizziness was observed after 6 weeks' training of the DNF, with additional improvements after 12 week of training. In addition, CROM increased and disability due to neck pain decreased. All improvements remained stable at 6 months follow-up. This was a case control study concerning a 19-year-old woman who had a 24-month history of neck pain and dizziness, with the symptoms starting during a 2-month immobilization in the intensive care

unit. The intervention consisted of DNF training where the exercise phase started as in my study but progression was made towards integration with function. However, by using the Fear-Avoidance Beliefs Questionnaire the author had revealed a high level of fear-avoidance. Therefore, the initial intervention was aimed at reducing the patient's fear-avoidance through education. As I suspect fear-avoidance and catastrophic thinking to be factors in my study, education about the nature of pain and dizziness might have been an appropriate initial intervention. One can speculate that this could reduce fear related to movement and increase the exercise compliance.

Initially, the treatment period in my study was supposed to be 4 weeks, which could have been too short a period to observe positive findings. However, the treatment period lasted for eight weeks, which should have been sufficient time to observe increased activity and endurance in the DNF. The treatment period was longer than expected due to sickness and an Easter break so one can speculate how well this prolongation of the treatment period could be utilized for specific training. Unfortunately, how often the patient did her home exercises was not registered in my study. The patient should have been instructed to keep a training diary during the treatment period, both as a reminder and motivation for doing the exercise and to provide an oversight of the training that would have helped in interpreting the results.

7. CONCLUSION

In my study, the aim was to examine the effects of manual therapy in combination with training of the DNF on cervicogenic dizziness. Only one patient was included, a patient that probably had increased risk of long-term disability. The internal and external validity of this study are considered to be low, which makes the interpretation of the results difficult. Nevertheless, the results may indicate that manual therapy can be an effective treatment in reducing the intensity of dizziness and self-perceived disability due to dizziness. These results are in accordance with previous studies. It is unlikely that training of the DNF would have had an additional effect in this study, as neither the activity nor the endurance of the DNF increased after the treatment. Therefore, further research, in the form of randomized controlled trials, is needed before concluding on the effects of this treatment on cervicogenic dizziness.

The background for my choice of topic was that I have always found dizziness interesting and at the same time challenging. After conducting this study, I find dizziness even more challenging. Dizziness is often a composite problem and it can be difficult to differentiate between dizziness that originates from the vestibular system, dizziness that originates from the neck and dizziness that can be derived from other factors, such as psychosocial factors. Neck pain and dysfunction at the upper cervical can be present regardless of the primary cause. When meeting a patient with dizziness, one must use the tests available that can help exclude underlying diseases, identify those that need referral to a specialist and those that have symptoms from the vestibular system. Further, one must screen for psychosocial factors and address these, if present, while concurrently addressing the physical findings.

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APPENDIX A

Based on guidelines from Wrisley et al. (2000) and Vidal and Huijbregts (2007).

History:

1. Patient description of the symptoms. If the description was consistent with vertigo a central or peripheral vestibular disorder is suspected, although cervicogenic dizziness could not be ruled out as a diagnosis (Wrisley et al., 2000).
2. Frequency and duration of the symptoms, association with neck pain.
3. Time and mode of onset. Exacerbating and relieving factors.
4. Similar questions were asked about the neck pain.

CAUSE	COMMON SYMPTOMS	FREQUENCY	DURATION	RELATED FACTORS
BENIGN PAROXYSMAL POSITIONAL VERTIGO	Vertigo	Episodic	Seconds	Related to head position, usually worse in AM
CERVICOGENIC DIZZINESS	Dizziness, disequilibrium	Episodic	Minutes to hours	Related to head position
PERILYMPHATIC FISTULA	Disequilibrium, vertigo	Episodic	Seconds to minutes	Vertigo during Valsalva maneuver
LABYRINTHINE CONCUSSION	Vertigo, disequilibrium	Episodic	Hours to days	Increases with fatigue
CENTRAL VESTIBULAR DYSFUNCTION	Dizziness, disequilibrium	More constant	Days to weeks	May be seen in combination with inner ear pathologies

Duration and frequency of common causes of dizziness (Wrisley et al., 2000)

Examination:

1. Hallpike-Dix maneuver. Tests the semicircular canals. Requires 45° of cervical rotation and 30° of cervical extension. If the test is positive the

patient is suspected to have Benign Paroxysmal Positional Vertigo and is excluded from the study.

