
Treatment of Cochlear-Tinnitus with Dexamethasone Infusion into the Tympanic Cavity

E. Sakata, M.D., A. Itoh, M.D., Y. Itoh, M.D.

Saitama Medical School, Department of Neurotology, Moroyama, Saitama, Japan

Abstract: Intratympanic dexamethasone infusion was performed as a treatment for cochlear-tinnitus and its efficacy was investigated. This is a Steroid Targeting Therapy (STT) for cochlear-tinnitus. The overall effective rate for the 1214 patients with 1466 affected ears was 71%. In this study, cochlear tinnitus was seen frequently in the age group of 50 - 60 years old, a relatively older population. The results of the treatment for tinnitus in different age groups did not show a correlation between age and efficacy rate of treatment. In the investigation of the treatment results with different underlying ear diseases, the efficacy rate was high for tinnitus accompanying chronic otitis media, Ménière's disease, and labyrinth syphilis. The efficacy rate tended to decrease more with longer disease duration. When the mean hearing level and treatment results were evaluated, a high effective rate was found in patients who had mild deafness. The efficacy rate was high in tinnitus of low tone pitch, and low tinnitus with high tone pitch. On the other hand, different degrees of loudness of tinnitus did not correlate with treatment effects. This treatment method is useful as a local therapy for cochlear-tinnitus in an outpatient setting.

Key Words: Cochlear Tinnitus, Dexamethasone Infusion, Tympanic Cavity

INTRODUCTION

Patients who complain of tinnitus murmuring in the ear due to various disturbances of the inner ear frequently consult neurotological outpatient departments. However, there is no clear treatment for tinnitus patients. In this study, we investigated the results of intratympanic dexamethasone infusion. Sakata reported this method for the first time in 1982.¹

METHODS

Subjects

The investigation period was for two years from April, 1990 to March, 1992. The subjects were 1214 patients with 1466 ears who received intratympanic dexamethasone infusion for the treatment of vertigo and tinnitus. Their tinnitus were assumed to be cochlear and continuous.

The patient's age structure: The youngest was 14 years, the oldest 89 years, with the mean 53.8 years. The peak was seen in patients in the 50's (32%) age group.

Treatment Method

Dexamethasone 2mg or 4mg was used for each ear. First, the patient sat in the examination chair at the outpatient department and in a position to visualize the tympanic membrane. The drug was infused into the middle ear through the tympanic membrane. Middle ear anesthesia was not generally performed via the tympanic puncture. To allow the maximum contact of the drug with the round window, the patient was positioned and kept silent at rest for 10 to 20 minutes. The infusion was repeated four times at an interval of one to two weeks. According to their condition, some patients received a second course three months after completion of the first one. The number of infusions varied among patients to a maximum of three courses.

Evaluation of Treatment Effect

To evaluate treatment effects on tinnitus, a 10 division subjective evaluation was used. This method is commonly

Reprint requests: E. Sakata, M.D., Saitama Medical School, Department of Neurotology, Moroyama, Saitama 350-04, Japan Fax: (81) 492-94-8883

used as a subjective evaluation for other sensory disturbances. The severity of tinnitus before treatment was regarded as 10 and the level after treatment was expressed as a level from 1 to 10. A level of 0 - 2 for the residual symptoms represented markedly effective, 3 - 6 represented effective, and 7 - 10 represented ineffective. The sum of the markedly effective and effective cases was defined as the overall efficacy rate. Short-term effects were evaluated at the first reexamination after the fourth intratympanic dexamethasone infusion. Subsequently, evaluations were conducted three, six, and 12 months later, and long-term effects were evaluated as possible.

RESULTS

The Short-Term effects of Dexamethasone Infusion into the Tympanic Cavity on Tinnitus

The overall efficacy rate for the 1214 patients with 1466 affected ears was 72%. The efficacy in different age groups was 54% for the second, 61% for the third, 59% for the fourth, 76% for the fifth, 87% for the sixth, 87% for the seventh, 73% for the eighth, and 67% for the ninth decades (Figure 1).

The efficacy rate was 71% for sudden deafness (240 ears), 72% for labyrinthine vertigo (261), 82% for chronic otitis media (135), 77% for Ménière's disease (88), 65% for noise deafness (208), 79% for labyrinth syphilis (14), 69% for genetic deafness (32), 68% for streptomycin intoxication (25), 39% for head injury (69), and 61% for others (394) (Figure 2).

