International Tinnitus Journal, Vol. 3, No. 1, 25–29 (1997)

Use of Masking for Tinnitus

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Abstract: The use of masking for tinnitus has been a primary method of treatment of patients with severe tinnitus since 1976. Over 5,000 patients have been treated in the Tinnitus Clinic at Oregon Health Sciences University since that time. The paper discusses the results of management of new patients followed for one year from January 1, 1992 through December 31, 1995. Of the 373 patients who could be accurately followed and evaluated for this period of time, 180 patients were recommended for tinnitus maskers or tinnitus instruments, and 83 were provided with masking tapes. The results of this study, along with the overall success of the tinnitus program utilizing masking, are discussed.

In 1976, a tinnitus clinic was inaugurated at Oregon Health Sciences University which has been in existence to the present time. During this time period, over 5000 patients have been evaluated for their complaint. The primary management of these patients has consisted in the use of maskers. An evaluation of those patients seen over the last four years will be presented.

THE MEDICAL EXAMINATION

Little has changed in the basic evaluation of the tinnitus patient. Initially, the patients have (1) a medical examination to rule out any medical problem that may cause or exacerbate their symptoms, (2) a routine audiometric evaluation to determine the type and degree of hearing impairment, and (3) a tinnitus evaluation.

During the course of history of the tinnitus clinic, most patients who are candidates for the masking program are referred by physicians and have already undergone a medical evaluation. Many patients have seen numerous physicians and continue to seek relief for their tinnitus. The majority of patients evaluated by our clinic have had a variety of treatment. Nonetheless, a thorough evaluation, preferably by an otolaryngologist, is an essential first step in evaluating and treating these patients. Tinnitus, like hearing loss, is a symptom and any possible medical or surgical treatment for the problem must be excluded prior to any recommendation. Medical evaluation also helps exclude those patients who present with objective tinnitus. A review of the most common medical problems which induce tinnitus has been presented in previous publications.

THE AUDIOMETRIC EVALUATION

The audiometric workup for the tinnitus patient does not differ greatly from the typical audiologic assessment performed for diagnostic purposes or for hearing aid evaluation. The procedure includes pure tone testing, speech testing, tympanometry, and an uncomfortable loudness level measurement. Many patients who have tinnitus and/or hearing loss also have a sound sensitivity problem which interferes with their ability to function in noisy environments. It is important therefore not to exceed their tolerance levels in fitting any instrument.

In addition to providing diagnostic information with regards to the type of hearing loss that the patient exhibits, the audiogram also aids in the selection of the appropriate masking device for a particular individual. Three different types of devices are used to offer relief for tinnitus patients: (1) tinnitus maskers, (2) tinnitus instruments, and (3) hearing aids. The selection of the unit depends primarily upon the amount of the patient's hearing loss.

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The audiogram is also helpful in determining the loudness level of the tinnitus. Most measurements of the loudness of tinnitus are based upon the patient's threshold for a particular sound and how much above the threshold one has to make the sound so that it equals the loudness of the patient's tinnitus. This level, which is based upon the patient's own threshold, is referred to as the sensation level. Although not all agree that this is a useful means for accurately determining the loudness of tinnitus, it has served us well in evaluating the severity of the patient's complaint.

The audiogram also may restrict the use of masking devices for patients who have severe hearing loss. Although considerable effort has been made to design maskers whose output does not exceed the level at which sound is potentially dangerous to the ear, the clinician must always be aware that patients with severe to profound hearing loss could lose some of their residual hearing if the masking level is too loud.

THE TINNITUS EVALUATION

In attempting to quantify the patient's tinnitus, an evaluation of pitch, loudness, masking effectiveness, residual inhibition, and an actual trial with masking devices helps determine whether the patient can benefit from a tinnitus masking program. These measurements can be made with a special tinnitus synthesizer (as in our case), or an audiometer. The pitch of the tinnitus for each patient is determined by a matching procedure. A signal is presented to the ear opposite the side where the tinnitus is being measured. The reference sound might be a pure tone signal for those patients who complain of a ringing sound, a high-frequency band of noise for those who report a hissing-like sound, a low-frequency noise band for patients who hear a roaring sound, or a combination of several sounds. Since many patients report having several sounds in their ears or localize their tinnitus in the head rather than the ear, our ability to match the pitch of the tinnitus is generally less accurate than for measuring loudness. To measure loudness, the best pitch match for the patient (previously determined) is used as the reference signal. That signal is increased until the patient first hears the sound. That is recorded as the threshold. Then the sound is increased until the patient indicates that it is equally loud to their tinnitus. The difference between the threshold and the loudness level is considered the tinnitus loudness. Unfortunately, the method that is used for making this measurement is controversial and does not always represent, or correlate to, the magnitude of the patient's complaint. We have found that the loudness level in 85% of patients is 5 decibels or less.

