

Clinical Evaluation of Tinnitus: a Review

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Tinnitus is a common symptom occurring in 10–15% of the general population. Different methods for the assessment of tinnitus, such as clinical gradings, psychoacoustical measurements and questionnaires are described, but also objective methods, e.g. imaging and brain functions. Judging from the literature and personal research, the relationships between the severity of tinnitus and psychological factors such as depression and poor concentration seem to more clearly demonstrated than those derived by psychoacoustical measurements. There is a demand for robust measurements of tinnitus, but there is no consensus in the grading of its severity. Our suggestion is to assess tinnitus suffering in adults (18–65 years) by its impact on working capacity. In the evaluation of tinnitus a tinnitus-specific questionnaire is useful, as well as a non-diagnosis-specific health questionnaire. The Tinnitus Severity Questionnaire (TSQ) and Nottingham Health Profile (NHP) are suggested. In the evaluation of rehabilitation program effects, visual analogue scales appear to be valuable. The association of psychological/psychiatric factors with the suffering of tinnitus must be taken into account early in the clinical assessment of tinnitus. *Key words: assessments, evaluation, tinnitus.*

GENERAL DEFINITIONS OF TINNITUS

Tinnitus is generally classified as either objective or subjective. Objective tinnitus is an acoustic sound produced within the body and is measurable and may even be audible to other people. Objective tinnitus may be described as the acoustical source creating the sound, such as muscular fasciculation or bruit in an abnormal vessel (Holgers, 1999). Subjective tinnitus is only perceived by the sufferer and the etiology of the symptom is not the same as for measurable sounds. Consequently, the management of subjective tinnitus differs from that of objective tinnitus and so do the problems facing the patients who have subjective compared to objective symptoms. Consequently, tinnitus may be defined as a sound sensation in the absence of an external or an internal acoustical source or electrical stimulation, and can be described as genuine tinnitus (Holgers, 1999).

EPIDEMIOLOGY

Tinnitus occurs in 10–15% of the general population and in 2% causes a significant impairment of daily life (Axelsson and Ringdahl, 1989; Davis, 1995). The majority of tinnitus patients have hearing loss (Coles et al., 1981; Axelsson and Ringdahl, 1989; Davis, 1989; Holgers and Barrenäs, 1996). Men seek help more often, at a younger age, and with greater hearing impairment than women, but in women tinnitus has often a more complex characterization and is at a lower pitch than in

men (Meric et al., 1998; Meikle and Griest, 1989; Holgers et al., 2000).

Imaging and brain function (ABR, PET, NMR)

Objective methods have been employed to investigate tinnitus. These include: auditory brainstem responses (ABR) (Shulman et al., 1984; Maurizi et al., 1985; Barnea et al., 1990; Ikner et al., 1990; Attias et al., 1993; Lemaire et al., 1995; Rosenhall et al., 1995), auditory evoked magnetic field (Hoke et al., 1989; Pantev et al., 1989; Hoke et al., 1990; Jacobson et al., 1991) and positron emission tomography (Arnold et al., 1996; Lockwood et al., 1998; Mirz et al., 1999). Increased blood flow in limbic and auditory cortical structures while selectively inducing tinnitus by oro-facial movements has been demonstrated by using PET (Mirz et al., 1999). Unfortunately, none of these methods has yet proven useful in assessing the severity of tinnitus.

Compression of the the intracranial portion of the cochlear nerve has been suggested as a cause of severe tinnitus. In patients with severe tinnitus, a prolonged interpeak latency of peaks I–III: 0.2 ms or more, or a prolonged interpeak latency III–V: 0.2 msec or more, have been used as inclusion criteria for microvascular decompression surgery of the cochlear nerve performed in Pittsburg, USA (Moller et al., 1993; Vasama et al., 1998). However, there is a high incidence of asymptomatic individuals who have compression of the nerve

without tinnitus (Vasama et al., 1998) so this treatment should be used very carefully.