The efficacy rate by diseased period was 77% for one month or less 98 patients, 88% for three months or less 94 patients, 70% for six months or less (63), 72% for one year or less (274), 69% for five years or less (511), 67% for 10 years or less (218), 59% for 20 years or less (157), and 60% for more than 20 years (51) (Figure 3).

The efficacy rate in different mean hearing levels was 72% for 0 - 20dB (427), 72% for 21 - 40dB (473), 60% for 41 - 60dB (320), 64% for 61 - 80dB (126), and 57% for 81dB or higher (51) (Figure 4).

The efficacy rate for different pitches of tinnitus was 88% for 125Hz (94), 74% for 250Hz (81), 79% for 500Hz (52), 70% for 1000Hz (73), 63% for 2000Hz (57), 77% for 3000Hz (39), 66% for 4000Hz (400), 100% for 6000Hz (3), 67% for 8000Hz (563), and 100% for white noise (3). Because there were only a few cases of band noise, the number of ears with pure tone or band noise were summed for each pitch (Figure 5).

The efficacy rate for different loudness of tinnitus was 68% for 0 - 5dB (837), 67% for 6 - 10dB (253), 65% for 11 - 15dB (17), 100% for 16 - 20dB (2), and 67% for 21dB or more (6) (Fig. 6).

The Long-Term Effects of Dexamethasone Infusion into the Tympanic Cavity on Tinnitus:

The long-term effects of dexamethasone infusion into the tympanic cavity on tinnitus were evaluated at about three, six, and 12 months after treatment. Because some patients did not appear after 12 months, the number of subjects evaluated after 12 months is lower.

The same 10 division subjective evaluation was used. The group having a variation of ± 2 was evaluated as having continuous tinnitus and the group having a deterioration of three or more was defined as a relapse. These results were from the investigation of the markedly effective and effective cases.