The third measure of tinnitus is the effectiveness of masking. After determining pitch and loudness, masking is attempted with wide bands of noise in the same ear as the tinnitus. The effectiveness of this noise to mask the tinnitus is determined by first establishing the threshold of the masking stimulus and then increasing the noise until the tinnitus is just masked. This level is termed the "minimum masking level" and again is the difference between the threshold level for the noise and the amount of noise needed to mask the tinnitus. This is a useful predictor in assessing the potential value of masking.

The final measurement in the clinical evaluation of the tinnitus patient is to determine if the tinnitus can be inhibited by exposure to the masking sound. Upon removal of the masking noise, patients who exhibit tinnitus inhibition will report complete elimination or reduction of the tinnitus. This intriguing phenomenon has been coined "residual inhibition" and is generally measured by presenting the masking signal to the patient for one minute and then, following removal of the noise, observing the duration of tinnitus inhibition. Occasional patients will describe long periods of residual inhibition while the majority of patients reported reduction in their ringing only for a short period of time e.g., a few seconds or minutes.

Following this evaluation, ear level instruments are tried on each patient. This is based on the observation that results obtained with the synthesizer or audiometer do not adequately predict the patient's ability to be masked with ear level instruments. Therefore, the synthesizer is not necessarily a good measure of the masking ability of an ear level instrument. The trial period with wearable instruments adds about a half hour to the evaluation process but has resulted in a more effective method of determining if a masking program should be initiated.

MANAGEMENT OF THE TINNITUS PATIENT

Once the clinician has completed the tinnitus evaluation, a decision is made as to whether the patient needs a masker, a hearing aid, or a tinnitus instrument. Over the course of the years with the tinnitus clinic, there has been a progressive diminution in those patients who receive maskers alone. The majority of patients are now receiving tinnitus instruments. Maskers or tinnitus instruments can be in the ear or behind the ear and, more recently, can be individually tuned.

Maskers are generally suggested for those patients who have normal, or near normal, hearing and do not need amplification. They have also been used for pa-

tients who have a sensitivity problem and cannot tolerate loud noise. There are a small number of patients who can control their tinnitus through the extension of residual inhibition. These patients, upon removal of the masking stimulus, experience reduced tinnitus and thus may benefit from intermittent use of a masking device.

Hearing aids are recommended for those patients who have a hearing loss and meet certain criteria: (a) the tinnitus does not have any effect on their sleep habits, and (b) they have extended residual inhibition. A hearing aid alone does not provide significant residual inhibition.

Over the past several years, of those patients who have merited a trial of masking, 60% have had recommendation for a tinnitus instrument. There are several reasons for this choice: (1) Most patients have both hearing loss and tinnitus; (2) Patients can use the masker for sleep and turn off the hearing aid; and (3) A number of patients may have severe tinnitus which is not masked with a hearing aid. The benefit of the combination unit appears to enhance this suppression. There is very little difference in cost between the tinnitus instrument and the hearing aid and so consequently when there is a possibility the patient may at some time use both the hearing aid and a masker, the tinnitus instrument is recommended.

The final step in the tinnitus masking program is the dispensing of the instruments when indicated. As is true with hearing aids, tinnitus maskers and tinnitus instruments are dispensed on a trial basis. Generally, the return rate of tinnitus maskers and tinnitus instruments is greater than that for hearing aids. Therefore, it is doubly important that the initial decision regarding the appropriate instrument be made carefully and thoughtfully.

Since 1976 and the inception of the tinnitus masking program, there have been several studies evaluating the efficacy of this approach for patients. The following review will present the most recent experience with our masking program. During the period from 1992 to the present, we have been recommending a new tunable tinnitus masker, or tinnitus instrument, manufactured by the Starkey Corporation. These devices have allowed clinicians and patients to make changes in the frequency response of the masking signal. They produce a tunable band of noise which allows for the high-frequency cutoff to be varied. The new tinnitus maskers (Model TM) are available either in the ear or in the canal with custom configuration and are recommended for patients with normal or near normal hearing. The masker is also combined with two hearing aid variations (tinnitus instruments) for those patients who have both hearing loss and a tinnitus problem. One model is a masker and linear hearing aid combination (Model TML) and the other is a masker and compression hearing aid combination (Model TMC). These new masking devices have been utilized since January 1, 1992.