2. Valsalva test. A valsalva maneuver may produce nystagmus or dizziness. Although no data are found regarding reliability and validity, a positive test indicates a need for referral and the patient will be excluded from the study.
3. Saccadic eye movements, tested by having the patient look back and forth between two targets. The therapist looks for overshooting or undershooting. Abnormalities indicate a need for referral and exclusion from the study.
4. Head-Shaking Nystagmus Test. The patient sits with his eyes closed. The therapist moves the patient's head back and forth horizontally for about 30 seconds. Nystagmus upon opening the eyes will indicate a peripheral vestibular lesion or Meniere's disease. A positive test indicates a need for referral and exclusion from the study.
5. De Kleyn test. The patient is supine. The therapist moves the patient's head in extension and rotation and holds the position for 30 sec. Positive test may include symptoms of vertigo, diplogia, nausea and dysphagia. Positive signs may include dysarthria or nystagmus. Positive test are indicative of vertebrobasilar insufficiency.

APPENDIX B

Numeric Pain Rating Scale (NPRS)

Hvordan vil du gradere de smertene du har hatt i løpet av det siste tre dagene. Sett ring rundt ett tall.

0 1 2 3 4 5 6 7 8 9 10

ingen smerter *så vondt som det går an å ha*

Visual Analog Scale (VAS)

Hvor svimmel har du følt deg i løpet av det siste tre dagene. Sett kryss på linje.

_____

Ikke noe svimmel *Så svimmel som det går an å være*

DIZZINESS HANDICAP INVENTORY

Instruksjon: Hensikten med dette skjemaet er å identifisere vanskeligheter du kan oppleve på grunn av din svimmelhet eller ustøhet. Vennligst besvar hvert av spørsmålene med ”ja”, ”nei” eller ”noen ganger". Besvar hvert spørsmål ut fra at det bare er forbundet med ditt svimmelhets- eller ustøhetsproblem.

nr		SPØRSMÅL	ja	nei	noen ganger
1		Øker problemet ditt når du ser opp?			
2		Føler du deg frustrert på grunn av problemet ditt?			
3		Begrenser du reising i jobb eller fritid på grunn av problemet ditt?			
4		Øker problemet ditt når du går mellom reolene i et supermarked?			
5		Har du vansker med å komme deg inn eller ut av seng på grunn av problemet ditt?			
6		Hemmer ditt problem deg i betydelig grad fra å delta i sosiale aktiviteter som å gå ut på middag, kino, dans eller i selskap?			
7		Har du vansker med å lese på grunn av problemet ditt?			
8		Øker problemet ditt når du utfører mer ambisiøse aktiviteter som sport, dans og husarbeid som å feie gulv eller sette oppvasken på plass?			
9		Er du redd for å gå hjemmefra uten å ha noen til å følge deg på grunn av problemet ditt?			
10		Har du vært forlegen/flau foran andre på grunn av problemet ditt?			
11		Øker problemet ditt når du snur fort på hodet?			
12		Unngår du høyder på grunn av problemet ditt?			

			ja	nei	noen ganger
13		Øker problemet ditt når du snur deg i sengen?			
14		Er det vanskelig for deg å utføre anstrengende husarbeid eller hagearbeid på grunn av problemet ditt?			
15		På grunn av problemet ditt er du redd for at folk kan tro at du er (be)ruset?			
16		Er det vanskelig for deg å gå på en tur alene på grunn av problemet ditt?			
17		Øker problemet ditt når du går langs et fortau?			
18		Er det vanskelig for deg å konsentrere deg på grunn av problemet ditt?			
19		Er det vanskelig for deg å gå rundt i huset ditt i mørket på grunn av problemet ditt?			
20		Er du redd for å være alene hjemme på grunn av problemet ditt?			
21		Føler du deg handikappet på grunn av problemet ditt?			
22		Har problemet ditt vært belastende på ditt forhold til familiemedlemmer eller venner?			
23		Er du deprimert på grunn av problemet ditt?			
24		Forstyrrer problemet ditt deg i å ivareta dine forpliktelser i jobb eller hjemme?			
25		Øker dine problemer når du bøyer deg forover?			

