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Outcomes of desensitization therapy in hyperacusis: A single case report

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Abstract

Humans have an astounding range of hearing. Still, the loudness level causing discomfort differs for every individual which is referred as Sound sensitivity. Hyperacusis is a hearing disorder characterized by an increased sensitivity to certain frequency and volume ranges of sound. The impact is primarily on patient's emotional well-being, hearing, communication and sleep. Reduced sound tolerance can confine the person to their home affecting their social life. However, to measure the impact of hyperacusis is challenging. A healthcare practitioner would examine the ears and, if required, refer a patient to an Otorhinolarygngologist or audiologist.

Currently, the management approach is sound therapy and counseling when there is no underlying Medical Conditions. Thus, this study focusses profiling outcomes of Desensitization therapy in Hyperacusis in a single patient who presented with decreased sound tolerance.

Keywords

sound sensitivity; hyperacusis; desensitization therapy.

Abbreviations

Ldls: Loudness Discomfort Levels; PTA: Pure Tone Audiometry; OAE: Oto Acoustic Emission, DPOAE: Distortion Product Oto Acoustic Emission, CSOAE: Contralateral Suppression Of Oto Acoustic Emission; ABR: Auditory Brainstem Response; BBN: Broad Band Noise; NBN: Narrow Band Noise.

Introduction

Humans have an astounding range of hearing, some of the individuals can literally hear a pin drop, at the same time, can tolerate loud sounds such as heavy machinery. The loudness that cause discomfort

differs from person to person and can also be affected by a person's mood, for example we may be less tolerant to loud sounds if we are stressed. This is referred to as Sound sensitivity or Noise sensitivity. Sound sensitivity is a clinical enigma where in, the person does not have a universal dislike for all sounds but finds specific sounds uncomfortable.

Hyperacusis is a debilitating hearing disorder that is characterized primarily by increased sensitivity to specific frequency and volume ranges of sound [1]. The disorder impacts on the individual's living based on the duration and severity of the disorder. Impact is primarily on patient's emotional well-being, hearing, sleep and concentration. In severe cases, reduced sound tolerance can confine the person to their home and affect their career and social life [2]. However, to measure the impact of hyperacusis is a tad puzzling. There are no objective tests for diagnosing decreased sound tolerance. Diagnosis depends mainly on the person's description of their discomfort. Audiological tests are used to assess the health of the ear. Subjective measures such as administration of self-rating hyperacusis questionnaires can be used as a tool for measuring hypersensitivity to sound and its impact on quality of life [3].

Currently, the management options with no underlying medical conditions to hyperacusis includes retraining therapy, acoustic therapy, cognitive behavioural therapy and desensitization therapy [4]. Thus, the present study aims at profiling the outcomes of Desensitization therapy in Hyperacusis in a single patient who presented with decreased sound tolerance. This study primarily holds the need for verification and validation of the effectiveness of desensitization therapy for hyperacusis.

Case Report

A 22 year old male presented with complaints of reduced tolerance to noises in the environment for 10 years, specific intolerance was reported to be for "Accelerating" noise of vehicles, horn sounds and screaming-noise of children. Behaviors such as aversion and rage were reported to be exhibited by the client due to his intolerance towards these sounds.

A detailed case history was taken including the client's current otorhinolaryngological findings, psychological and medical history, followed by Audiological Evaluation. A protocol was formed including subjective and objective evaluation to compare and follow up for both pre - treatment measures and post-treatment outcomes.

Test battery

1) Pure tone audiometry
2) Loudness Discomfort Levels (LDLs)
3) Sound tolerance evaluation
4) Immittance Audiometry
5) Oto Acoustic Emission (OAE)
6) Contralateral suppression of OAE
7) Auditory Brainstem Response (ABR)
8) Self-rating Questionnaire - Modified Khalfa Hyperacusis Questionnaire.

