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Balance problems and dizziness after neck surgery – associations with pain and health-related quality of life

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ABSTRACT

Introduction: Symptoms of dizziness or imbalance are often present in individuals with a variety of neck-disorders. The aims of this study were to determine the prevalence of patient-reported balance problems and dizziness 10–13 years after surgery for cervical degenerative disc disease; evaluate associations with neck pain and health-related quality of life; and investigate how these individuals described dizziness.

Material and methods: Sixty-eight individuals, 10 years or more after anterior cervical decompression and fusion surgery, who previously participated in a randomized controlled trial were included. Participants completed questionnaires including ratings of dizziness and balance problems, the Dizziness Handicap Inventory, and an open-ended question regarding their experience of dizziness. Secondary outcomes were neck pain and quality of life.

Results: Seventy-two percent experienced occasional or daily symptoms of unsteadiness and/or dizziness. Intensity ratings for dizziness during movement and for balance problems were similar and rather low, but had an impact on quality of life. Ratings of dizziness at rest were even lower. Dizziness ratings were associated with neck pain. Strenuous activities were related to dizziness and dizziness was primarily described as intermittent and non-rotatory.

Conclusions: Dizziness or balance problems in the long-term after surgery for cervical degenerative disc disease are common and have an impact on daily life. Ratings of problem frequency and intensity were usually low. Dizziness and balance problems may affect quality of life. Patients’ descriptions of these problems are in line with common symptoms of cervicogenic dizziness.

Introduction

Dizziness significantly impairs health-related quality of life (Weidt et al., 2014), strongly contributes to disability (Mueller et al., 2014), and can trigger both anxiety and depression (Staab and Ruckenstein, 2003). Patients with dizziness due to vestibular or non-vestibular causes experience reduced quality of life (Neuhauser et al., 2008) as measured with generic and disease-specific instruments.

Symptoms of dizziness or imbalance are often present in individuals with a variety of neck-disorders. Dizziness and imbalance may originate from altered proprioceptive signals due to for example degenerative cervical disorders (Yacovino and Hain, 2013). Dizziness is prevalent in 50% of individuals with cervical spondylosis (Olszewski et al., 2006) and cervico-brachial pain (Karlberg, Persson, and Magnusson, 1995). Patients with cervical radiculopathy scheduled for surgery have also been shown to have reduced somatosensory control (Wibault et al., 2013), which may be a factor in neck-related dizziness. Dizziness is associated with more advanced radiographic degenerative changes (Machaly, Senna, and Sadek, 2011). There is a suggested association with abundant distribution of mechanoreceptors in diseased cervical discs (Yang et al., 2017). An abundance of proprioceptive receptors in the neck are located in the joints, ligaments, and deep cervical neck-muscles (Armstrong, McNair, and Taylor, 2008; Boyd-Clark, Briggs, and Galea, 2002), which may all be affected in degenerative disc disease and after neck surgery. Cervical proprioception contributes to the perception of head motion and converges with vestibular and visual information for spatial orientation and balance. Both animal and human studies have shown that neck perturbations can cause dizziness and imbalance (de Jong, de Jong, Cohen, and Jongkees, 1977; Yacovino and Hain, 2013).

At present, there is no reliable diagnostic test to establish that dizziness is caused by a neck condition (Hain, 2015; Yacovino and Hain, 2013). The diagnosis of cervicogenic...
dizziness is based on correlating symptoms of dizziness and/or imbalance with neck pain, after excluding other possible causes of dizziness based on history, examination, and vestibular function tests (Wrisley, Sparto, Whitney, and Furman, 2000).