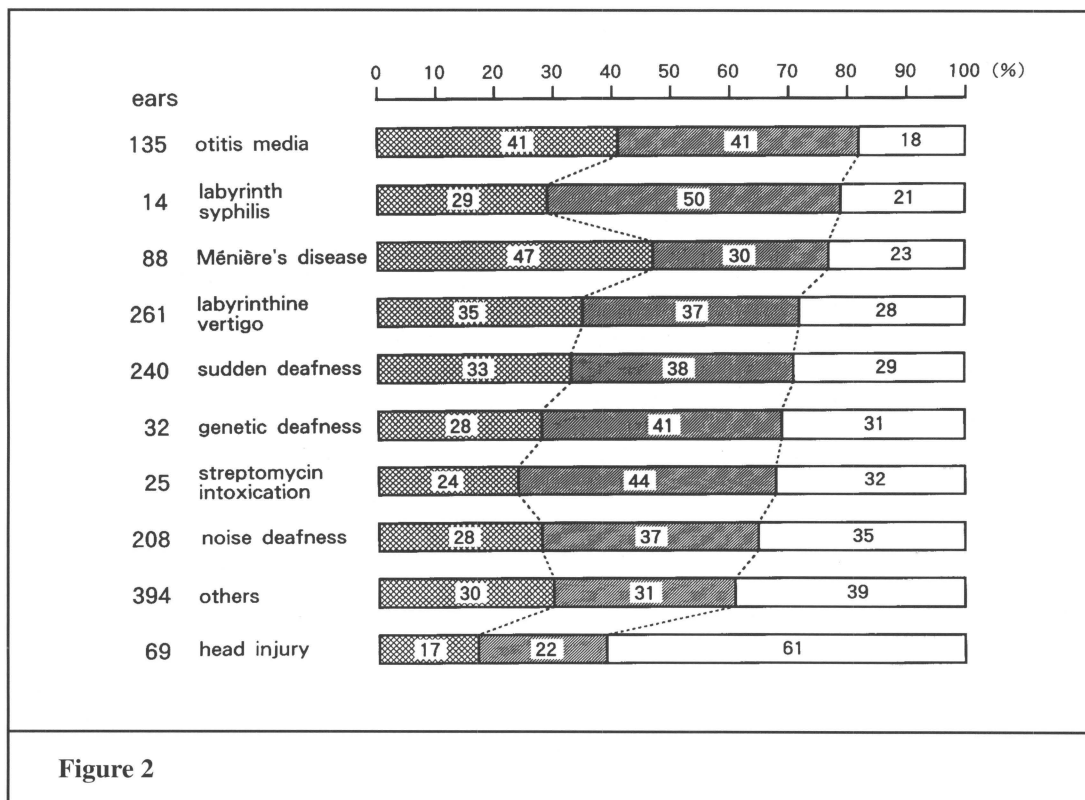
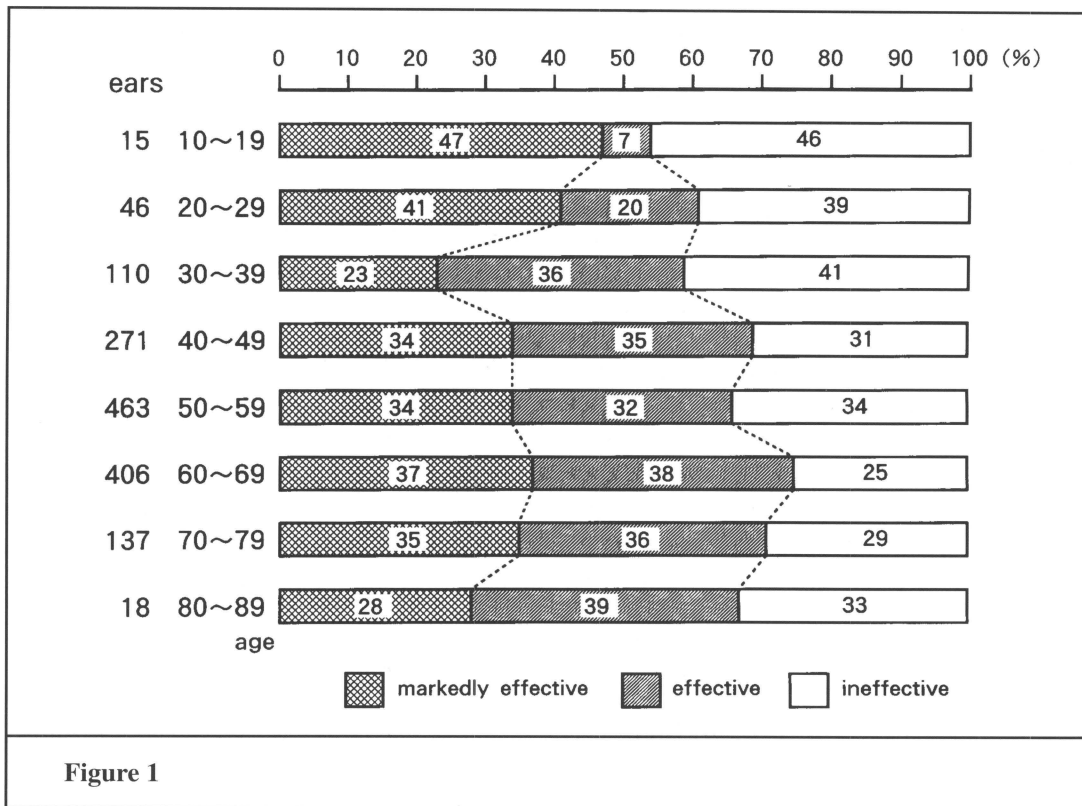
The long-term efficacy rate in different age groups at three months was 50% for the second and third, 80% for the fourth, 81% for the fifth, 71% for the sixth, 82% for the seventh, and 83% for the eighth decade or older. The long-term efficacy rate after six months in the group with continuous tinnitus was 67% for the second and third, 68% for the fourth, 75% for the fifth, 77% for the sixth, 77% for the seventh, 75% for the eighth decade or older. The long-term efficacy rate after 12 months in the same group was 50% for the fourth, 67% for the fifth, 78% for the sixth, 75% for the seventh, and 75% for the eighth decade or older. In the group with continuous tinnitus after three months, the long-term efficacy rate was 89% for chronic otitis media, 67% for labyrinth syphilis, 80% for Ménière's disease, 100% for genetic deafness, 79% for labyrinthine vertigo, 82% for sudden deafness, 90% for noise deafness, and 80% for others.

