Retrospective Review

Response to Cervical Medial Branch Blocks In Patients with Cervicogenic Vertigo

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Background: Among the various causes of vertigo, the so-called cervicogenic vertigo (CV) has been the most controversial. However, perturbations of proprioceptive signals and abnormal activity of the cervical afferents can induce vertigo. Medial branch blocks (MBBs) are a diagnostic tool designed to test whether a patient's neck pain is mediated by one or more of the medial branches of the dorsal rami of the spinal nerve. It is unknown whether MBBs are also suitable for testing symptoms other than pain.

Objectives: The purpose of this study was to test whether MBBs of the cervical spine can be used as a diagnostic tool to identify patients with CV.

Study Design: A retrospective practice audit (clinical observation).

Setting: An interventional pain management and spine practice.

Methods: An electronic medical record system was used to identify patients in a single spine center. Included were consecutive patients with neck pain and vertigo, who had received cervical MBBs in a period from July 2001 to April 2016. The patients were tested with a MBB of about 1 mL of bupivacaine (0.25%) and 20 mg triamcinolone. Injections were performed with fluoroscopic visualization using established techniques in 2 or 3 levels on one or both sides. Vertigo was analyzed through the global clinical impression of the patient (i.e., "gone," "better," "the same," or "worse").

Results: One-hundred seventy-eight patients met the inclusion criteria. One-hundred eleven patients (62.4%) experienced a significant improvement of the vertigo. In 47 patients (26.4%), no information about the vertigo was available at follow-up; these patients were assumed to have no improvement (worst-case scenario). Hence, altogether 67 patients (37.6%) had a negative result. The median relief of the vertigo was 2 months. Differences in age, gender, level of treatment, or pain duration between patients with relief of the vertigo and without relief were not found. Nine patients with a whiplash injury in their medical history were also tested. They experienced a lower success rate and had longer duration of pain before the treatment; however, these differences are not statistically significant.

Limitations: It was the primary intention to treat neck pain; the assessment of vertigo was an additional aim. Therefore, the history taken and the clinical examination were not targeted specifically to vertigo. A placebo effect cannot be excluded. Further studies with the primary focus on CV are necessary to prove the significance of MBBs.

Conclusions: This is the first study to demonstrate that MBBs of the cervical spine can be a useful tool for the diagnosis of CV, because they temporarily block cervical afferents. In 63.4% of patients with neck pain and suspected CV, the vertigo was significantly improved. Further placebo-controlled studies with the primary intention on CV are necessary to prove the significance of MBBs.

Key words: Cervicogenic vertigo, medial branch block, facet joint, zygapophysial joint, neck pain, differential diagnosis

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Vertigo and dizziness are among the 20 most common causes of consultation in adult patients (1,2). In 80% of these cases, the symptoms are so intense they require medical intervention (1). Among the various causes of vertigo, the so-called cervicogenic vertigo (CV) has been the most controversial (1). However, there is clear experimental and clinical evidence that neck perturbations or purely proprioceptive signals can induce vertigo and imbalance (1,3-5). Different pathophysiological mechanisms have been attributed (1) and many definitions are given for CV, some of which require pain and others that do not (6). Furman and Cass (7) defined CV as a vague feeling of balance alteration and spatial orientation that is produced by an abnormal activity of the cervical afferents. It is not the result of a vestibular dysfunction. Yahia et al (8) defined CV as an association of the following features: chronic cervical pain, vertigo after cervical rotation without nystagmus, cervical osteoarthritis, and/or intervertebral disc degenerative changes. In view of the lack of clear criteria, it seems that the most reasonable approach is to consider the diagnosis after ruling out other possible sources of vertigo (1).

Nevertheless, 3 main categories of CV were differentiated: vascular, whiplash, and vertigo associated with cervical changes other than whiplash (3). Supporters of CV claim that its actual prevalence is underestimated due to the overestimation of other diagnostic categories in clinics (1). However, there is only limited data about the prevalence of CV. The study by Karlberg et al (9) showed that vertigo and subjective balance disturbances are common complaints in the patients with cervical root compression (10). Another study showed that vertigo was present in 50% of patients with cervical spondylosis (10-13), while cervical spondylosis was the cause of dizziness in 65% of elderly patients in another study (6). Following whiplash injury, 25–50% of neck traumatized patients experience vertigo (1,14).