Anterior cervical decompression and fusion (ACDF) is a frequently used surgical technique among patients with cervical radiculopathy who have failed conservative treatment. In 2015, approximately 650 cervical disc removal surgeries with fusion were performed in Sweden (Fritzell et al., 2016). Publications on subjective ratings and descriptions of dizziness and imbalance in patients with cervical disc disorders in general are sparse, and are especially limited in patients with dizziness who have degenerative cervical disorders. Only a few uncontrolled studies have specifically reported on dizziness or balance problems after neck surgery due to degenerative cervical disorders. Freppel et al. (2013) found no dizziness but impaired postural control measured with static posturography in 17 persons with degenerative cervical spine diseases and radiculopathy. Results from a few studies show improvements in dizziness symptoms after surgical or laser treatments in patients with cervical degenerative disease (Li et al., 2016; Ren et al., 2014; Sun et al., 2013). However, other short-term (Peolsson, Kammerlind, and Ledin, 2004) and long-term (Hermansen, Cleland, Kammerlind, and Peolsson, 2014) follow-ups of postural control and balance performance show impaired postural control remains after ACDF surgery. The former study did not focus on dizziness and the latter did not address the subjective experience of balance problems or dizziness.

We hypothesize that patients with degenerative cervical disc disease at long-term follow-up after surgery might experience dizziness or subjective balance problems either due to their original disorder or as these problems could have developed over time. Knowledge about the prevalence and character of dizziness in patients in the long-term after surgery might help guide clinicians in rehabilitation planning and when providing patients with post-operative information. The aims of the present study were to determine the prevalence of patient-reported balance problems and dizziness 10–13 years after surgery for cervical degenerative disc disease, to evaluate associations with neck pain and health-related quality of life, and to investigate how these individuals describe dizziness.

**Material and methods**

This is a cross-sectional study with 10–13-year follow-up using self-reported data on dizziness and balance problems. Participants were originally included in a randomized controlled trial (RCT) evaluating outcomes after ACDF (Vavruch et al., 2002).

The original RCT was conducted at a University Hospital in Sweden between 1995 and 1998 (Vavruch et al., 2002). Included in the original study were patients with radiculopathy of degenerative origin, verified by MRI, with or without neck pain of at least 6-month duration. The exclusion criteria were myelopathy, psychiatric disorders, drug abuse, and previous spine surgery (Vavruch et al., 2002).

At the time of surgery, patients were randomly assigned to either surgery with the Cloward procedure (CP) (Cloward, 1958), or the carbon fiber fusion cage (CIFC) (Smith and Robinson, 1958) techniques by an attending nurse. These surgical techniques are similar, but use two different grafts (i.e. CP uses a cylindrical bicortical bone graft; and CIFC uses a carbon fiber fusion cage) to promote fusion and enhance stability. A total of 95 patients were included in the original study (Vavruch et al., 2002). Previous follow-ups show no differences in self-rated outcomes between the two surgical treatment groups (Hermansen, Cleland, Kammerlind, and Peolsson, 2014; Hermansen, Hedlund, Vavruch, and Peolsson, 2011). Due to these previous results, the analyses in the present study proceeded with all participants as one sample.

Postoperatively all individuals were instructed to wear a Philadelphia collar for six weeks and follow a standardized protocol after removal of the collar. This included a referral to physical therapy in primary health care (the rehabilitation program was not specifically designed for the study).

After a minimum of 10 years following surgery, a set of questionnaires were sent out to 90 individuals who participated in the original RCT and were still available (four individuals had died and one was excluded due to a WAD acquired 6 weeks postoperatively). Self-reported measures of functioning and psychosocial factors including dizziness and balance problems were in the set of questionnaires. A total of 73 individuals returned the completed questionnaires. The 17 drop-outs were due to severe diseases such as cancer or stroke, one patient returned an incomplete questionnaire and nine failed to return the questionnaire despite reminders.

**Participants**

Of the returned questionnaires, 68 individuals (38 women, 30 men; 31 CP, 37 CIFC) completed both ratings of dizziness and balance problems intensity and frequency of unsteadiness/dizziness and were included in the analyses performed in the present study. Twenty-five individuals...
answered the open-ended question about their perceptions of dizziness and were included in the qualitative part of the analysis. Demographics and background data are shown in Table 1.