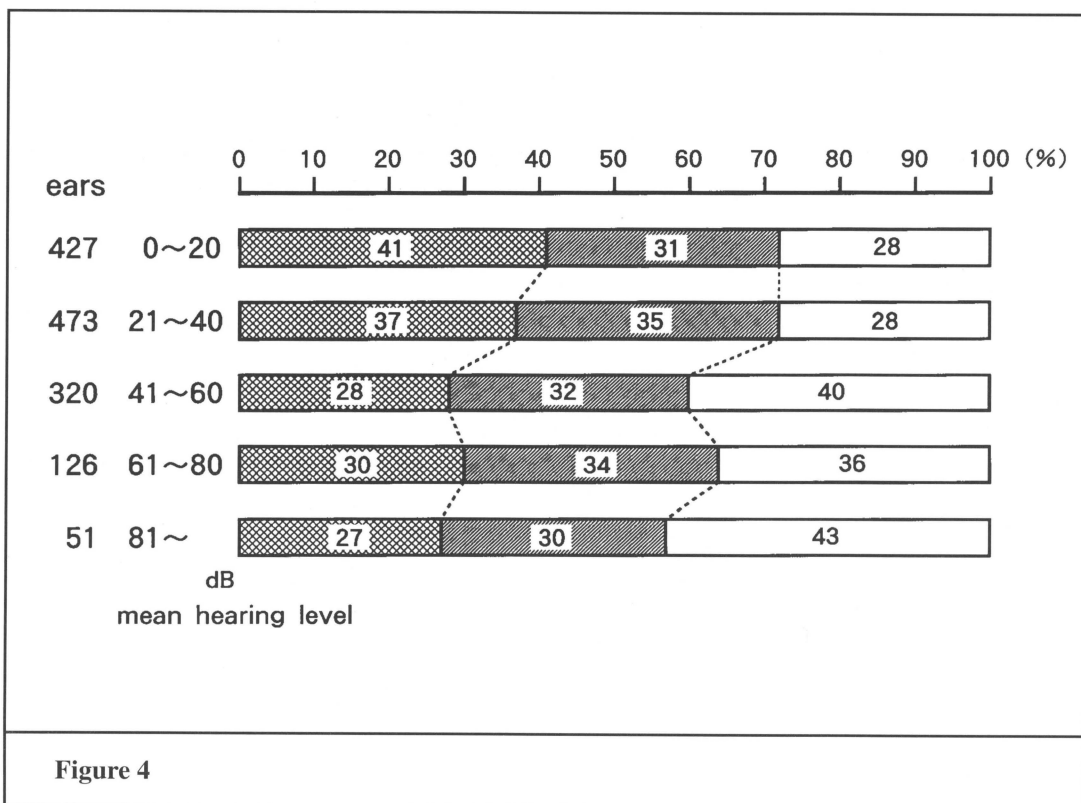
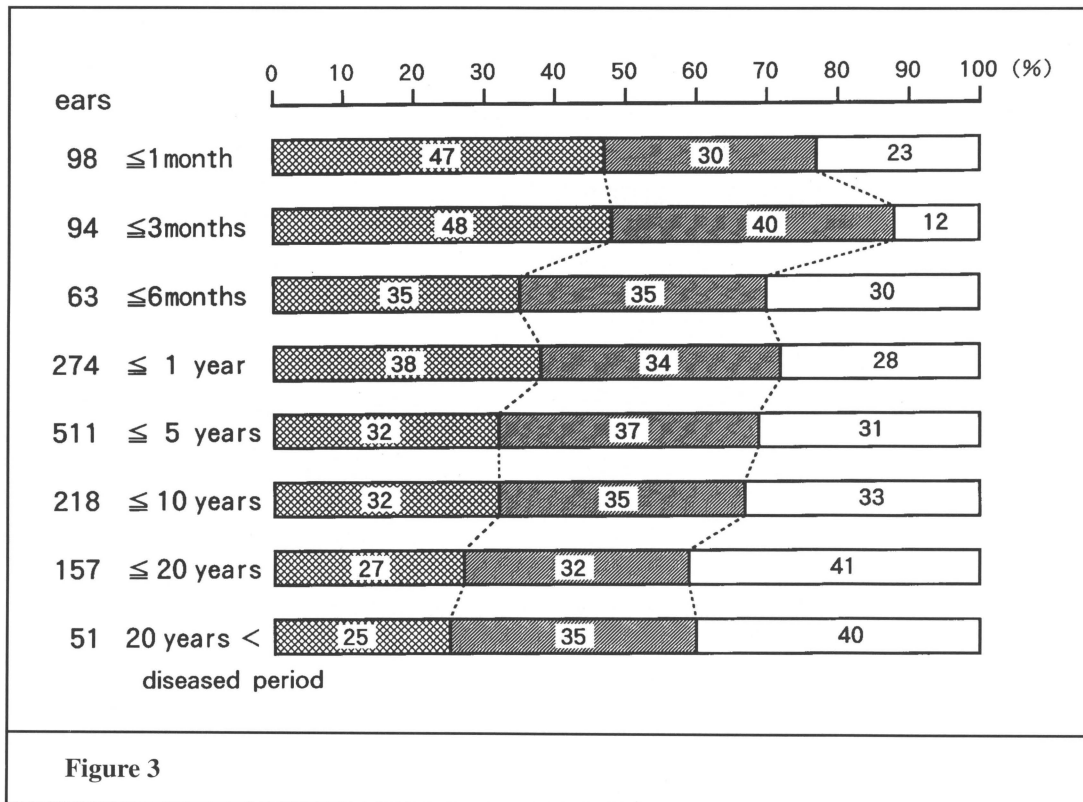
The long-term efficacy rate after six months in the same group was 87% for chronic otitis media, 67% for labyrinth syphilis, 78% for Ménière's disease, 67% for genetic deafness, 78% for labyrinthine vertigo, 74% for sudden deafness, 75% for noise deafness, and 74% for others.