The following symptoms typically occur in CV: pain and limited range of cervical movement, vertigo or dizziness, imbalance or unsteadiness, a motion sickness sensation, and ataxia of posture and gait (1,6,15,16). In general, the symptoms become more severe with cephalic movements, and they can be episodic and last from minutes to hours (1). Typically, the symptomatology does not usually include an illusory perception of rotational or linear movement, but rather fits the definition of imbalance, or more broadly, the definition of dizziness.

There is no diagnostic method or specific test to establish whether a patient's vertigo is caused by an underlying neck condition (1,17). Nevertheless, several diagnostic tests are often applied. They can be divided into ones that use blood flow, eye movements, postural sway, and subjective joint position as outcome variables. The vertebral artery test consists of determining whether the combination of head extension and rotation provokes dizziness. Côté et al (18) found that the vertebral artery test has little or no predictive value for vertebral artery blood flow. Other tests attempt to document eye movement associated with sustained neck rotation, such as the smooth pursuit neck torsion test or the cervical torsion test. L'Heureux-Lebeau et al (17) recently reported that more than 2 degrees per second nystagmus during the cervical torsion test was more common in patients with CV than patients with benign paroxysmal positional vertigo. Other tests measure the effect of head or neck movement on balance. Whereas postural stability testing is not diagnostic of CV due to its lack of specificity and vulnerability to cognitive factors, a normal posturography sway test might be helpful in reducing the likelihood of CV (3). Reduced cervical proprioception or joint position error might be a diagnostic sign of CV (17,19). Vestibular laboratory tests serve to exclude inner ear disorders as an alternative cause of vertigo. Imaging studies are useful to detect structural injury to the neck, which increases the probability of CV, but they do not establish cause. This leaves the clinician with a group of patients who might have CV, but without a way to prove or disprove the diagnosis (3).

The treatment for CV usually consists of different types of physical therapy. However, the data in the literature regarding the treatment are limited (1). Manual physical therapy (1) or vestibular rehabilitation associated with manual therapy (7) may be useful. Sometimes exercises on visual stability (cervico-ocular reflex exercises) are recommended (20,21). Another physical therapy treatment is passive joint mobilization (sustained natural apophyseal glides) (20). Short-term benzodiazepines or antidepressants may improve emotional symptoms (1). Some studies report excellent outcomes after cervical spine surgery (5,22,23). However, it remains unreasonable to perform cervical spine surgery for CV lacking other indications for surgery.

Medial branch blocks (MBBs) are a diagnostic tool designed to test whether a patient's pain is mediated by one or more of the medial branches of the dorsal rami of the spinal nerve. The prevalence of cervical

facet joint involvement in chronic neck pain is between 36% and 67% (24-29). Cervical facet joint pain can radiate to the head, neck, and shoulders (24,25). This is the result of repetitive stress, leading to inflammation and stretching of the joint capsule (24,30). Free nerve endings can be found in the joints; therefore, the facet joints are a possible pain source (24,25). The joints are innervated by the medial branches of the dorsal rami (Fig. 1) (31). The gold standard for the diagnosis of facet joint pain is MBBs (32). The target nerve is anesthetized with a small volume of local anesthetic. If the pain is not relieved after a MBB, the target nerve cannot be regarded as mediating the pain, which means the facet joint is not the pain source. To reduce the possibility of responses being false-positives, controlled blocks are mandatory (32,33). If the response is positive, the pain source is identified and a good chance of obtaining pain relief after radiofrequency neurotomy is predicted (32,34,35). The rationale of cervical medial branch thermal radiofrequency neurotomy is to achieve pain relief by coagulating the medial branch, which conducts the pain, and, thereby, interrupting the nociceptive pathways (35).

To establish whether a patient's vertigo is caused by an underlying neck condition is difficult because no specific test exists. The purpose of this study was to test whether MBBs of the cervical spine can be used as a diagnostic tool to identify patients with CV. MBBs are a diagnostic tool used to find a pain source, however it is unknown whether MBBs are also suitable for testing symptoms other than pain. If the diagnosis is proven by controlled blocks, radiofrequency neurotomy is a rational and evidence-based therapy option (32,36).

Methods

This study was designed as a retrospective practice audit. An electronic medical record system was used to identify patients in a single spine center. The therapeutic interventions were performed in a single ambulatory spine center.