This study was performed in accordance with the declaration of Helsinki and was approved by the Regional Ethics Review Board in Linköping, Sweden (Dnr M119-08). All participants provided informed consent as part of returning the questionnaires.

Data collection

Data were collected using self-reported measures to evaluate dizziness, a false perception of movement or spatial orientation (the Swedish word used includes both vertigo and more non-specific sensations such as lightheadedness) and the subjective experience of balance problems. These self-reported measures were included in the set of questionnaires used in the long-term follow-up of functioning after ACDF surgery (Hermansen, Hedlund, Vavruch, and Peolsson, 2011).

Intensity ratings

Self-reported dizziness intensity at rest and during movement and the intensity of balance problems were rated on a 100-mm Visual Analog Scale (VAS: 0 = no symptoms, 100 = worst imaginable symptoms) (Kammerlind, Bergquist Larsson, Ledin, and Skargren, 2005). VAS ratings of pain intensity have previously been established to have good reliability and validity (Carlsson, 1983). Self-reported intensity of dizziness and balance problems using the 100-mm VAS has previously been used in patients with: vestibular dysfunction (Kammerlind, Bergquist Larsson, Ledin, and Skargren, 2005); and also to evaluate dizziness in patients with WAD (Treleaven et al., 2016) and cervicogenic dizziness (Reid and Rivett, 2005).

Frequency ratings

Self-reported ratings of unsteadiness/dizziness frequency were measured on a 5-grade rating scale (0 = never to 4 = constantly). For statistical analysis, the frequency ratings were categorized as never (0), occasionally (1), or daily/constantly (2–4). Similar dizziness frequency ratings have previously been used in studies on dizziness of cervicogenic origin (Reid et al., 2015).

Impact of dizziness and unsteadiness

The Dizziness Handicap Inventory (DHI) was used to quantify the impact of dizziness and/or unsteadiness on daily life (Jacobson and Newman, 1990). The DHI is a 25-item questionnaire, with the response alternatives of “yes” (4 points), “sometimes” (2 points), or “no” (0 point) and a total score ranging from 0 (no handicap) to 100 (severe/maximal handicap). The Swedish version of the DHI showed good reliability and content validity in patients with dizziness due to vestibular dysfunction (Järlsäter and Mattsson, 2003; Kammerlind, Bergquist Larsson, Ledin, and Skargren, 2005). The DHI has previously been used in studies on dizziness of cervicogenic origin (Reid et al., 2015). Patients were instructed to complete this questionnaire only if they experienced any form of dizziness or unsteadiness. A DHI score of 31–60 is the cut-off for moderate disability, and a score of 61 or worse is the cut-off for severe disability due to dizziness (Whitney, Wrisley, Brown, and Furman, 2004).

Experience of dizziness

Participants who experienced dizziness or balance problems were asked to answer an open-ended question related to their experience of dizziness. The question was posed as follows: “In your own words, describe what kind of difficulties due to dizziness you experience, how you experience them, and how they affect your everyday life.”

Complementary outcome measures

Neck pain intensity was measured using a 100 mm VAS pain scale (0 = no pain, 100 = worst imaginable pain) (Carlsson, 1983). Neck-related disability was measured using the Neck Disability Index (Ackelman and Lindgren, 2002; Vernon and Mior, 1991). Health-related quality of life was reported using the EuroQol 5 dimensions (EQ-5D) (Brooks, 1996) index score (0 = poor overall health to 1 = good overall health), and health status was rated on the Euroqol 100 mm vertical VAS (0 = worst imaginable health to 100 = best imaginable health).