Pure tone audiometry and loudness discomfort levels were tested using Cello Inventis. Audiometric Thresholds were measured across individual frequencies including octaves and mid octaves (250 Hz-8 KHz). Pure tone average was calculated to estimate the degree of hearing sensitivity. Sound specific Loudness Discomfort Levels (LDLs) was calculated using pure tones, warble tones, speech stimuli and narrow band noise to find sound specific intolerance. Immittance Audiometry was performed using Clarinet plus Inventis. Tympanometry and Reflexometry was carried as a usual paradigm to rule out middle ear pathology. Oto acoustic Emission (DPOAE- Distortion Product Oto acoustic emission) and Auditory Brainstem Response were tested using Intelligent Hearing Systems, SMARTDPOAE 4.70 and SMARTEP VERSION 4.22 to find inner ear and auditory nerve status/functioning respectively. Conventional ABR testing was carried out at 70 dBnHL at the rate of 11.1/s and 60.1/s in rarefaction and condensation polarity using click stimulus. Lower intensity was preferred during ABR testing as the client reported intolerance at higher rates and intensities. Contralateral suppression of OAE testing was carried on using MAICO MA-53 Audiometer and IHS OAE system to find difference in suppression using contralateral stimulation using white noise at 55 dBHL. Sound Tolerance Evaluation was done in free-field using Piano Inventis audiometer. Thresholds across each frequency (125 Hz-8 KHz) was measured using pure-tones, warble tones, narrow band noise, speech stimuli, to find intolerance present in each frequency for specific stimulus. Modified Khalfa Hyperacusis Questionnaire [5] which includes 3 domains; Functional, Social and Emotional with a total of 20 questions was administered to the client. Loudness sensitivity handicap scale of 0-100 indicating normal to severe sensitivity is useful to monitor the impact of hyperacusis on the subject pre and post therapy.

The client was enrolled in Systematic Desensitization Therapy for two months with frequency of 2 sessions per week. Each session was for 30 minutes. 8 sessions included desensitization therapy in a closed-field set up using Audiometers and 8 sessions included Closed-field plus outdoors. Outdoors included real-time check using vehicle noise in natural environment. Exposure of sounds was titrated upward in frequency and intensity, depending upon performance.

Management Goals

1. To desensitize the patient for Broad Band Noise (BBN)
2. To desensitize the patient for noise at 1.5 kHz (since intolerance was specific to this frequency)
3. To desensitize the patient for noise at 4 kHz (since intolerance was specific to this frequency)
4. To desensitize the patient for bike/car accelerating noise

Discussion and conclusion

During the course of sound desensitization management, the patient showed significant changes in sound tolerance in clinical setting and real environment with the planned protocol of therapy.

Table 1: Comparison of pre-desensitization therapy and post-desensitization therapy diagnostic test results.

Tests/ Evaluation done	Pre-therapy results	Post-therapy results
Pure tone audiometry	Bilateral hearing sensitivity within normal limits	Bilateral hearing sensitivity within normal limits
Loudness discomfort Level	Average LDL: 70 dBHL (for pure- tones) Average LDL :75dBHL (for NBN)	Average LDL: 100-120 dBHL(for pure-tones) Average LDL: 100 dBHL (for NBN)
Sound tolerance Evaluation	Intolerance present for NBN- 1.5	No significant intolerance
	kHz &4 kHz at 75 dBHL. Intolerance seen at 70 dBHL for speech stimuli. No significant intolerance present for Warble stimuli.	present for NBN, speech stimuli and Warble stimuli.
Immittance Audiometry	Bilateral "A" type tympanogram with ipsilateral and contralateral reflexes present, indicating Normal Middle ear functioning	Bilateral "A" type tympanogram with ipsilateral andcontralateral reflexes present, indicating Normal Middle ear functioning
Oto Acoustic Emission	Bilateral DPOAES present, Suggestive of normal Outer hair cell functioning in both ears	Bilateral DPOAES present, Suggestive of normal Outer hair cell functioning in both ears
Contralateral Suppression of OAE	Suppression present.	Suppression present.
Auditory Brainstem response	Bilateral No indication of Retro cochlear pathology	Bilateral No indication of Retro cochlear pathology
Modified Khalfa hyperacusis questionnaire	Loudness sensitivity handicap scale revealed score of 52 indicating moderate handicap.	Loudness sensitivity handicap scale revealed score of 7 indicating Normal sensitivity.