All consecutive patients presenting with vertigo, who had received cervical MBBs between July 2001 and April 2016, were included. Neck pain of appropriate quality was the
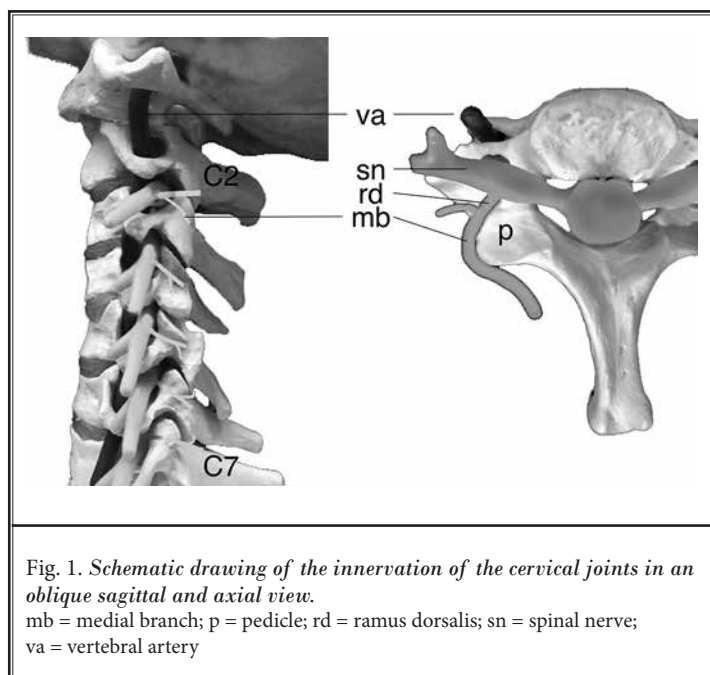

Fig. 1. *Schematic drawing of the innervation of the cervical joints in an oblique sagittal and axial view.*
mb = medial branch; p = pedicle; rd = ramus dorsalis; sn = spinal nerve; va = vertebral artery

primary indication for treatment. The vertigo was an additional complaint of the patient. Any patients with oncologic diseases or infections of the spine were excluded.

The patients were treated for facet joint pain and vertigo with a MBB of about 1 mL of bupivacaine (0.25%) and 20 mg triamcinolone. Injections were performed with fluoroscopic visualization using established techniques (32). A lateral view of the spine was obtained. The target point was the centroid of the articular pillar with the same segmental number as the target nerve. The needle was placed straight along the x-ray beam to the medial branch (Fig. 2). The target joints were identified by the pain pattern (pain maps) (37), local tenderness over the area, and provocation of pain with deep pressure. The MBBs were performed on the symptomatic side. Patients with bilateral pain were tested on both sides. A minimum of 2 medial branches (for one symptomatic joint) was tested at one time.

For every patient, the first follow-up examination was between one and 4 weeks after the intervention. Further examinations were arranged according to the needs of the patients. Each time, a physician interview and clinical examination was used to capture information. Vertigo was analyzed through the global clinical impression of the patient. At every follow-up examination, the patient was asked about the vertigo. Modified Macnab outcome criteria were used (1 = gone, 2 = better, 3 = the same, and 4 = worse) (38). Ratings of one and 2 were considered to be positive outcomes, and ratings of 3 and 4 were considered to be negative outcomes. In patients with a positive outcome, another block was possible.

Fig. 2. *Lateral fluoroscopic view with the needle in position for a C5 MBB*

A statistical analysis was performed. Chi-square tests were used to compare patients with favorable response to treatment and patients with negative response to treatment, as well as to investigate subgroups of patients. Welch's t-test and Mann-Whitney U Test were used to test the hypothesis that 2 populations had equal means or medians, respectively. $P < 0.05$ was set as the threshold to interpret the results as significant.

RESULTS

Between July 2001 and April 2016, 178 consecutive patients with vertigo met the inclusion criteria. The data of the patients are shown in Table 1. One-hundred five patients (59.0%) were women and 73 (41.0%) were men. The mean age was 51.8 ± 13.1 years (between 21 and 78 years). One-hundred twenty-one patients (68.0%) received one treatment, 32 patients (18.0 %) received 2 treatments, and 25 patients (14.0%) received more than 3 treatments. The medial branches of the upper cervical spine (C2 to C4) were blocked in 115 patients (64.6%). The level C2/3 was included in 37 patients (20.8%). Most patients were treated on both sides (142 patients, 79.8%). Twenty patients (11.2%) only received treatment on the left side and 15 patients only on the right side (8.4%). All patients had a history of neck pain and vertigo between several days and years (median 4.0 months, interquartile range = 10.0 [12.0–2.0]). Furthermore, 9 patients (5.1%) reported a whiplash injury in their medical history.