Data analyses

Descriptive data were calculated using non-parametric statistics due to non-normal distribution of data. Spearman’s rho was used to evaluate the relationship

| Table 1. Demographics and background characteristics of the participants (n= 68). |
|-----------------------------------------|-----------|
| Median age, years (Q1–Q3)             | 60 (52–66) |
| Median time since surgery, months (Q1–Q3) | 139 (128–145) |
| Median neck pain, VAS (Q1–Q3)        | 31 (5–51)  |
| Median neck disability, NDI (Q1–Q3)  | 32 (13–44) |
| Median EQ-SD (Q1–Q3)                  | 73 (.66–.88) |
| Median EQ-VAS (Q1–Q3)                 | 70 (50–85)  |
| Q1: lower quartile; Q3: upper quartile; VAS: visual analogue scale; NDI: neck disability index; EQ-SD: EuroQol 5 dimensions; EQ-VAS: EuroQol 100 mm vertical visual analog scale. |
between pain and dizziness, and pain and balance problems. Spearman’s rho was also used to evaluate how pain, dizziness, and balance problems were related to health-related quality of life. Bootstrapping was used to calculate the 95% confidence intervals. A p-value of <0.05 was considered statistically significant.

To explore how dizziness was described by the participants, data from the DHI and open-ended question were analyzed. The DHI items most commonly answered with “yes” or “sometimes” as well as items most commonly answered with “no” were identified. The answers to the open-ended question were categorized according to; cause or trigger of episodes and temporal relationships to other factors/activities, description of dizziness, and how these difficulties influenced private, occupational, or recreational areas of life.

Results

Prevalence of patient-reported unsteadiness or dizziness

Of the 68 participants, 49 (72%, 95% CI 60–82%) experienced unsteadiness or dizziness (Table 2).

Dizziness intensity and association with pain and quality of life

VAS intensity ratings for dizziness during movement were rather low, and dizziness at rest ratings were even lower (Table 2). Pain significantly correlated with dizziness at rest ($R_s = 0.36$, $p = 0.002$) and during movement ($R_s = 0.38$, $p = 0.009$) (Table 3). Pain and dizziness during movement significantly correlated with both ratings of health-related quality of life (EQ-5D, EQ-VAS) where high levels of pain were associated with lower ratings of quality of life (Table 4).

Table 2. Self-reported balance problems and dizziness 10–13 years after ACDF.

<table>
<thead>
<tr>
<th>Outcome measure</th>
<th>Frequency of neck-related dizziness and/or balance problems, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Neve</td>
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<tr>
<td></td>
<td>Occasionally</td>
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<tr>
<td></td>
<td>Every day</td>
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<tr>
<td><strong>Symptoms on VAS, mm (median, Q1–Q3)</strong></td>
<td></td>
</tr>
<tr>
<td>Dizziness at rest</td>
<td>2 (0–12)</td>
</tr>
<tr>
<td>Dizziness during movement</td>
<td>11 (2–27)</td>
</tr>
<tr>
<td>Balance problems</td>
<td>15 (2–38)</td>
</tr>
<tr>
<td><strong>Dizziness Handicap Inventory, Median total score (Q1–Q3)</strong></td>
<td></td>
</tr>
</tbody>
</table>

$n = 68$, $n = 57$. ACDF: anterior cervical decompression and fusion surgery; Q1: lower quartile; Q3: upper quartile; VAS: 100 mm visual analog scale.

Self-reported balance problems, intensity, and association with pain and quality of life

VAS intensity ratings of balance problems were rather low and similar to dizziness during movement. Pain did not correlate with balance problems (Table 3). There was a significant, negative correlation between balance problems and both ratings of health-related quality of life (Table 4).

Disability due to dizziness or unsteadiness

The patients’ symptoms of dizziness or balance problems had impact on daily life according to the DHI (Table 2). Twenty-one (31%) individuals had moderate, and six (9%) had severe disability as measured with DHI (DHI 31-60 and ≥61, respectively).