Clinical management of tinnitus

There is a demand for robust measurements of tinnitus severity, but there is no consensus in the methods for grading the suffering. In the clinical management of tinnitus patients, it is essential to have reliable tools for the examination of the symptomatology of the tinnitus, the identification of its predictors and assessment of risk as well as to evaluate the efficacy of various therapeutic measures. The severity of tinnitus can be variously described by: how often it occurs, how intrusive it is, the limitations it imposes on activities of daily life and work, its effects on psychological health, and effects on general health and life quality. Due to the lack of objective measurements and the multi-dimensional character of tinnitus it is important to use instruments which can probe a wide range of related symptoms, including concentration, sleeping problems, hearing difficulties, anxiety, depression disorders and different psychosomatic problems.

Tinnitus is often assessed psychometrically, psycho-acoustically and/or by clinical gradings. Patients may be asked to describe verbally the "sound qualities" and spatial localization of their tinnitus perceptions; however, this has unspecific diagnostic utility because the subjective qualities of tinnitus sounds (e.g. ringing, buzzing, whistling, and pulsating), do not correspond to distinct etiologies (Alberti, 1987).

Clinical gradings

Judgments of tinnitus severity can be made using clinical gradings based on scales of symptoms. Klockhoff introduced a three-stage grading system: not always present, always present, always present and always disturbing (Klockhoff, 1967).

Based on epidemiological data from the MRC Institute of Hearing Research, Coles categorised tinnitus annoyance as: none, slight, moderate, severe. He also categorised the degree of effect on life: none, slight, moderate, severe (Coles et al., 1981). Some authors have categorized tinnitus by the presence or absence of helpseeking (Yes/No) (Hallberg et al., 1993; Attias et al., 1995). Another rather robust measure is the effect on the patient's capacity for work (Holgers et al., 2000). This system has four categories (0%, 25%, 50% or 100% sickleave).

Psycho-acoustic measurements

The utility of psycho-acoustic measurements to assess objectively the severity of tinnitus is questionable,

because they are not strongly related to subjective discomfort (Table 1).

However, many patients feel that these tests are valuable for psychological reasons as they sometimes make it easier to describe their suffering to others. Psycho-acoustic measurements include the matching of tinnitus pitch, quality, loudness and masking levels (Hinchcliffe et al., 1983; Tyler et al., 1983; Coles et al., 1984; Tyler et al., 1984; Penner et al., 1987).

The most common features of tinnitus are "tonal" and high-pitched sound qualities, as well as a bilateral perception of its "origin" (Meikle et al., 1984; Stouffer and Tyler, 1990). In patients with noise induced hearing loss, the pitch of tinnitus is often high (Axelsson and Sandh, 1985). The perceived loudness of tinnitus often appears to be close to the hearing threshold at the poorest audiometric frequency and the difference between the tinnitus audiometric level and the threshold of hearing is approximately 5 dBHL (Mann, 1981; Axelsson and Sandh, 1985).

One measure of the intrusiveness of tinnitus is its "maskability" – the level of external sound required to obscure the perception of the tinnitus. Both narrow and broad band noises have been used (Feldmann et al., 1971; Shailer et al., 1981; Penner et al., 1987; Tyler et al., 1987; Smith et al., 1991). The effectiveness of masking does not appear to be dependent on which ear is exposed to the masking noise (Tyler et al., 1987). This suggests that the awareness of tinnitus originates in predominantly central cortical structures.

Questionnaires

Many different questionnaires have been developed for investigation of the symptoms of tinnitus (Gerber et al., 1985/86; Hallam et al., 1985; Collet et al., 1990; Kuk et al., 1990; Baskill et al., 1991; Coles et al., 1991; Halford, 1991; Wilson et al., 1991; Erlandsson et al., 1992; Hallberg et al., 1993; Newman et al., 1994; Attias et al., 1995; Goebel et al., 1998; Newman et al., 1998).

These questionnaires fall into two main categories: non-diagnosis-specific and tinnitus-specific.

These are used as both self-report surveys and as structured clinical interviews. Depending on the aspects of tinnitus which are the focus of the questionnaire, on intervention or rehabilitation, different questionnaires may be more or less appropriate. The dimensions of the questionnaires vary and are presented in Table 1.