Table 1. *Patient data comparing positive results with negative results after MBB.*

	All Patients	Positive Result	Negative Result	Significance
n	178	111 (62.4%)	67 (37,6%)	
Age (mean)	51.8 ± 13.1 yrs	53.1 ± 13.2 yrs	49.5 ± 12.6 yrs	**$P < 0.05$** $\|t\| = 1.66, (\alpha1 = 0.05)$ $t(145) = 1.65$
Female	105 (59.0%)	61 (55.0%)	44 (65.7%)	$P = 0.16$
Single treatment	121 (68.0%)	59 (53.2%)	62 (92.5%)	**$P < 0.0001$**
Upper spine C4 or higher	115 (64.6%)	74 (66.7%)	41 (61.2%)	$P = 0.46$
Including C2/3	37 (20.8%)	26 (23.4%)	11 (16.4%)	$P = 0.26$
Both sides	142 (79.8%)	93 (83.8%)	49 (73.1%)	$P = 0.09$
Pain duration (median) IQR = Q3 – Q1	4.0 months 10.0 = 12.0 – 2.0	4.0 months 10.0 = 12.0 – 2.0	4.0 months 10.3 = 12.0 – 1.7	$P > 0.05$ (z = 0.31)
Whiplash	9 (5.1%)	4 (3.6%)	5 (7.5%)	$P = 0.25$
Duration of relief (median) IQR = Q3 – Q1	2.0 mos 3.0 = 4.0 – 1.0	2.0 mos 3.0 = 4.0 – 1.0		

IQR: interquartile range.

All patients were invited to a follow-up examination after the intervention. However, for 47 patients (26.4%), no information about the vertigo was available at the follow-up examination. One-hundred eleven patients (62.4%) experienced a significant improvement of the vertigo, while 20 patients (11.2%) reported no improvement. Because of the high number of patients without follow-up, these patients were assumed to have no improvement (worst-case scenario). Therefore, 67 patients (37.6%) were deemed as having a negative result (Table 1). The median duration of relief of the vertigo was 2.0 months, IQR = 3.0 (4.0–1.0). The successfully treated patients were slightly older (53.1 ± 13.2 years vs. 49.5 ± 12.6 years, $P < 0.05$, $|t| = 1.66$, $[\alpha1 = 0.05]t[145] = 1.65$). In unsuccessful treatments, a MBB was not repeated; therefore significantly more patients with a negative result had only one block (92.5% vs. 53.2%, P < 0.0001, Table 1). If the MBB was performed bilaterally, the success rate was higher compared with a treatment on only one painful side (84.5% vs. 73.1%), however, this difference is not significant ($P = 0.06$).

Because chronification of symptoms (pain and vertigo) might be an important aspect, patients with vertigo for less than one month were compared with patients with a longer duration of vertigo (Table 2). No difference in the success rate was found. However, this success rate was achieved with significantly less injections in patients with a short duration of vertigo (90.3% of patients with one treatment vs. 63.3%, $P = 0.003$).

Whiplash injury is a separate category of CV. There was a lower success rate (44.4% success vs. 63.3%, $P = 0.25$) in patients after whiplash injury and a longer pain duration (15.0 months vs. 4.0 months, $P > 0.05$, z = 1.79), however, these differences are not statistically significant. Also, in all other characteristics (age, gender, level, pain duration, or pain relief) no significant difference was found (Table 3).

Discussion

Furman and Cass (7) defined CV as a vague feeling of balance alteration and spatial orientation that is produced by an abnormal activity of the cervical afferents. MBBs can stop the afferents from the facet joints by anesthetizing the supplying nerve. The purpose of this study was to determine how far blocking of the medial branches of selected facet joints influences the vertigo symptomatology of patients presenting with neck pain and vertigo. A positive correlation would be significant, because a denervation of the medial branch with radiofrequency is possible. Under the condition of a worst-case scenario in this study, 62.4% of the patients experienced a significant improvement of the vertigo after MBBs. Therefore, MBBs are not only useful for the diagnosis of facet joint pain but also for the diagnosis of CV.