Patients own descriptions of symptoms

The DHI items/questions most commonly answered with “yes” or “sometimes” were: item #1 – Does looking up increase your problems; item #8 – Does performing more ambitious activities such as sports, dancing, household chores (e.g. sweeping or putting dishes away) increase your problems; item #11 – Do quick movements of your head increase your problems; item #14 – Because of your problem, is it difficult for you to do strenuous work in the home or yard work; and item #25 – Does bending over increase your problems?

Twenty-five individuals provided answers to the open-ended question of their experience of dizziness. Thirteen participants described triggers of their perceived dizziness, and some described more than one trigger. Eight individuals described a causal relationship with neck position or neck-movements, or strenuous activities that in some way affected neck position or movements. Seven individuals described the cause of dizziness as activities that challenged their balance such as walking in the woods or standing on one leg. Activities like turning over in or getting out of bed were described by three individuals.

The quality of dizziness was described by 12 individuals as non-rotatory, a vague feeling of discomfort, a sensation of lightheadedness, or imbalance/postural unsteadiness. Two individuals described nausea and a tendency to faint. Only one individual described symptoms as rotatory vertigo, and one individual experienced nausea along with unsteadiness.
Fourteen individuals provided information about how dizziness influenced their lives. Two of these described not having too many problems. Dizziness was described as influencing cognitive abilities (i.e. their ability to fully concentrate on matters) or their emotional status (i.e. worrying, losing their temper, or being less happy). Seven individuals described being limited by their dizziness by either having a need for mobility aids or being limited in activities such as driving or recreational activities.

**Discussion**

The main findings of this follow-up study were that 10–13 years after neck surgery, 72% of patients experienced occasional or daily symptoms of unsteadiness and/or dizziness. Intensity ratings for balance problems and dizziness during movements were similar and rather low and dizziness at rest ratings were even lower. Health-related quality of life correlated to symptoms. There was a strong correlation with dizziness during movement and balance problems. There was a strong correlation with neck pain. The qualitative results of the study showed that the informants indicated more strenuous activities as being related to dizziness and that dizziness was primarily described as intermittent and non-rotatory.

A majority of patients reported unsteadiness/dizziness and these problems had an impact on daily life as measured by the DHI, but the symptoms usually did not occur daily and the ratings on VAS were usually low. As the results show, dizziness during movement and self-reported balance problems significantly correlated with health-related quality of life but dizziness at rest did not. These results are somewhat puzzling because when dizziness is movement related, certain movements can be avoided and when balance is a problem, challenging activities may be avoided. In addition, dizziness at rest is more difficult for the individual to control and may be perceived as a larger problem, thus affecting quality of life. On the other hand, having to avoid certain activities could be the cause of lower health-related quality of life as indicated by the results of the present study. Also, the ratings of dizziness at rest were lower than dizziness during movement and self-reported balance problems which might also explain these results.

The prevalence of dizziness in different neck disorders has been investigated less than has postural control and balance. In the present study, 72% of patients experienced some form of unsteadiness or dizziness. This is a high prevalence considering that the 1-week to 1-month prevalence of all types of dizziness ranges between 16% and 29% in community settings (Muridin and Schilder, 2015). However, it is not that much higher than the prevalence of dizziness in populations with neck-disorders. Approximately 50% of patients with cervico-brachial pain who are scheduled for a neurosurgical consult (Karlberg, Persson, and Magnusson, 1995), and 47% of patients short-term after ACDF surgery (Peolsson, Kammerlind, and Ledin, 2004) present with dizziness. Also, 75% of patients with longstanding WAD (Treleaven, Jull, and Sterling, 2003) report dizziness. Some of the discrepancies in prevalence might however be due to differences in data collection between studies. In the present study, participants were instructed to indicate any unsteadiness/dizziness problems they experienced either occasionally or continuously. The community-based results (Muridin and Schilder, 2015) include studies with both “any” or “bad enough” ratings of dizziness, leaving dizziness underestimated. In the neck-disorder-based studies (Karlberg, Persson, and Magnusson, 1995; Peolsson, Kammerlind, and Ledin, 2004; Treleaven, Jull, and Sterling, 2003), the participants were instructed to indicate any dizziness or
if they had complaints of dizziness and/or unsteadiness, which was more similar to the ratings of the present study. There is a possibility that the prevalence in the present study is over-rated because the results are based on a question that combines dizziness and unsteadiness.

