Stellate Ganglion Block for the Relief of Tinnitus in Vibration Disease

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Summary: Vibration disease results from the long-term use of vibratory tools such as chain-saws and pneumatic hammers. Vibration, noise, and cold are stressors that impair the human body. Consequently, signs and symptoms can occur, including tinnitus which can be associated with hearing loss. Tinnitus occurs in approximately 40% of the patients, and is hard to effectively treat. Stellate ganglion block was performed in patients with tinnitus. The efficacy of the ganglion block was evaluated by the five steps' method of patient self-assessment and by the audiometric method. The effective rates of the ganglion block for tinnitus was 62.5% by self-assessment and 68.8% by audiometric assessment. The hearing acuity partially recovered and was associated with good or partial relief of tinnitus. A follow-up study for 18 months revealed that the efficacy of stellate ganglion block for tinnitus persisted. Thus, stellate ganglion block therapy can be effective for the treatment of tinnitus in patients with vibration disease.

Key words: tinnitus — stellate ganglion block — procaine — hearing acuity — vibration disease

Introduction

Habitual use of vibratory tools produces many signs and symptoms in the operators (Matoba et al. 1977). The major stressors are vibration, noise and cold which chronically affect the human body. The patients are afflicted with disturbances of peripheral circulatory, nervous, muscular and supporting systems and also by disorders of the acoustic system and autonomic nervous system. Tinnitus has been experienced by approximately 40% of the patients with vibration disease (Matoba et al. 1977). The current methods for treatment of tinnitus are masking, biofeedback, amplification, surgical and medical (Shea and Emmett, 1981). Unfortunately, it is difficult to adequately treat the tinnitus. Recently, the beneficial effects of intra-venous lidocaine, procaine, and other local anesthetics on tinnitus have been reported (Lewy, 1937; Shea and Harell, 1978; Israel et al. 1981; McCormick and Thomas, 1981). The anesthetic has a blocking action on the central and peripheral nervous systems (Ritchie, 1975; Strichartz, 1976). Accordingly, it would seem more appropriate to administer the drugs locally to avoid the adverse effects on the central nervous system. The methods by which procaine can be locally administered include stellate ganglion block, major occipital nerve block, and transtympanic infusion. Stellate ganglion block was tested as therapy for tinnitus in patients with vibration disease.

Subjects and Methods

Nineteen male patients with tinnitus in
vibration disease were studied. The average age was 51±5 (mean±SD) years. No patients had cardiovascular diseases. The vibratory tool used was the chain-saw. The average duration of habitual use of the chain-saw was 10.2±3.2 years. Before the present treatment, the patients had been hospitalized for an average of 6.7±3.5 cumulative months. Twenty-six percent of the patients were hospitalized once, 63% twice, 11% three times; however, the tinnitus was not completely relieved during hospitalization. The period between the last use of the chain-saw and treatment was an average 6.3±1.3 years.

Left or right stellate ganglion block was performed every other day for 6 weeks. A standard procedure was followed. A patient would lie in the supine position. A pillow was inserted under the neck of the patient, forcing the neck upward. The local anesthetic was injected into or around the stellate ganglion. The dose was 4ml of 2% procaine hydrochloride. Pressure was applied to the injection site for several minutes. A Horner’s syndrome was transiently induced by the injection. Also a temporary hoarseness appeared in some patients. The therapy was combined with physiotherapy including therapeutic exercise and hot packs of mineral paste on the shoulders.

Before and after the treatment period, the tinnitus was evaluated by self-assessment using the 5 steps' method and the audiometric method. The audiometric method involved the following procedure. The examiner operated the audiograph by gradually increasing the frequency and intensity of a pure sound. The examinee indicated whether the tone of the pure sound was almost the same as the tone of the tinnitus. These procedures were repeatedly performed to characterize the tinnitus. Drugs were not administered during the trial period.

After the 6 week treatment period, the patients were observed for 12 to 18 months.

Results

1. Subjective tinnitus

The severity of the tinnitus was evaluated by the patient’s self-assessment before and after treatment. The tinnitus in vibration disease can be intermittent or continuous in nature, and metallic or blowing in tone. In 79% of the subjects, the tinnitus was apparently reduced by stellate ganglion block therapy (Fig. 1). Greater than 2 steps improvement occurred in 62.5% of the patients. The number of patients with a severity of more than “one-plus” were decreased from 84% to 26%.

2. Objective assessment of tinnitus

The tinnitus was objectively evaluated with the audiometric method. A typical effect of treatment is shown in Fig. 2. This subject was a 54 year-old man who had complained of tinnitus for approximately 7 years. Stellate ganglion block therapy

![Fig. 1. Changes in severity of subjective tinnitus evaluated by self-assessment. Stellate ganglion block leads to a marked reduction in the severity of the tinnitus. Groups at more than "one-plus" were greatly decreased.](image-url)
markedly decreased the frequency of the tinnitus, and also moderately reduced the intensity.

In general, tinnitus was associated with a hearing loss. Figure 3 shows audiograms before and after treatment. At discharge, the hearing acuity of both ears, but especially the right ear, had distinctly improved as compared to the acuity on admission which is shown in the right audiogram. The intensity of the tinnitus in the right ear had decreased markedly as well. Consequently, intense and continuous tinnitus became weak and intermittent. The hearing acuity was improved during the treatment in 77% of the patients.

3. Effective rates of the therapy on tinnitus

The effective rate of stellate ganglion block therapy on tinnitus was estimated by self-assessment using the 5 steps' method and by the audiometric method. The improvement rates of tinnitus were 62.5% by self-assessment and 68.8% by audiometric assessment (Table 1). The intensity of the tinnitus was significantly decreased (p<0.01).