Table 2. *Patient data comparing patients with a short duration of vertigo with patients with vertigo for more than one month duration before treatment.*

	All Patients	Vertigo duration ≤ 1 month	Vertigo duration > 1 month	Significance
n	178	31 (17.4%)	147 (82.6 %)	
Age (mean)	51.8 ± 13.1 yrs	48.5 ± 12.3 yrs	52.5 ± 13.2 yrs	$P > 0.05$ $|t| = 1.63$, $(\alpha1 = 0.05)t(46) = 1.68$
Female	105 (59.0%)	21 (67.7%)	84 (57.1)	$P = 0.28$
Single treatment	121 (68.0%)	28 (90.3%)	93 (63.3)	**$P = 0.003$**
Upper spine C4 or higher	115 (64.6%)	18 (58.1%)	97 (66.0%)	$P = 0.40$
Including C2/3	37 (20.8%)	7 (22.6%)	30 (20.4%)	$P = 0.79$
Both sides	142 (79.8%)	21 (67.7%)	121 (82.3%)	$P = 0.07$
Pain duration (median) IQR = Q3 – Q1	4.0 months 10.0 = 12.0 – 2.0	0.8 months 0.3 = 0.8 – 0.5	6.0 months 15.0 = 18.0 – 3.0	$P < 0.05$ (z = 8.6)
Whiplash	9 (5,1%)	1 (3.2 %)	8 (5.4%)	$P = 0.61$
Success rate	111 (62.4%)	19 (61.3%)	92 (62.6%)	$P = 0.89$
Duration of relief (median) IQR = Q3 – Q1	2.0 months 3.0 = 4.0 – 1.0	2.0 months 2.1 = 2.8 – 0.6	2.3 months 3.0 = 4.0 – 1.0	$P > 0.05$ (z = 1.70)

IQR: interquartile range.

Table 3. *Patient data comparing patients with and without whiplash injury in medical history.*

	All Patients	**Whiplash**	**No Whiplash**	**Significance**
n	178	9 (5.1%)	169 (94.9%)	
Age (mean)	51.8 ± 13.1 yrs	49.6 ± 14.3 yrs	51.9 ± 13.0 yrs	$P > 0.05$ $\|t\| = 0.47$, $(\alpha1 = 0.05)t(9) = 1.83)$
Female	105 (59.0%)	7 (77.8%)	98 (58.0%)	$P = 0.24$
Single treatment	121 (68.0%)	6 (66.7%)	115 (68.0%)	$P = 0.93$
Upper spine C4 or higher	115 (64.6%)	8 (88.9%)	107 (63.3%)	$P = 0.12$
Including C2/3	37 (20.8%)	2 (22.2%)	35 (20.7%)	$P = 0.91$
Both sides	142 (79.8%)	8 (88.9%)	134 (79.3%)	$P = 0.48$
Pain duration (median) IQR = Q3 – Q1	4.0 mohs 10.0 = 12.0 – 2.0	15.0 mos 22.8 = 27.0 – 4.3	4.0 mos 10.3 = 12.0 – 1.8	$P > 0.05$ (z = 1.79)
Success rate	111 (62.4%)	4 (44.4%)	107 (63.3%)	$P = 0.25$
Duration of relief (median) IQR = Q3 – Q1	2.0 mos 3.0 = 4.0 – 1.0	5.0 mos 4.9 = 8.0 – 3.1	2.0 mos 3.0 = 4.0 – 1.0	$P > 0.05$ (z = 0.89)

IQR: interquartile range.

There are neither epidemiological data nor population-based studies for CV (1). Only a preponderance of women with neck pain or with vertigo is reported (39). In this study, 59% of the patients were women. Except for these population data it is difficult to compare the results of this study with the literature, because no study about the importance of MBBs for the diagnosis of CV exists. The principles, validity, and utility of MBBs for pain are well-examined (32), but connections to vertigo and MBBs as a diagnostic tool for CV are not described in the literature. There is an agreement in the literature that no specific test for the diagnosis of CV is known (1). However, similar symptoms compared to CV (6) can be provoked by deafferentiation of C1 to C3 in monkeys and by local anesthesia of posterolateral neck tissue in humans (4) or the C2 nerve (40). In these patients, posturographic tests, subjective visual vertical determinations, or eye movement recordings were normal (40). The cervico-ocular reflex has been well-documented in humans. (41,42). Blocking cervical afferents (4), passively rotating the arm in the dark (43), and neck vibration (1) can induce nystagmus.