The long-term efficacy rate after 12 months in the same group was 50% for chronic otitis media, 67% for labyrinth syphilis, 50% for Ménière's disease, 67% for labyrinthine vertigo, 86% for sudden deafness, 100% for noise deafness, and 46% for others.

The long-term efficacy rate at three months for groups with different length of disease was 83% for six months or less of diseased period, 79% for 12 months or less, and 84% for 13 months or longer.

The long-term efficacy rate at six months for groups with





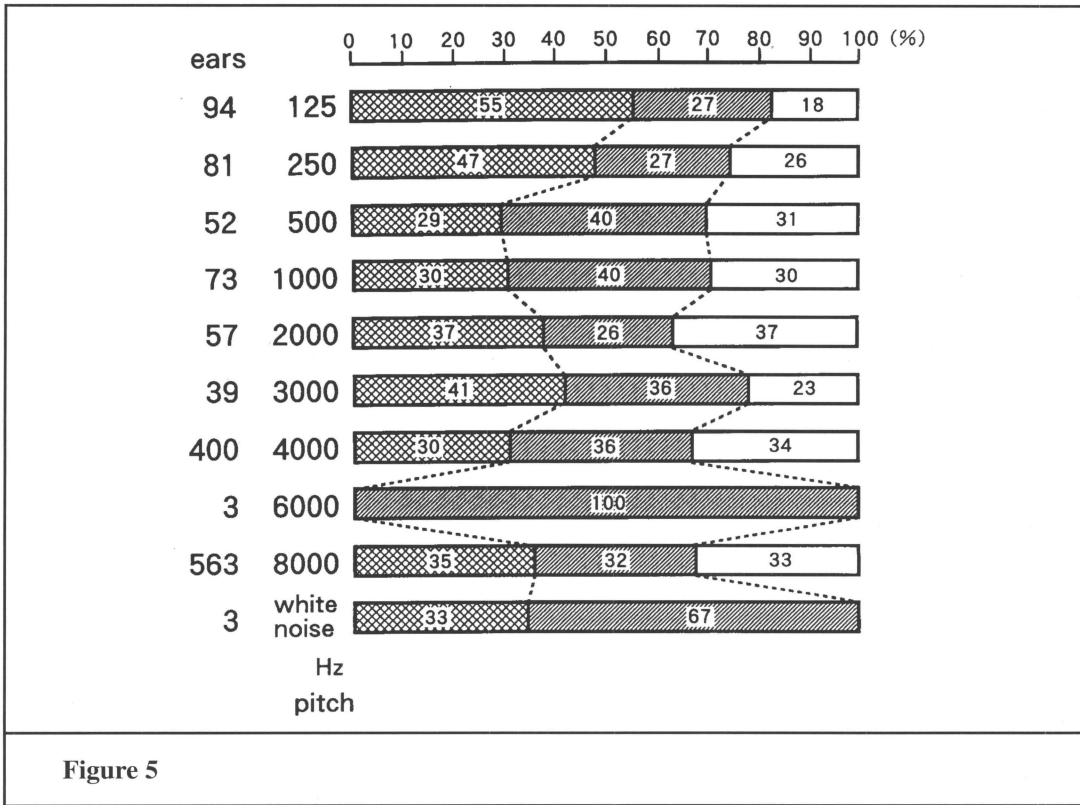


Figure 5

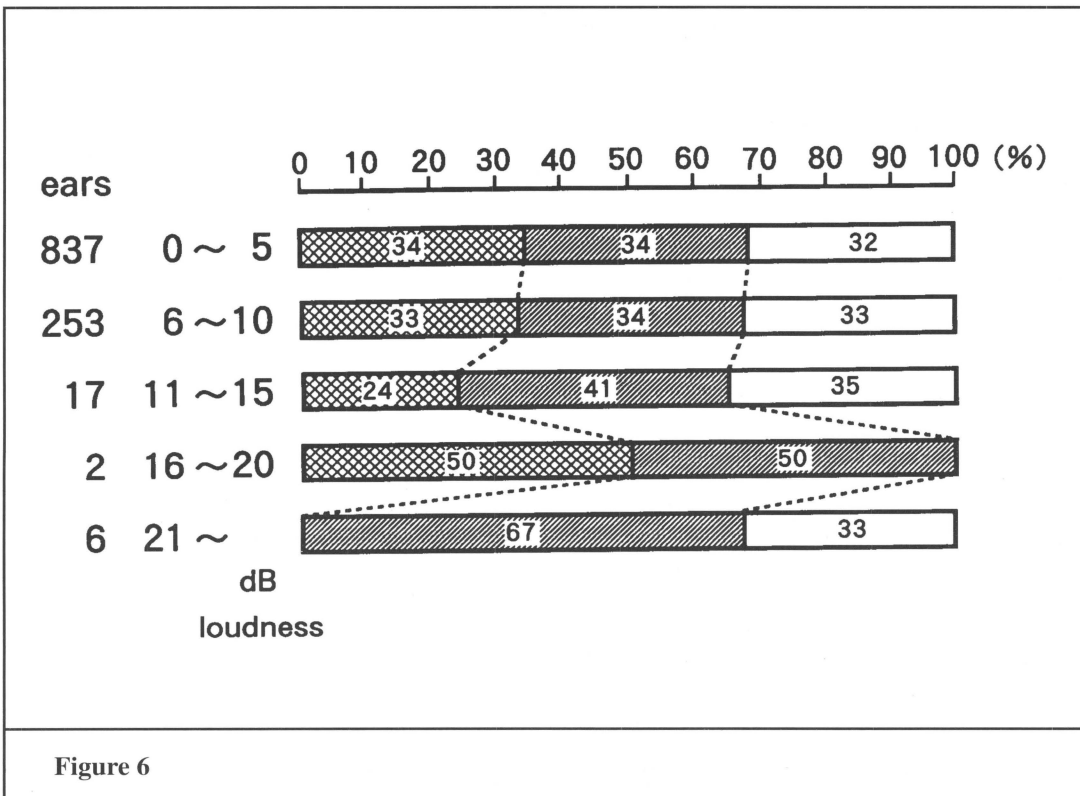


Figure 6

different length of disease was 77% for six months or less, 74% for 12 months or less, and 65% for 13 months or longer. The long-term efficacy rate at 12 months for groups with different length of disease was 100% for 6 months or less, 74% for 12 months or less, and 75% for 13 months or longer.

The long-term efficacy rate after three months for groups with different pitches of tinnitus was 72% for 125Hz, 90% for 250Hz, 80% for 500Hz, 56% for 1000Hz, 71% for 2000Hz, 100% for 3000Hz, 70% for 4000Hz, and 70% for 8000Hz. After 6 months, the long-term efficacy rates were 83% for 125Hz, 77% for 250Hz, 60% for 500Hz, 64% for 1000Hz, 71% for 2000Hz, 67% for 3000Hz, 69% for 4000Hz, and 81% for 8000Hz. After 12 months, the long-term efficacy rates were 100% for 125Hz, 100% for 250Hz, 60% for 500Hz, 67% for 1000Hz, 100% for 2000Hz, 100% for 3000Hz, 78% for 4000Hz, and 73% for 8000Hz.