From January 1, 1992 through December 31, 1995, 618 new patients were seen at our tinnitus clinic. Table I represents the recommendations for these patients from our clinic. As is noted, over 38% of the patients had no recommendation for either tinnitus instruments, maskers, hearing aids, or masking tapes. This figure has varied between 38% and 42% throughout the duration of the tinnitus clinic. In this group of patients, there were either medical contraindications for use of these devices, other medical ailments which could account for the complaint, insufficient symptoms to merit masking, inability to be effectively masked, or inability to pay for a device.

All of the information regarding this series of patients was entered into the Tinnitus Data Registry at Oregon Hearing Research Center. At the end of one year, follow-up questionnaires were sent to each patient. Of

Table I: Total number of specific recommendations for 618 new patients seen from January 1, 1992 through December 31, 1995. In addition, 134 reevaluations were conducted.

No recommendation	151
Medical recommendation*	92
Tinnitus Instruments	196
Tinnitus Maskers	82
Hearing Aids	29
Masking Tapes*	105

*Many patients are provided with masking tapes until they purchase their wearable devices and some patients are given both medical and equipment recommendations.

Table II: Number of specific recommendations made for 373 patients seen over a 4-year period from January 1, 1992 to December 31, 1995 who returned their follow-up questionnaires.

No recommendation	75
Medical recommendation	35
Instrument recommendation	154
Instrument + Medical recommendation	26
Masking tape recommendation	67
Masking tape + Medical recommendation	16
Total	373

Table III: Number of patients with specific equipment recommendations who purchased devices.

Hearing aids	12
Tinnitus Maskers	18
Tinnitus Instruments	70

*83 patients were also provided masking tapes to use in conjunction with a cassette recorder.

Table IV: Period of the day patients wear their instruments.

	Hearing Aids		Tinnitus Maskers		Tinnitus Instruments	
Period	**No.**	**%**	**No.**	**%**	**No.**	**%**
All of the time	5	41.7	1	5.6	18	25.7
Morning only			1	5.6	4	5.7
Evening only			3	16.7	5	7.1
Various times during day	3	25.0	4	22.2	13	18.6
Night time only			5	27.8	2	2.9
No set pattern	1	8.3	3	16.7	13	18.6
No data	3	25.0	1	5.6	15	21.4

the 618 patients seen during this four-year period of time, 373 returned their questionnaires. The data was analysed independently of any clinicians involved in the patient management.

The specific recommendations for the 373 patients who returned their questionnaires and/or were reevaluated are presented in Table II. A total of 180 patients were given recommendations to be fitted with tinnitus maskers or tinnitus instruments and 83 were provided with masking tapes when they were seen at the clinic. These masking tapes have proven to be very successful in offering relief to tinnitus patients who find their tinnitus bothersome only part of the time - especially at night. Many patients indicate that their tinnitus is annoying only when they are in quiet environment or when the tinnitus is especially loud. These patients do not need expensive wearable maskers but can use these tapes in conjunction with a cassette tape recorder when they are experiencing difficulty. Also, these tapes can be utilized at night for sleep purposes using an external speaker. Patients who had medical recommendations generally were treated pharmacologically with medications, such as Xanax, Klonopin, Ativan, or Nortriptyline. Some received recommendation for alternate treatments - e.g., biofeedback, counselling.

Of the 180 patients who were provided with instrument recommendations, exactly 100 patients purchased these devices. The specific recommendation for those 100 patients is shown in Table III. This table clearly indicates that the tinnitus instrument has been the unit of choice for most of our patients. Not only is the tinnitus instrument more effective in masking the tinnitus, but the masking noise presented is more acceptable as a substitute for the tinnitus than it is for the tinnitus masker. This finding has been consistent through the years. Hearing aids do reduce the level of tinnitus for some patients but do not offer sufficient relief for patients with severe symptoms.