When selecting a questionnaire it is also very important to evaluate the integrity of each instrument. Common statistical tests can assess test-retest reliability (e.g. Cohen's kappa), internal consistency (Cronbach's *a*), and validity (e.g. correlations with other measurements) (Cronbach 1951). Examples of this type of evaluation,

Table 1. Correlations between the instruments/measurements and psychoacoustically, psychological measurements and aspects of general health are presented. Tinnitus Severity Questionnaire (TSQ), Tinnitus Handicap Inventory (THI), Tinnitus Handicap Questionnaire (THQ), Tinnitus Reaction Questionnaire (TRQ), Subjective Tinnitus Severity Scale (STSS), Help-seeking (H), Non Help-seeking (NH), Absence from Work (AWT), Nottingham Health Profile (NHP), Beck Depression Inventory (BDI), Minnesota Multiphasic Personality Inventory (MMPI), Body Mass Index (BMI), Pure Tone Average (PTA), Symptom Rating Scale List (SRSL).

| Instruments or clinical gradings | Correlation to Audiometry | Correlation to Psychology | Correlation to General Health |
|--|---|--|---|
| TSQ Coles et al., 1991, Baskill et al., 1991, Erlandsson et al., 1992, Holgers & Barrenäs, 1996, Erlandsson and Holgers, 1999 | TSQ vs hearing parameters ns TSQ vs PTA 3; 4; 6 kHz moderate | TSQ vs perceived attitudes (THSS) low TSQ vs disability/handicap (THSS) moderate TSQ vs emotional disturbances (NHP) high | Frequent headache low dizziness/vertigo low oversensitivity to sounds low TSQ vs pain and sleep/NHP moderate |
| THI Newman et al., 1994, 1995, 1998 | THI vs pitch and loudness low | THI vs BDI weak vs SRSL high | THI vs MSPQ weak THQ vs general health moderate |
| THQ Kuk et al., 1990, Newman et al., 1994, 1995, 1998, Meric et al., 1998 loudness match – ns mean heavy thresholds – moderate | THQ vs loudness match ns PTA ns – moderate | THQ vs MMPI low vs perceived loudness moderate vs depression moderate vs life satisfaction moderate | THQ vs general health moderate |
| TRQ Meric et al., 1998, Wilson et al., 1991 | | TRQ vs MMPI low | |
| STSS and clinical ratings (1–3) Halford et al., 1990 | STSS vs loudness match at 1 kHz moderate | Clinical ratings vs STSS high | |
| THSS Erlandsson et al., 1992 | | | |
| Helpseeking (H) Non Helpseeking (NH) Attias et al., 1995, Hallberg and Erlandsson, 1993 | Pure tone thresholds lower in H than NH | More concentration difficulties, irritability and psychiatric symptomatology in the H group | |
| AWT ± Holgers et al., 2000 | AWT vs hearing thresholds moderate speech recognition test ns | ANT vs emotional reactions, social isolation (NHP) high | NHP; physical immobility, sleep, pain Energy (NHP) moderate – high BMT; physical exercise |

applied to some well-known instruments, are presented in Table 2.

Another type is the open-ended questionnaire (Tyler and Baker, 1983; Sanchez and Stephens, 1997). Patients were asked to list problems associated with tinnitus and five main problems emerged: psychological, hearing, health, sleep and situational difficulties (Sanchez and Stephens, 1997).

Visual analog scales (VAS) are also often used, where supporting sentences are given at both ends of 100 mm scales. The sentences may be presented as: “My tinnitus does not annoy me at all” to “My tinnitus is unbearable” or “I can’t hear tinnitus at all” to “My tinnitus is

extremely loud”, which all focus on tinnitus annoyance and loudness. From our experiences, VAS seems to be a useful tool in the measurement of the outcome of rehabilitation programs ((Holgers, 1999).

The importance of different measurements of tinnitus

While a common feature of these reports is that the perceived severity of tinnitus does not bear a strong relationship to psycho-acoustically measured tinnitus and hearing thresholds, there are some reports of a moderate association between the severity of tinnitus and audio-

Table 2. Examples of instruments and measurements, number of items, levels and dimension. Tinnitus Severity Questionnaire (TSQ), Tinnitus Handicap Inventory (THI), Tinnitus Handicap Questionnaire (THQ), Tinnitus Reaction Questionnaire (TRQ), Subjective Tinnitus Severity Scale (STSS), Help-seeking (H), Non Help-seeking (NH), Absence from Work (AWT), Tinnitus Handicap and Support Scale (THSS), Nottingham Health Profile (NHP), Beck Depression Inventory (BDI), Minnesota Multiphasic Personality Inventory (MMPI), Modified Somatic Perception Questionnaire (MSPQ), Personal Loudness Units (PLU).