4. Follow-up study

After treatment, the patients were followed for 12 to 18 months. Tinnitus was evaluated by self-assessment and audiometric methods. Excellent or good relief occurred in 42.1% of the patients. Partial relief and no relief were observed in 42.1% and 15.8%, respectively.
Fig. 4 shows the time-course of tinnitus after treatment. This subject was a 49 year-old man who had complained of tinnitus for about 7 years. The tinnitus before treatment was continuous and intense. After stellate ganglion block therapy, the tinnitus became intermittent and weak. The score assessed by the patient was reduced from 10 to 3 points. The intensity and frequency of the tinnitus was decreased as shown by the square symbols (Fig. 4). The effect of therapy on the tinnitus persisted, even after 17 months.

5. Changes of other subjective symptoms

Stellate ganglion block therapy also had an influence on other signs and symptoms of vibration disease, as shown in Table 2.

### TABLE 1
Rates of effective therapy with stellate ganglion block

<table>
<thead>
<tr>
<th>Self-assessment (5 steps' method*)</th>
<th>Audiometric assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved</td>
<td>62.5 %</td>
</tr>
<tr>
<td>Unchanged</td>
<td>37.5 %</td>
</tr>
<tr>
<td>Aggravated</td>
<td>—</td>
</tr>
</tbody>
</table>

* More than 2 steps’ improvement is necessary.

Improvement was described as a change of more than 2 steps’ using the 5 steps’ method. The prevalence of tinnitus was 84.2 %. More than 2 steps’ improvement after treatment of the tinnitus occurred in 62.5 % of the patients. Headache, a heavy feeling in the head, nuchal stiffness, stiff shoulder and insomnia were also reduced.

### TABLE 2
Improvement of subjective symptoms

<table>
<thead>
<tr>
<th>Prevalence</th>
<th>Improvement</th>
<th>Unchanged</th>
<th>Improvement Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4 steps</td>
<td>3 steps</td>
<td>2 steps</td>
</tr>
<tr>
<td>Tinnitus</td>
<td>16 (84.2 %)</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Headache</td>
<td>14 (73.7 %)</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Heavy feeling in the head</td>
<td>17 (89.5 %)</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Nuchal stiffness</td>
<td>19 (100.0 %)</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Stiff shoulder</td>
<td>17 (89.5 %)</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Difficulty falling asleep</td>
<td>8 (42.1 %)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Disturbed from a sound sleep</td>
<td>11 (57.9 %)</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

Fig. 4. Typical follow-up study of tinnitus which was improved by stellate ganglion block. Even 18 months after therapy, the improvement persisted. A large and continuous tinnitus became weak and intermittent.
Discussion

Vibration disease is induced by the action of stressors, such as vibration, noise and cold temperatures (Matoba, 1979). Typical levels of tool vibration are between 90 and 140 dB (0.316 to 100 m/s²) and of tool noise are between 80 and 120 dB (A). Habitual exposure to such stressors may excite the hypothalamus and the limbic lobe in the cortex, which are the loci of the higher centers of the autonomic nervous system. Consequently, sympathetic tone can be significantly augmented, and the concentrations of circulating catecholamines can be increased (Koizumi and Brooks, 1980). In these situations vasoconstriction may occur, leading to a decrease in blood flow to the acoustic tissues. Experimentally, noise produces a reduction of cochlear blood flow in the conscious rabbit (Hultcrantz, 1979). Lesions of the hair cells in the inner ear result from circulatory disturbances due to the vasoconstriction (Hawkins, 1971). Electrical stimulation of sympathetic nerves produces a decrease in the potential of cochlear microphonics. This may be due to circulatory disturbances in the inner ear (Seymour, 1971). Eventually, this may lead to tinnitus and hearing loss, as shown in Fig. 5. Approximately 40% of the patients with vibration disease complain of tinnitus and associate hearing loss.

Local anesthetics have been used for the treatment of tinnitus since the report of Lewy in 1937. Procaine, a local anesthetic, has a vasodilatory action, probably due to the suppression of sympathetic nerve activity (Ritchie, 1975; Strichartz, 1976; Ritchie and Greece, 1980). Procaine can be administered orally, intravenously or by transtympanic infusion (McCornick and Thomas, 1981; Shea and Harell, 1978; Sakata and Umeda, 1976). Stellate ganglion block by procaine injection may also produce vasodilation, leading to an increase in blood flow. Experimental data indicated that cervical sympathectomy increased blood flow in the inner ear.

![Diagram](image)

Fig. 5. A hypothetical scheme for the effect of stellate ganglion block therapy on tinnitus. Three major stressors, vibration, noise and cold, elicit vibration disease. These stressors produce vasoconstriction, leading to ischemic changes of acoustic tissues. Consequently, tinnitus associated with hearing loss may occur. In contrast, stellate ganglion block results in vasodilation, which leads to repair of the injured tissues. Neurophysiologically, this may be related to the law of supersensitivity after denervation, as described by Cannon.
Denervation of a tissue results in supersensitivity to both chemical and physical stimuli (Cannon, 1939). Changes of the characteristics of the tissue may result in increased nutrition from the blood flow. Thus, supersensitivity, as well as increased blood flow, from stellate ganglion block may accelerate the repair of the injured tissues in the inner ear. In 11 of 19 patients, the tinnitus was either reduced or eliminated, and the hearing acuity was improved as well. In the follow-up study, the effect lasted for a long period. In conclusion, stellate ganglion block therapy can be effective in the treatment of patients with tinnitus from vibration disease.

References