Table IV demonstrates the duration and time of day the patients tend to wear their instruments. As would be expected, hearing aids are worn much of the day to improve understanding of conversational speech. The same is true of the tinnitus instrument, which includes both amplification and masking. Some patients use only the hearing aid portion of their instrument during the day, but at night when they are in a quieter environment they will use the masking portion. Only a few people use the masker or tinnitus instrument all the time. However, there are patients who use it 24 hours a day and remove it only to shower. The masker is used primarily in quiet and for sleep. Initially, we had thought that patients would utilize their maskers for most of the time. However, most patients do not wear the masking apparatus more than three to four hours each day. The effectiveness of the masking devices is reported in Table V. Clearly, for those who purchase

Table V: Effectiveness of the instruments to mask tinnitus.

	Hearing Aids		Tinnitus Maskers		Tinnitus Instruments	
Period	**No.**	**%**	**No.**	**%**	**No.**	**%**
All of the time			2	11.1	4	5.7
Most of the time	3	25.0	9	50.0	27	38.6
Part time	5	41.7	6	33.3	26	37.1
Never	2	16.7	1	5.6	9	12.9
No data	2	16.7			4	5.7

Table VI: Changes in the loudness of the tinnitus when the masking noise is removed.

	Hearing Aids		Tinnitus Maskers		Tinnitus Instruments	
Changes	**No.**	**%**	**No.**	**%**	**No.**	**%**
No change	7	58.3	10	55.6	26	37.7
Tinnitus disappeared					4	5.7
Tinnitus softer	4	33.3	5	27.8	22	31.4
Tinnitus louder			2	11.1	7	10.0
No data	1	8.3	1	5.6	11	15.8

Table VII: Number of patients who find maskers helpful when tinnitus is troublesome.

	Hearing Aids		Tinnitus Maskers		Tinnitus Instruments	
Reply	**No.**	**%**	**No.**	**%**	**No.**	**%**
Yes	3	25.0	14.0	77.8	51	72.9
No	3	25.0	1	5.6	13	18.6
No data	6	50.0	3	16.7	6	8.6

the instrument, the tinnitus masker is an instrument deemed more effective in masking than were hearing aids. It's obvious that many patients cannot be completely masked or prefer to use the masking noise at a lower level that does not totally mask their tinnitus. However, if patients can significantly mute their tinnitus to reasonable intensity level, they generally cope with their problem quite well.

The phenomenon of residual inhibition hopefully was thought to indicate those patients who would have most success with masking devices. This has not been clearly demonstrated. Considerably more residual inhibition is observed under ear phones than with wearable masking devices because the noise level generated under ear phones (10 dB above tinnitus threshold) is greater than that used for the ear level units. Table VI reveals the number of patients who observe this phenomenon with the various instruments. A large percentage observe no change in their tinnitus with wearable units. It is also interesting to note that some patients report an increase in their tinnitus when the instrument is removed. These patients can generally mask their tinnitus quite effectively when the noise is present, but when they remove the device the noise may appear quite loud for a short period of time before returning to its original level.

One last and important observation with regard to patients who were involved in the tinnitus program is that many of them view their masking devices as a source of comfort, knowing that if they need relief they can find it within the masking device. Many times patients will report that just having the instrument available when they require it is a relief to them. Table VII demonstrates the number of patients in our group who felt the maskers were helpful when the tinnitus was troublesome.

In summary, several features stand out:

1. Thirty-eight percent of patients seen in our clinic did not receive recommendation for any device. These patients either had tinnitus of insufficient degree to require masking, could not be masked, or had medical problems which were felt to be contraindicative to the use of a masking device. This has been consistent throughout the years.
2. In our most recent follow-up, 55% of those patients who were specifically advised to purchase a hearing aid, masker or tinnitus instrument did so. Although few felt the instruments effectively inhibited tinnitus all the time (6%), only 12% felt the instruments were totally ineffective (the majority of these used only the hearing aid).
3. Thirty-six percent noted significant residual inhibition after using a device which was beneficial.
4. Eighty-two percent of patients who received tinnitus instruments had significant relief of symptoms.

In conclusion, it appears that reasonable success can be achieved with these new masking devices if care is taken in fitting them. Although the results obtained with the masking devices are not as positive as we had hoped in that only 30% of patients seen in our clinic benefitted from some type of masking instrumentation. When combining the successful instrument users with those who benefited from masking tapes, the overall success of the program has been good. This is especially true since the majority of these patients had received prior treatment. Many of our patients who could not benefit from masking were successfully managed by other treatment modalities.

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