| Instruments and/or clinical measurements | Number of items and levels | Reliability/ consistency | Dimensions |
|---|----------------------------|---|---|
| TSQ Coles et al., 1991, Baskill et al., 1991, Erlandsson et al., 1992, Holgers & Barrenäs, 1996, Erlandsson and Holgers, 2000 | 10 items 5 levels | Test-retest 0,62 – 0,72 High internal consistency | I general tinnitus severity II life quality III psychological aspects |
| THI Newman et al., 1994, 1996, 1998 | 25 items 3 levels | Cronbach $\alpha = 0,93$ THI vs THQ $r = 0,78$ | I functional II emotional III catastrophic |
| THQ Kuk et al., 1990, Newman et al., 1994, 1996, 1998, Meric et al., 1998 | 27 items scale of 0–100 | Cronbach $\alpha = 0,94$ THI vs THQ $r = 0,78$ Test – retest $r = 0,89$ | I effects of tinnitus on social emotional and physical behaviours II hearing ability III patient's view of tinnitus |
| TRQ Meric et al., 1998, Wilson et al., 1991 | 26 items 5 levels | Test – retest 0,88 Cronbach $\alpha = 0,96$ | I general distress II interference with work and leisure activities III severe signs of distress IV avoidance of activities |
| STSS and clinical ratings (1–3) Halford et al., 1990 | 16 items 2 levels | Clinical validity vs STSS $r = 0,73$ $r = 0,76$ | I distress intrusion II cognitive focus III irritant IV constancy focus V distraction |
| THSS Erlandsson et al., 1992 | 28 items 5 levels | | I perceived attitudes II social support ns III disability handicap – 0,66 |
| TQ Hallam RS, 1996, Goebel and Hiller, 1998 | 40 items 3 levels | Test – retest 0,94 Cronbach $\alpha = 0,94$ | I emotional and cognitive distress, II intrusiveness, III hearing difficulties, IV sleep disturbances V somatic complaints. |
| Helpseeking (H) Non Helpseeking (NH) Attias et al., 1995, Hallberg and Erlandsson, 1993 | 2 levels | | Helpseeking/non helpseeking related to tinnitus |
| AWT ± Holgers et al., 1999 | 2 levels | | Sick leave related to tinnitus |

metric parameters such as pure tone averages and tinnitus loudness match.

Closer relationships are found between the severity of tinnitus and psychological factors such as depression, poor concentration, and irritability. Seventy-five percent of consecutive tinnitus patients seeking help at our

department of audiology were diagnosed with depressive or anxiety disorders according to the criteria of the Diagnostical Manual of Mental Disorders (DSM-III-R) (Zöger et al., 2001). Other important etiologic factors influencing tinnitus severity are poor general health, poor sleep and pain. The suffering of tinnitus is also associated

with frequent headaches, dizziness and an oversensitivity to sound (Table 1).

SUMMARY AND CONCLUSION

It is very important to have reliable tools to assess the severity of tinnitus in patients who are included in the clinical studies. Due to multifactorial mechanisms behind tinnitus suffering, a number of questionnaires have been developed, focusing on different dimensions of the suffering. However, due to the diversity of the scales, it is sometimes difficult to make comparisons between studies performed at different centers. There is a demand for robust measurements of tinnitus, and a consensus in the methods for grading the severity of tinnitus. Our suggestion is to assess the tinnitus suffering by its impact on working capacity, together with use of tinnitus-specific and non-diagnosis-specific health questionnaires. The TSQ and NHP may be suggested. In the evaluation of the effects of rehabilitation programs visual analog scales seem to be useful.

Since tinnitus symptoms have a strong correlation to depression and anxiety disorders, a diagnostic interview focusing on existing or earlier depression and anxiety disorders as well as psychosocial and medical stress impact, should be included early in the diagnostics. In each case, a careful audiological, somatic and neuro-otological approach must be carried out to investigate the etiology of the debut of tinnitus and to find out the reason why the patient suffers from tinnitus.

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