Pain from different neck-structures may cause disturbed afferent input by altering muscle spindle sensitivity, central modulation of proprioceptive input and sensorimotor control (Kristjansson and Treleaven, 2009; Röijezon, Clark, and Treleaven, 2015). Neck-muscle fatigue and muscle tension may affect muscle spindles and Golgi tendon organs due to, for example, an accumulation of metabolites or reduced blood flow, thereby causing altered postural control (Stapley, Beretta, Toffola, and Schieppati, 2006; Taylor, Butler, and Gandevia, 2000). Hypomobility of the cervical segments may also alter proprioception by reduced discharge from the mechanoreceptors of the facet joints, although previous studies show ambiguous results on the correlation between reduced neck-mobility and dizziness (Malmstrom et al., 2007; Yahia et al., 2009). Neck pain, reduced neck-muscle endurance, and reduced neck-mobility are impairments seen in patients after ACDF (Hermansen, Cleland, Kammerlind, and Peolsson, 2014).

In the present study, pain was significantly correlated with dizziness but not with balance problem ratings. There was a medium size correlation between pain and dizziness ratings ($R_s 0.36$ and $R_s 0.38$). Although correlation coefficients do not provide an answer to which variable causes the other to change, it is theoretically reasonable to believe that neck pain would influence dizziness rather than the opposite. Dizziness was probably also affected by other factors that were not evaluated in this study (i.e. the degree of degenerative changes of neck-structures or inactivity and thereby low stimulation of the balance system). It is thought that the degenerative process of the cervical spine continues or even increases after surgery (Hilibrand et al., 1999; Matsumoto et al., 2010). Since dizziness is associated with more advanced radiographic degenerative changes (Machaly, Senna, and Sadek, 2011), such continued degenerative processes may also be a contributing factor to the high frequency of dizziness in the present sample 10–13 years after surgery.

The analyses in this study were based on self-reported ratings of dizziness or balance problems. However, participants were not screened for vestibular, visual, or other causes of dizziness or balance problems. Therefore, there is a possibility that some self-reported dizziness or balance problems may have been caused by disorders other than participants’ degenerative disease. However, based on rather low intensity ratings, primarily intermittent and non-rotatory dizziness, and that the informants indicated more strenuous activities as being related to dizziness, it is likely that the dizziness was mainly cervicogenic. Malmstrom et al. (2007) described workload, household work, neck-muscle tension, and head on trunk movements as common provoking factors in a group of subjects with suspected cervicogenic dizziness. Treleaven, Jull, and Sterling (2003) reported a combination of unsteadiness and non-rotatory dizziness in persons with WAD.

A possible bias of the study is that some of the drop-outs might have chosen not to return the questionnaire because they did not have any remaining symptoms. Five out of the 73 responders did not complete both ratings of dizziness and balance problem intensity, and frequency of unsteadiness/dizziness, and therefore could not be included in the present study. The construct of the frequency question, which included both unsteadiness and dizziness, is also a limitation due to an inability to separate frequencies of the two separate conditions of unsteadiness and dizziness. Another limitation was that only half of the participants with dizziness answered the open-ended question about their perception of dizziness.

**Conclusions**

Self-reported dizziness and balance problems in the long-term after surgery for cervical degenerative disc disease are common and have an impact on daily life. Ratings of problem frequency and intensity were usually low, with dizziness intensity moderately correlated to neck pain. Dizziness and balance problems may affect quality of life. Patients’ descriptions of these problems are in line with common symptoms of cervicogenic dizziness.

**Disclosure of interest**

The authors report no declarations of interest.

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