Comparison of pre and post desensitization had shown evident progress in the audiological tests done. Pre therapy pure tone audiometric results revealed Bilateral Hearing sensitivity within normal limits. Pre therapy Loudness Discomfort Level (LDL) results revealed that the average LDL is 70 dBHL for pure-tones, 75 dBHL for narrow band noise (NBN) (Figure 1) and post therapy pure tone audiometric results revealed Bilateral Hearing sensitivity within normal limits and average LDL is 100-120 dBHL for pure-tones and100 dBHL for NBN (Figure 2). The Loudness Discomfort Level (LDL) had significantly reduced post therapy for both pure tones and narrow band noise (Figure 2). Pre therapy Sound tolerance Evaluation revealed Intolerance present for NBN- 1.5 kHz & 4 kHz at 75 dBHL, Intolerance seen at 70 dBHL for speech stimuli and No significant intolerance present for Warble stimuli.

Post therapy Sound tolerance Evaluation revealed no significant intolerance present for NBN, speech stimuli and warble stimuli. The sound tolerance of the patient had increased significantly. Pre and Post therapy Immittance Audiometry revealed Bilateral "A" type tympanogram with ipsilateral and contralateral reflexes present, indicating Normal Middle ear functioning. Pre and Post therapy Oto acoustic emission test results revealed Bilateral DPOAES present, Suggestive of normal Outer hair cell functioning in both ears. In Contralateral Suppression of OAE, Suppression was evident in both Pre-therapy and Post-therapy. Pre and Post therapy. Auditory Brainstem response revealed Bilateral No indication of Retro cochlear pathology. Pre Therapy Modified Khalfa hyperacusis questionnaire revealed Loudness sensitivity handicap score of 52 indicating moderate handicap and post therapy Score of 7 indicating Normal sensitivity. The results had thus proven there is a significant improvement in Tolerance and Loudness Sensitivity.

Figure 1. Pre Therapy results

Pre-therapy Pure tone Audiometry thresholds and Loudness Discomfort Levels showing Bilateral Hearing sensitivity within normal limits; Average LDL: 70 dBHL (for pure-tones)

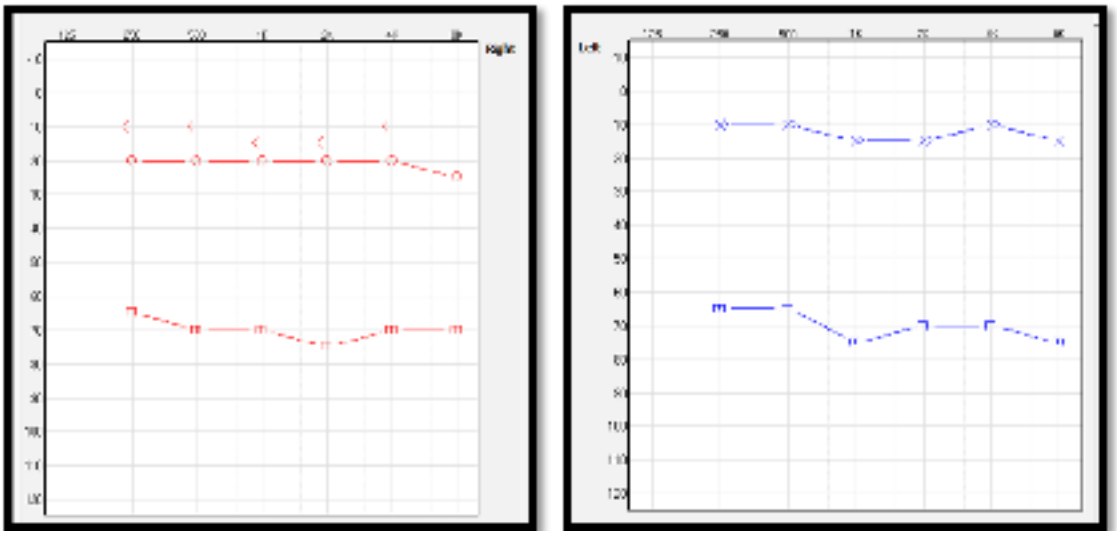

Figure 1: Indicates right bone conduction threshold, **(0)** – indicates right air conduction threshold, **(m)** – indicates Loudness discomfort level in right ear (x) – indicates left air conduction threshold, **(>)**- indicates left bone conduction threshold, (m) – indicates Loudness discomfort level in left ear

Figure 2. Post Therapy Results

Post therapy pure tone audiometric thresholds and Loudness Discomort levels revealing bilateral Hearing sensitivity within normal limits; Average loudness discomfort level: 100-120 dBHL (for pure-tones).