Around 1955, Ryan and Cope (44) suggested that the origin of CV stemmed from the existence of abnormal sensory information coming from the damaged joint receptors of the upper cervical regions. To maintain balance and generate appropriate motor responses for equilibrium, redundant inputs from the eyes, the ear, and proprioception from the cervical spine are combined (1). Cervical proprioceptive receptors are situated in the upper part of the cervical spine, particularly in the posterior joint capsules and the perivertebral muscles (6,10,16,45). The cervical joints are the most densely innervated of all the spinal joints (20). These receptors can transmit erroneous proprioceptive information in case of mechanical stimulation because of degenerative changes and abnormal motion. Inflammation can generate amplified responses (46) because the mechanoreceptors can become more sensitive to mechanical stimuli (47,48). This will lead to a sensory mismatch between vestibular and cervical inputs which will result in CV.

The medial branches of the dorsal rami, arising from the spinal nerve, supply 2 adjacent facet joints and also the multifidus muscle, the interspinous muscle, and ligament (32, 49). The MBBs we performed in this study, therefore, anesthetized the afferents from the mechanoreceptors of the facet joints and from the muscle spindles. Amplified or altered responses because of inflammation or degenerative mechanical stimulation are not transmitted anymore. Therefore, MBBs are suitable as a specific test for CV. This study demonstrates the feasibility in a daily clinical practice.

Several studies, both in animals and humans, have suggested that proprioceptive information relayed in the upper 3 cervical dorsal roots is important for postural control and balance function (4,10,50-52). However, in this study, the levels were chosen by localization of the neck pain. The upper cervical levels were not favored for MBBs. Also, a subgroup including C2/3 was assessed

because of the anatomical peculiarities (third occipital nerve, connections to the nucleus cochlearis). The result for the upper cervical spine and the lower cervical spine did not show significant differences in this study.

It is imaginable that inflammatory processes are located only at the joints of one side if the patient has pain only on one side. Therefore, in this study, MBBs were performed bilaterally or single-sided. The responses are better after bilateral treatment. Because the difference is not significant, it is difficult to give the recommendation to always treat both sides.

Whiplash-associated vertigo is often regarded as a separate subgroup of CV. The explanation for the formation of vertigo in these patients is again a modification of the proprioceptive cervical balance because of limitation of movement and strains of the joint capsule and the paravertebral ligaments (1,3,53). The results of the MBBs in our study are comparable in patients with and without whiplash. This is in accordance with the presumption of a similar pathomechanism in both patient groups.

This study shows the feasibility of testing the diagnosis of CV with MBBs in a large patient collective. MBBs are a specific diagnostic tool, because afferents from the joints and the muscles are blocked. However, some limitations exist. The primary intention was to treat neck pain, and the assessment of vertigo was an additional aim. Therefore, the history taken and the clinical examination were not targeted specifically to vertigo. A placebo effect cannot be excluded. Further studies with the primary focus on CV are necessary to prove the significance of MBBs. A combination of diagnostic tools testing different entities of vertigo and MBBs will be necessary in further studies. It would be great to define end-points before and after the MBB to measure the changes in vertigo (comparable to visual analog scale). Blinded, placebo-controlled studies using saline could exclude a placebo effect. If MBBs are a useful diagnostic test for CV, a treatment study with radiofrequency neurotomy of the medial branches would be the rational consequence. So far, the authors have some promising short-term results with individual cases after radiofrequency neurotomy for CV.

Conclusion

MBBs are a rational diagnostic tool to temporarily block cervical afferents from the facet joints and the muscles and, therefore, to test whether the symptoms of a patient are mediated by the medial branches. For neck pain, MBBs are a standard diagnostic tool. However, this is the first study to demonstrate that MBBs can also be useful for the diagnosis of CV. In 63.4% of patients with neck pain and suspected CV, the vertigo was significantly improved. Further studies, ideally placebo-controlled, with the primary intention on CV are necessary to prove the significance of MBBs. If MBBs are a useful diagnostic test for CV, a treatment study with radiofrequency neurotomy would be the rational consequence.

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