The long-term efficacy rate after three months in the groups with different loudness of tinnitus was 77% for 5dB or less, 77% for 10dB or less, 50% for 15dB or less, and 50% for 20dB or less. After six months, the long-term efficacy rates were 85% for 5dB or less, 77% for 10dB or less, 67% for 15dB or less. After 12 months, the long-term efficacy rates were 100% for 5dB or less, 69% for 10dB or less, 67% for 15dB or less.

DISCUSSION

In this study, we evaluated patients with cochlear-tinnitus for the purpose of treatment. Because the symptom resulted from inner ear disturbances, sensorineural deafness accompanied most cases. There have been many hypotheses for the etiology of tinnitus such as¹ increased spontaneous electric discharge from the auditory hair cells (abnormal excitation),² decreased spontaneous electric discharge from the auditory hair cells,³ changes of chemical components in internal external lymph fluid,⁴ increased Brownian movement in lymph fluid accompanying decoupling of the auditory hairs of the tectorial membrane,⁵ and others. None of these hypotheses are universally accepted as proven results.

We performed an intratympanic dexamethasone infusion in this study. The drug solution was administered into the middle ear through a tympanic puncture. The drug solution probably enters the inner ear through the round window. This is a Steroid Targeting Therapy (STT) for cochlear-tinnitus. Compared to systemic administration, the local administration enables the use of a high concentration drug solution.⁶ A great advantage of intratympanic dexamethasone infusion is its use in the outpatient department. For Ménière's disease, the local infusion has been effective not only in tinnitus, but also vertigo. An important point for this treatment is contact

of the drug solution with the round window for a longer period.

In this study, cochlear tinnitus was seen frequently in the age group of 50 - 60 years of age, a relatively older population. The results of the treatment for tinnitus in different age groups did not show a correlation between age and treatment efficacy rate. In the investigation of the treatment results with different underlying ear diseases, the efficacy rate was high for tinnitus accompanying chronic otitis media, Ménière's disease, and labyrinth syphilis. The efficacy rate tended to decrease more with longer disease duration. When the mean hearing level and treatment results were evaluated, a high efficacy rate was found in patients who had mild deafness. The efficacy rate was high in tinnitus of low tone pitch, and low tinnitus with high tone pitch. On the other hand, different degrees of loudness of tinnitus did not correlate with treatment effects.

With respect to the fluctuation of tinnitus in different underlying ear disease after treatment, patients with well-maintained tinnitus after three - six months were common in the group with chronic otitis media, and the patients with recurrence were common in the group with functional inner ear disturbance, such as Ménière's disease and labyrinth syphilis. Patients with well-maintained tinnitus after three - six months were common in low tone ranges (125 or 250Hz). In the groups with a middle or high tone ranges, the recurrent rate was also large.

The overall efficacy rate of intratympanic dexamethasone infusion was 77% immediately after treatment and 68% after six months. It appears that treatment effects were persistent to some extent.

The mechanism of this action of this treatment involves several steroid actions, including sedative effects, metabolic improving effect, and edema relieving effect, which may eliminate abnormal excitation of auditory hair cells which are believed to cause tinnitus. For Ménière's disease, this treatment may improve endolymphatic hydrops.

In this intratympanic Dexamethasone infusion method, it is assumed that the drug enters the inner ear through the round window. Accordingly, it is necessary to position the patient to assure that the drug solution makes contact with the round window for as long as possible. When the infusion is performed in a sitting position in the outpatient department, the face was positioned to turn upward as much as possible. After the drug is infused, the patient should be kept silent, resting for approximately 10 minutes.

In our outpatient department, we use intratympanic dexamethasone infusion for patients with tinnitus refractory to drug administration.^{1,7-11} We sometimes perform inner ear anesthesia with lidocaine at the same

intratympanic infusion.^{1,8-15} However, because this treatment induces labyrinthine hypofunction, the patient must rest in bed for about three to four hours. Thus, it is difficult to use inner ear anesthesia as an outpatient treatment.

Intratympanic dexamethasone infusion was effective for tinnitus accompanying chronic otitis media, Ménière's disease, and labyrinth syphilis. It was less effective for tinnitus cases accompanying streptomycin intoxication or after head injury. Intratympanic infusion of 4% lidocaine or the intravenous infusion of 2% lidocaine should be attempted for patients who have poor results from the intratympanic dexamethasone infusion.