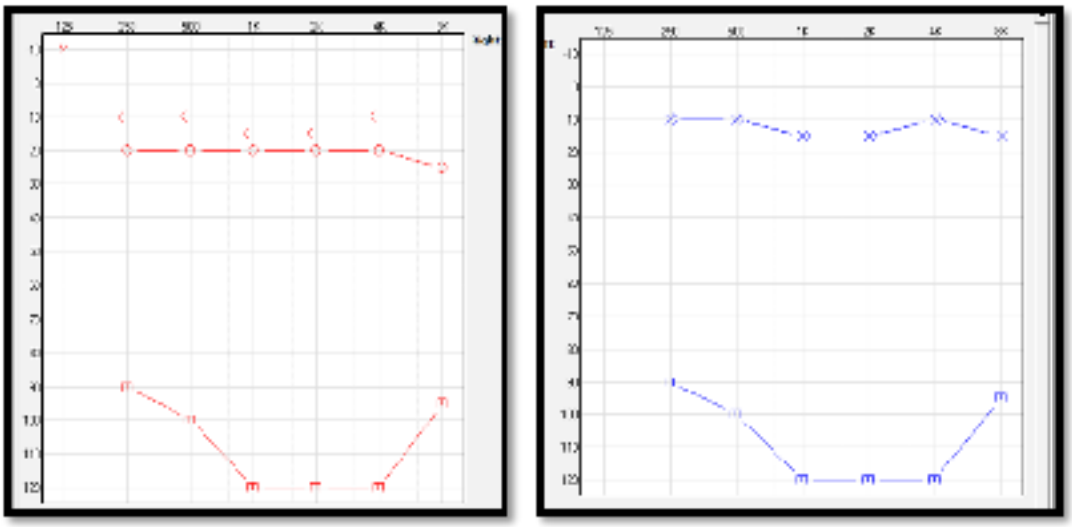

Figure 2: Indicates right bone conduction threshold, **(0)** – Indicates right air conduction threshold, **(m)** – indicates Loudness discomfort level in right ear **(x)** – Indicates left air conduction threshold, **(>)**- Indicates left bone conduction threshold, **(m)** – Indicates Loudness discomfort level in left ear

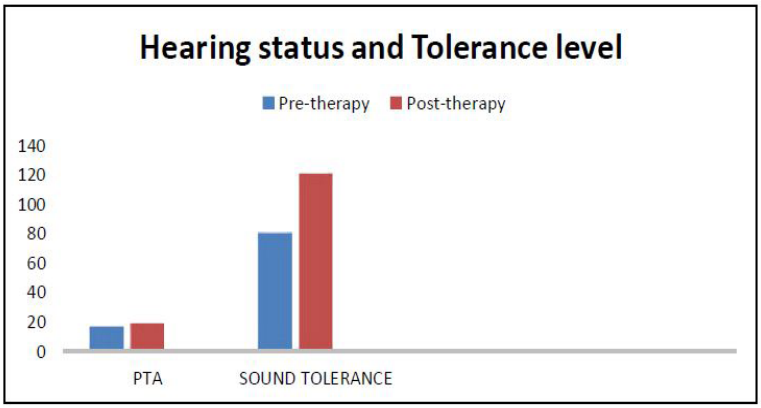

Figure 3: The client's hearing sensitivity and Sound tolerance pre and post desensitization therapy.

Conclusion

Whilst hyperacusis is not so common, there are significant number of people who face challenges due to their reduced sound tolerance. Since the management option are meagre and less researched, it is vital to study the effectiveness of various treatment paradigm. This study emphasizes to develop a systematic desensitization therapy for hyperacusis. The client's assertiveness and tolerance for environmental sounds was increased remarkably which is evident with supporting subjective and objective evaluation outcomes post therapy in this study. Thus, Systematic Desensitization management could be one of the effective management tool for individuals with hyperacusis. Further research could be implemented on effectiveness of the therapy in other sound sensitivity disorders.

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