

Synopsis

Tinnitus or 'ringing in the ears' is a very common disorder that often causes distress and decreases the patient's quality of life. The ability to do intellectual work can be affected and sleeping difficulties are frequently reported. Various types and causes of tinnitus have been described. One specific type, somatic tinnitus, is of particular interest for physical therapists. In patients with somatic tinnitus, the intensity and the character of the tinnitus are altered, for instance by forceful muscle contractions of the neck or jaw muscles. Physiologically this phenomenon is explained by the presence of connections between the somatosensory system of the cervical spine and temporomandibular area on the one hand and the central auditory system on the other hand. It is however still unclear whether or not altered somatosensory information can actually cause tinnitus and no information is available on the altered cervical somatosensory afference. As such, the need for thorough cervical spine assessment rises, as well as the need for prognostic factors that can predict the effect of cervical physical therapy in patients with somatic tinnitus.

This thesis focuses on cervical spine related somatic tinnitus (cervicogenic somatic tinnitus CST), assessing several cervical functions and investigating the effect of a standardized cervical physical therapy treatment program on tinnitus complaints.

In the **first part** of this thesis the assessment of cervical sensorimotor control (cSMC) is highlighted. This cSMC might be affected in patients with CST, as cSMC includes the cervical somatosensory information that is thought to alter the tinnitus in patients with CST.

In order to assess cSMC in patients with CST, a reliable and valid measuring method was needed. The review in chapter 1 pointed out two methods (head repositioning accuracy to the neutral head position and The Fly™) as sufficiently reliable and valid, but important limitations were found for both. Therefore, we used a third method, the continuous linear movement test (CLMT), which had proven to have good discriminant and content validity, but needed further investigation of its reliability.

The reliability study of the CLMT (chapter 2) showed negligible to excellent test-retest reliability results, depending on the used outcome measure. Of all outcome measures, those recorded during rotation movements proved to be more reliable than during flexion-extension and lateral flexion. This consequently makes rotation the preferred movement for CLMT assessment.

In the **second part** of this thesis, we firstly used the CLMT and a set of clinical cervical spine tests to investigate cervical spine functions in patients with CST. Secondly, we wanted to identify prognostic indicators for cervical physical therapy treatment success in patients with CST.

Cervical spine complaints appeared to be very common in patients with CST as well as in patients with other types of tinnitus. Hence, cervical spine assessment is essential in the investigation of tinnitus patients. In addition to the diagnostic criteria for CST, that are mainly based on anamnestic features, the neck Bournemouth questionnaire (NBQ) can be used as a first indicator for CST. This questionnaire is especially useful to exclude CST in case of a score < 14 points. The absence of trigger points can confirm the exclusion of CST. A positive manual rotation and/or adapted Spurling test, on the other hand can be used to include CST.

Regarding cSMC, significant differences were found between patients with CST and asymptomatic control subjects. Using the CLMT, we found that patients with CST needed significantly more time to perform one movement cycle (e.g. left to right rotation). We also noted smaller range of motion figures

in the patient group, although these differences were not statistically significant. Finally, patients with CST showed significantly jerkier movements during rotation compared to the asymptomatic subjects.

These findings showed us the presence of several cervical spine dysfunctions in patients with CST and the usefulness of clinical cervical spine tests in diagnosing CST, but could not explain why some patients benefit from cervical spine treatment and others don't. Therefore, we searched for prognostic indicators for treatment success using a randomized controlled trial (RCT).

This RCT investigated the effect of a standardized cervical physical therapy treatment on tinnitus and neck related parameters in patients with suspected CST, recruited in a tertiary referral center. Immediately after treatment 53% of the patients experienced a substantial improvement of their tinnitus and all patients indicated a substantial improvement of their neck complaints. Further investigation of the baseline characteristics of the patients that experienced tinnitus improvement after cervical physical therapy, identified 3 prognostic indicators. Generally, patients with low-pitched tinnitus, covarying with neck complaints and increasing during inadequate cervical spine postures are most likely to benefit from cervical physical therapy.

Given the results of this thesis, the evaluation and treatment of CST should be a regular feature in the management of every patient suffering from tinnitus. Physical therapists can have a supportive role in the diagnostic process of CST given their specific skills in the clinical evaluation and treatment of cervical spine dysfunctions. Consequently, physical therapists can contribute to a multidisciplinary treatment of CST.