

Doppler Ultrasonography in Tinnitus Patients

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Abstract: Tinnitus can be functionally measured and localized through sensorimotor and neurosensory tests. According to our Neurofisiología Otooftalmológica data bank, 60% of patients requiring a consultation have a history of cardiocirculatory disorders. This figure has moved us to study cerebrovascular processes in those patients seeking consultation for a tinnitus symptom only. The sudden appearance of the tinnitus symptom alone, independent of patient age, leads us to consider a pathology of vascular origin, which should be evaluated and treated immediately. A mistake or delay in the diagnosis could cause the symptom to become chronic, owing to the appearance of microlesions at any level of the auditory pathway, as has been demonstrated in former investigations.

Key Words: diagnosis; Doppler ultrasonography; tinnitus; treatment; extracranial USD

Tinnitus can be functionally measured and localized through sensorimotor and neurosensory tests. As we have demonstrated in former publications [1,2], these tests indicated the numerous and different locations of the symptom and enabled us to prove that in approximately 24% of affected patients, tinnitus had a peripheral origin; in 35%, it originated in the brainstem; and in 41%, it originated at a supratentorial level.

As regards the pathogenesis of tinnitus, there could be several different causes, such as metabolic disorders, degenerative diseases, tumors, and vascular disorders. According to our data bank, 60% of the patients requiring a consultation have a history of cardiocirculatory disorders. This figure has motivated us to study cerebrovascular processes in patients consulting exclusively for the tinnitus symptom.

MATERIALS AND METHODS

We studied 171 patients who sought medical consultation for only the tinnitus symptom. Their average age was $49.10 \text{ years} \pm 15.71 \text{ years}$. These patients have undergone several examinations, including extracranial Doppler ultrasonography (USD) of the supratrochlear and vertebral arteries and transcranial USD. The USD

evaluation [3] consists of supporting in the skull area a probe capable of emitting a variable-frequency sound (variation depending on the artery depth). The sound is reflected by the blood cell column that circulates through the artery.

The breakeven point of the intracranial inner carotid circuit with the extracranial circuit is the supratrochlear artery, which easily located at the level of the upper and inner angle of the eye. To simplify statistical data collection, we studied the supratrochlear artery and evaluated different arterial parameters by means of computer methods: maximum systolic velocity (MSV, in centimeters per second), end-diastolic velocity (EDV, in centimeters per second), and the stenosis index (SI, expressed as a percentage).

RESULTS

For the purpose of establishing whether variations of hemodynamic parameters exist with respect to some other pathological processes, we compared a tinnitus population with similar groups. One group consisted of patients who have been seen exclusively for migraine or severe headache, and another group was made up of patients who have sought consultation for vertigo or dizziness symptoms. Table 1 shows an increase in MSV in tinnitus patients as compared to migraine patients and to the general population. This increase is observed also in vertigo patients but with a standard deviation higher than that in the tinnitus group. EDV parameters do not show a significant value among the different pathologies.

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Table 1. Increase in Systolic Velocity

USD Supratrochlear Artery	No.	MSV (cm/sec)	EDV (cm/sec)
General	770	14.76 ± 5.92	6.89 ± 4.71
Vertigo	160	18.15 ± 11.19	7.89 ± 5.87
Migraine	152	9.17 ± 7.65	5.45 ± 4.53
Tinnitus	171	19.91 ± 4.62	5.52 ± 4.82

EDV = end-diastolic velocity; MSV = maximum systolic velocity; USD = Doppler ultrasonography.

Table 2. Increase in Stenosis Index

USD Supratrochlear Artery	No.	Stenosis Index (%)
General	770	25.94 ± 22.31
Vertigo	160	26.47 ± 21.92
Migraine	152	23.96 ± 19.02
Tinnitus	171	67.02 ± 23.35

USD = Doppler ultrasonography.

Table 3. Variations of Parameters

USD Supratrochlear Artery	No.	MSV (cm/sec)	EDV (cm/sec)	Stenosis Index (%)
20–40 years old	38	20.77 ± 6.58	7.97 ± 6.13	57.70 ± 23.16
41–60 years old	60	19.78 ± 3.37	3.80 ± 3.51	65.82 ± 24.30
61 years old	73	19.20 ± 3.93	4.79 ± 4.82	77.55 ± 22.61
Total	171	19.91 ± 4.62	5.52 ± 4.82	67.02 ± 23.35

EDV = end-diastolic velocity; MSV = maximum systolic velocity; USD = Doppler ultrasonography.

Table 2 shows an important increase in the SI among tinnitus patients as compared to other patients studied, which coincides with the increase of the MSV. Table 3 shows the variations of these parameters among the tinnitus patients, in accordance with the different ages of the patients. The SI is remarkably increased relative to increasing age of the patients. Values corresponding to MSV and to EDV are not statistically significant, regardless of age.

Table 4. Behavior of Vascular Parameters

USD Supratrochlear Artery	Tinnitus Population (no.)	MSV (cm/sec)	EDV (cm/sec)	Stenosis Index (%)
Before treatment	171	19.91 ± 4.62	5.52 ± 4.82	67.02 ± 23.35
After treatment	63	17.94 ± 3.08	8.15 ± 2.13	38.91 ± 11.23

EDV = end-diastolic velocity; MSV = maximum systolic velocity; USD = Doppler ultrasonography.

The group of patients who sought consultation solely for tinnitus showed an important increase in the SI independent of age; this increase is not observed in patients with other pathological processes or symptoms. These SI values, reaching 57.70% in young people between the ages of 20 and 40 years, are easily proved in our daily consultation. It is particularly evident in those patients who are under stress due to present working conditions (e.g., managers of multinational companies or upwardly mobile young businesspeople who are receiving clinical treatment for arterial hypertension). Also, in most of these patients, ophthalmological examination reveals recurring incidents of macular edema, which may coincide with the fluctuations in their tinnitus variations.

Finally, Table 4 compares the behavior of vascular parameters before and after treatment. We observed an important drop in the SI and a significant decrease of the tinnitus symptom after administration of a vascular antispasmodic and neuroprotective agent.

As an example of these typical clinical manifestations, we report the clinical case of a 35-year-old patient who presented with arterial hypertension 6 months ago. He consulted for tinnitus and turbid vision, both of which symptoms appeared suddenly 1 month previously. The results of his auditory examinations were normal. However, his ophthalmological examination denoted a bilateral macular edema. Extracranial USD of both supratrochlear arteries revealed an important increase of both the MSV and the SI.

A vasodilating medication, nimodipine, was indicated, administration of which resulted in a highly significant improvement in cerebral hemodynamic study results after 20 days of treatment, as well as disappearance of the tinnitus symptom and improved visual acuity.

CONCLUSIONS

The sudden appearance of the tinnitus symptom alone, independent of patient age, leads us to con-

sider a pathology of vascular origin, which should be evaluated and treated immediately. A mistake or delay in the diagnosis could cause the symptom to become chronic, owing to the appearance of microlesions at any level of the auditory pathway, as has been demonstrated in former investigations [1, 2].

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