The short-term side effects of this treatment include pain at the time of tympanic puncture, temporary vertigo immediately after the infusion and acute otitis media. The temporary vertigo is probably caused by caloric stimulation. To avoid it, it is desirable to infuse the drug solution at body temperature. Acute otitis media was seen in two of 1466 ears. Persistent side effects were rare; tympanic perforation in two of 1466 ears. There were no patients who had rapid hearing reduction after the treatment.

SUMMARY

We performed intratympanic dexamethasone infusion as a treatment for cochlear-tinnitus and investigated its efficacy. This is a Steroid Targeting Therapy (STT) for cochlear-tinnitus.

The intratympanic dexamethasone infusion was effective for tinnitus accompanying chronic otitis media, Ménière's disease, and labyrinthine syphilis.

This treatment method is useful as a local therapy for cochlear-tinnitus in the outpatient setting.

REFERENCES

1. Sakata E, Itoh A, Ohtsu K, Nakazawa H, Iwashita N: Pathology and treatment of cochlear tinnitus by blocking with 4% Lidocaine and Decadron infusion. *Practica Otologica (Japan)* 75:2525- 2535,1982.
2. Durrant JD: Auditory physiology and an auditory physiologist view of tinnitus. *J Laryngol Otol Suppl* 4:21-28,1981.
3. Kiang NYS, Moxon EC, Levine RA: Auditory nerve activity in cats with normal and abnormal cochleas. Sensorineural hearing loss. G.W.A. Wolstenholme, J. Knight, Eds. London: Churchill, pp 241-273. 1970.
4. Strichartz GR: Pharmacological properties of sodium channels in nerve membranes. *Advances in neurology* Vol 31. S.G. Waxman, J.M. Ritchie, Eds. New York: Raven Press, pp343- 356, 1981.
5. Hilding AC: Studies on the otic labyrinth: The possible relation of the insertion of the tectorial membrane to acoustic trauma, nerve deafness and tinnitus. *Ann Otol Rhinol Laryngol*, 62:470- 476,1953.
6. Sato H, Takabayashi N, Yagi N: Uptake of steroid in the inner ear after intratympanic administration of CMC steroid. *Practica Otologica (Kyoto)*, 82:715- 718,1989.
7. Sakata E, Itoh A, Ohtsu K, Nakazawa H, Iwashita N, Noguchi T: Treatment of cochlear tinnitus. Effect of transtympanic infusion with Dexamethasone fluid. *Audiology (Japan)* 26:148- 151,1983.
8. Sakata E, Nakazawa H, Iwashita N: Therapie des Ohrensausens. Paukenhöhleninfusion von Lidocain- und Steroidlösung. *ANL* 11:11- 18,1984.
9. Sakata E, Kitago Y, Murata Y, Teramoto K: Behandlung der Ménièreschen Krankheit. Paukenhöhleninfusion von Lidocain- und Steroidlösung. *ANL* 13:79- 89,1986.
10. Sakata E, Itoh N, Itoh A, Ohtsu K, Nakazawa H, Nakaigawa K, Itoh Y: Comparative studies of the therapeutic effects of inner ear anesthesia and middle ear infusion of a steroid solution for Ménière's disease. *Practica Otologica (Japan)* 80:57- 65,1987.
11. Itoh A, Sakata E: Treatment of vestibular disorder - Intratympanic dexamethasone injection and inner ear anesthesia with lidocaine. *Acta Otolaryngol Suppl* 481:617- 623,1991.
12. Ristow W: Zur Behandlung der Ménièrekrankheit mittels temporärer Labyrinthanästhesie. *Z Laryngol* 47:442- 448,1968.
13. Itoh A: Treatment of tinnitus caused by cochlear dysfunction - Transtympanic anesthesia on inner ear with local anesthetic (4% Lidocaine). *Audiology (Japan)* 26:142- 147,1983.
14. Itoh A, Sakata E: Evaluation of treatment of Ménière's disease. *Equilibrium Res (Japan)* 54:180- 186,1955.
15. Itoh A, Sakata E: Evaluation of the therapeutic effect of inner ear anesthesia in Ménière's disease. *Vertigo Nausea Tinnitus and Hearing Loss in Central and Peripheral Vestibular Diseases*. C.F. Claussen, E. Sakata, A. Itoh, Eds. Excerpta Medica, pp173- 176, 1995.