

Acoustics of tinnitus

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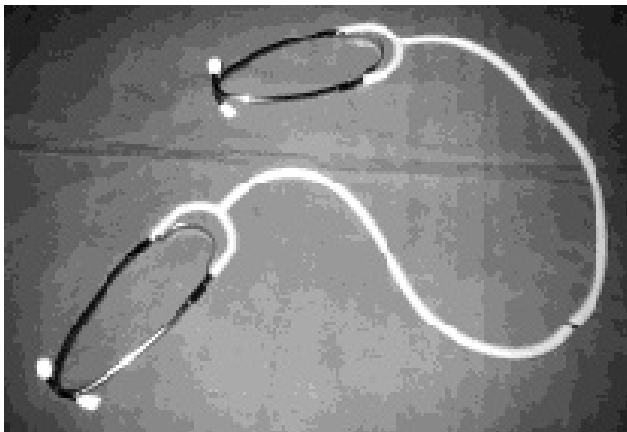


Figure 1 - Franceschi's acouphénoscope (realization by F Passariello).

Tinnitus is auditory sensations caused by somatic disorders independently of any external stimulus¹. This differentiates them from abnormal sensations triggered by stimuli outside the body and auditory hallucinations of psychic origin. These sensations correspond either to mechanical noises that can be perceived by an outside observer with or without a detection instrument, or to perceptual anomalies responsible for an auditory sensation in the absence of an objective internal sound source. They are classically defined as continuous or intermittent hums of low tone, short-duration clicks without a well-defined tonal character, continuous or intermittent whistling of high tone, and continuous or intermittent ringing of medium tone. They can also be classified according to their etiology:

- Tinnitus produced by vascular, arterial, venous and arteriovenous murmurs.

*English translation and reprint
of the chapter*

"Acoustique des acouphènes"

from the book

L'Encefalo ben temperato, 1997

Keywords Murmur, Supra-aortic arterial stenosis, venous stenosis, AV-Fistula, AVF and arterial stenosis

- Tinnitus generated by the chain of transmission: snapping of the eardrum, myoclonus of the hammer muscles
- Tinnitus of cochleo-neurological origin creating an illusion of sound
 - 1) cochlear endo-lymphatic hypertension associating hearing deficit, true dizziness and tinnitus (Meniere's disease)
 - 2) hypothetical hyperactivity or inhibition of the controllers of cochlear external hair cells
 - 3) noise in loss-making auditory frequency bands.

In any case, tinnitus can interfere more or less seriously with the psyche.

Vascular causes

These are either vibrations produced by the turbulent passage of blood through a vessel close enough to a cranial wall to be transmitted to the cochlea by bone, or hyperkinetic arterial beats close to the ear.

Turbulence is modulated in frequency as well as amplitude by the heart rate. Very clearly when it comes to excessive speeds in an artery, either at the level of a stenosis or a kinking, or because of very high flow by arteriovenous fistulas downstream. Less clearly when the turbulence generated comes from a venous flow. In any case, sufficient reduction of the flow leads to a cessation of tinnitus.

Instrumental exploration methods may show stenoses, kinking or arteriovenous fistulas, but the proof of their responsibility must be supplemented by flow reduction maneuvers, the most immediate of which are the direct manual compressions of the vessels that suppress tinnitus can only provide proof.

The most common causes are juxta and intra-petrous or endocranial arterial stenosis of the internal carotid artery, rarer stenoses of the basilar trunk, arteriovenous fistulas between the branches of the external carotid artery and/or vertebral artery, intracranial arteriovenous fistulas. Sometimes it is an internal jugular vein, generating noise from the gulf without an angiographic detection of an obvious anomaly. But it is probably either its bayonet path at this level that can determine turbulence, or vibrations of an undetectable fibrinous flap.

The clinical diagnosis is established on the pulsatile character of tinnitus, punctuated by the heart and sometimes associated with a murmur audible to the stethoscope, of tone comparable to that of an arterial murmur. The responsible vessel is the internal jugular vein when it is abolished for a slight compression of the antero-lateral side of the neck, a maneuver that the patient already often knows how to do to stop his tinnitus. It is the carotid when abolition is caused by the direct compression of the common carotid. The differentiation between the external and internal carotid origin is more difficult but is sometimes obvious when the patient himself has already identified the site of compression that relieves him. These are fistulas between the external carotid artery and the lateral sinus when effective compression concerns the occipital artery. Arterial hyperkinesis beats have the tone of a drumbeat punctuated by the heart. The use of a double inverted stethoscope worn by both the patient and the doctor can make it possible to hear what the patient is hearing (Fig. 1).

The doppler echo oriented by the clinic, combining continuous Doppler, intracranial pulsed Doppler, Duplex scan, and possibly color coding, must look for stenosis and arteriovenous fistulas possibly responsible. The modalities

are a bit complex and require a good knowledge and experience of compression maneuvers.

Angiography, often guided by Echo-Doppler data, will confirm the diagnosis. Treatments consist, when topography permits, in removing stenoses, reducing the flow rates of arteriovenous fistulas and jugular veins. They range from surgery to irradiation to embolization.

It is also understandable why vascular pulsatile tinnitus can be aggravated by vaso-active treatments intended to reduce microcirculatory resistance and therefore increase speeds and flow rates.

Otologic causes

The clicking of the eardrum and sometimes the whistling by dysfunction of the Eustachian tube, are evoked on their occasional occurrence often circumstantiated (blowing efforts, plane travel).

Myoclonus of the hammer muscle causes tinnitus in the form of brief burst clicks, irregular, not rhythmic by the heart and of equivalent etiology to those of myoclonus of the eyelid.

Continuous buzzing and whistling are sometimes related to a primary cause, Meniere's disease, sound trauma but most often impossible to explain to oneself as well as to the patient leading to multiple and negative paraclinical investigations apart from the often associated hearing deficits and as we have said in the frequency band corresponding to that of tinnitus by an equivalent of the phantom limb phenomenon.

Auditory hallucinations (acousmia)

It is not a proper tinnitus, but it must be recognized as a differential diagnosis. These are chronic or acute delusional psychiatric phenomena.

They must be carefully analysed to avoid the error that had led to the psychiatric hospital a man because he heard Radio Paris every day from 7 am to 24 hours in the absence of a radio receiver and which was miraculously cured by the removal of a dental prosthesis that inadvertently functioned as a galena station set to the frequency of the Radio Paris transmitter. Temporal epilepsies can also lead to auditory hallucinations.

Conclusion

Most of the tinnitus is of cochleo-neurological origin, rebellious to para-clinical investigations and desperately incurable today. The other causes, among which the vascular causes deserve to be recognized because of the neurological and vital risks related to their nature but also the reasonable possibilities of effectively treating a symptom that is not dangerous by itself but very uncomfortable that can disturb the psyche until suicide.

References

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