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APPENDIX C

Forespørsel om deltakelse i forskningsprosjektet

"Effekten av manual terapy og deep neck fleksor trening på cervicogenic svimmelhet"

Bakgrunn og hensikt

Forespørsel om å delta i en forskningsstudie der en undersøker hvilken effekt behandling hos manual terapeut har på svimmelhet på grunn av nakkeplager. Behandlingen vil bestå av manuelle teknikker og spesifik trening av nakkemuskletur.

Hva innebærer studien?

Studien har et omfang på totalt åtte uker. Du vil først bli grundig undersøkt. Hvis du oppfyller kriteriene for å bli med i prosjektet vil du bli testet med fysiske tester og spørreskjema tre ganger i løpet av de første 10 dagene. Bevegelse i nakken og styrke i nakkemuskleturen vil bli målt og et spørreskjema som registrerer svimmelhet og funksjon i dagliglivet skal fylles ut. Selve studien vil bestå av behandling av ledd og muskletur av nakken hos manuellterapeut og spesifikke øvelser for nakkemuskletur. I tillegg vil du lære øvelser som du skal gjøre hjemme hver dag. Du vil få behandling 2 ganger i uken i fire uker, og annenhver gang vil det bli gjennomført testing i tillegg. Hver behandling vil ta 30 minutter og du må beregne litt mer tid de gangene du skal testes i tillegg. Studien avsluttes med oppfølgingsundersøkelser en gang i uken i tre uker. Du må ikke betale for timene der det kun er testing, men du må betale vanlig takst for behandlingene.

Hva skjer med prøvene og informasjonen om deg?

Prøvene tatt av deg og informasjonen som registreres om deg skal kun brukes slik som beskrevet i hensikten med studien. Alle opplysningene og prøvene vil bli behandlet uten navn og fødselsnummer eller andre direkte gjenkjennende opplysninger. En kode knytter deg til dine opplysninger og prøver gjennom en navneliste. Det er kun autorisert personell knyttet til prosjektet som har adgang til navnelisten og som kan finne tilbake til deg. Det vil ikke være mulig å identifisere deg i resultatene av studien når disse publiseres.

Frivillig deltakelse

Det er frivillig å delta i studien. Du kan når som helst og uten å oppgi noen grunn trekke ditt samtykke til å delta i studien. Dette vil ikke få konsekvenser for din videre behandling. Dersom du ønsker å delta, undertegner du samtykkeerklæringen. Om du nå sier ja til å delta, kan du senere trekke tilbake ditt samtykke uten at det påvirker din øvrige behandling. Dersom du senere ønsker å trekke deg eller har spørsmål til studien, kan du kontakte xxxxxxxxxxx

_____ _____

Aut. Fysioterapeut

Førsteamanuensis
Veileder, Universitetet i Bergen

Samtykke til deltakelse i studien

"Effekten av manual terapy og deep neck flexor trening på cervicogenic svimmelhet"

Jeg er villig til å delta i studien for å undersøke effekten av manual terapy behandling og deep neck fleksjon trening på svimmelhet som oppstår fra nakken. Jeg har mottatt muntlig og skriftlig informasjon om studien.

Jeg er klar over min rett til å trekke meg fra studien uansett tidspunkt og uten å oppgi grunn og uten at det vil få negative konsekvenser for videre behandling som jeg ellers får ved instituttet.

(Signert av prosjektdeltaker, dato)

Jeg bekrefter å ha gitt informasjon om studien

(Signert, rolle i studien, dato)