

Masking of Tinnitus through a Cochlear Implant

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Abstract

The relief of tinnitus has been effected in a cochlear-implant patient by presenting masking sounds to the microphone of the implant. Oddly enough, the presence of the masking sound improved the clarity of speech and music.

Key Words: Cochlear implant, masking, speech and music sounds, tinnitus

An Israeli man (HD), living in Tel Aviv, lost the hearing in his left ear while serving in the military in the Sinai Desert in 1974. Apparently, his hearing loss occurred as a result of extreme dehydration, which nearly caused his death. HD was hospitalized for 10 days to be treated for the dehydration. Although the hearing in his right ear remained fairly normal, his left ear experienced a severe hearing loss. Noise exposure from shooting was not considered a cause for his hearing loss, since he had always used ear protection at such times. The following is information gleaned from a 2-year correspondence with the patient.

For the first 6 months after hospitalization, HD only worked half-days due to doctor's orders, and during that time simple physical tasks such as climbing the stairs presented considerable difficulty. Unfortunately, the hearing loss in his left ear proved to be permanent and was accompanied by significant tinnitus.

In 1996, HD probably imparted additional damage to both ears by attending a Rolling Stones concert, where he found the loud noise to be extremely uncomfortable. Covering his right ear did little to relieve the discomfort. During that same time period, he found he was exceptionally sensitive to loud noises at soccer games and similar events. He may have been experiencing hyperacusis; however, this possibility was not tested.

The night he became completely deaf, he heard a sound "like dripping water" in his right ear (the better ear at that time), after which he experienced complete deafness. He also became aware of tinnitus in his right ear as well as the left ear. As a result of the complete bilateral deafness, his left ear was implanted in 1996 with a Spectra 22 channel speech processor. Although his device contains 22 separate channels, only three channels were activated, and, generally, he uses only the first channel.

HD contacted us in 1997, stating that despite the cochlear implant, tinnitus was still present in his left ear and was possibly louder than before implantation. Several studies have established that the cochlear implant can relieve tinnitus in 53 percent to 83 percent of patients (House, 1976; Berliner et al, 1987; Hazell et al, 1989; McKerrow et al, 1991; Kim et al, 1995). We asked if he had tried masking through the microphone of his cochlear implant. He replied that he had not and that he knew nothing about masking as a relief procedure for tinnitus. We then sent him a Moses/Lang compact disc (CD)¹ that contains seven different bands of noise, six of which have been developed specifically for tinnitus masking:

Band 2:	100 Hz- 4,000 Hz
Band 3:	2,000 Hz-14,000 Hz
Band 4:	4,000 Hz-14,000 Hz
Band 5:	6,000 Hz-14,000 Hz
Band 6:	8,000 Hz-14,000 Hz
Band 7:	10,000 Hz-14,000 Hz

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¹The Moses/Lang CD has been developed by the Oregon Hearing Research Center and is available at nominal charge by contacting the Center at 3181 SW Sam Jackson Park Road, Portland, OR 97231 (phone: 503-494-8032).

To compensate for reduced hearing sensitivity at high frequencies in the more usual tinnitus patient, all six masking bands have amplitude spectra that increase 10 dB per octave from low to high frequencies. (Band 1 consists of "pink noise" and is intended for use in desensitization of individuals with hyperacusis.)

We suggested to HD that he acoustically present each of the masking bands to the microphone of his implant to see if any of them would succeed in masking his tinnitus. If so, he should then determine which noise band masked his tinnitus at the lowest volume. Shortly thereafter, he reported that Band 5 (6 kHz to 14 kHz) completely masked his left ear tinnitus and at the lowest volume of any of the noise bands. We suggested that he use Band 5 to mask his tinnitus whenever he felt the need for relief, and he has done so.

After several months, HD reported an unusual effect of using the Moses/Lang CD: while he listened to the masking noise, *his perception of speech and music became much clearer*, particularly that of his own voice and his own violin playing. HD reported that he had observed this result many times. HD had been unable to play the violin since the onset of deafness; the increased clarity in the perception of music made it possible for him to play again. This result was unexpected, and we recommended that he use the Moses/Lang CD for longer periods of time to see if the "clearing" effects would be extended or increased.

The clarification of HD's perception of implant-transmitted speech and music due to the addition of a high-frequency band of noise is a phenomenon that requires further examination. It would be desirable to quantify that result and to explore its relationship to the specific characteristics of the implant signals, for example, to determine the precise waveform and other characteristics of the electrical signal that is delivered to the ear by HD's cochlear implant, both in the presence and in the absence of the masking sounds. It is conceivable that similar procedures could be employed for improving signal perception in other cochlear-implant patients.

Consideration should also be given to the mechanism(s) that might underlie the observed improvement in clarity of speech and music. It is possible that HD's response to the masking sounds transmitted through the cochlear implant involves underlying physiologic processes, such as the stochastic resonance phenomena that have recently begun to receive attention (Morse

and Evans, 1996; Chialvo et al, 1997). If so, further study is needed to identify the optimal implant characteristics to maximize the beneficial effects of adding noise.

Tinnitus masking in patients whose hearing permits use of acoustic stimulation commonly results in the occurrence of residual inhibition (the temporary cessation or reduction of tinnitus following the offset of the masking sound). HD now reports that he typically experiences a 2- to 3-minute absence of his tinnitus after turning off the masking sound. Although his residual inhibition is brief, he also reports that he has experienced an increase in the number of days in which his tinnitus is reduced in loudness since he began to use the Moses/Lang CD. In addition, after extended use of the masking CD, he notes that the tinnitus in the right ear (the nonimplanted ear) is being partially masked.

Finally, HD has reported one other important observation that may be of interest to individuals who have received cochlear implants and continue to experience tinnitus. Sometimes HD's tinnitus awakens him during the night. When this occurs, playing the Moses/Lang CD allows him to get back to sleep. HD reports that he is now using the CD for extended periods of time each day and that, in his words, it has become "my best friend."

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