Otoacoustic emission

An otoacoustic emission (OAE) is a sound which is generated from within the inner ear. Having been predicted by Thomas Gold in 1948, its existence was first demonstrated experimentally by David Kemp in 1978 and otoacoustic emissions have since been shown to arise through a number of different cellular and mechanical causes within the inner ear.

Studies have shown that OAEs disappear after the inner ear has been damaged, so OAEs are often used in the laboratory and the clinic as a measure of inner ear health.

Broadly speaking, there are two types of otoacoustic emissions: spontaneous otoacoustic emissions (SOAEs), which can occur without external stimulation, and evoked otoacoustic emissions (EOAEs), which require an evoking stimulus.

OAEs are considered to be related to the amplification function of the cochlea. In the absence of external stimulation, the activity of the cochlear amplifier increases, leading to the production of sound. Several lines of evidence suggest that, in mammals, outer hair cells are the elements that enhance cochlear sensitivity and frequency selectivity and hence act as the energy sources for amplification. One theory is that they act to increase the discriminability of signal variations in continuous noise by lowering the masking effect of its cochlear amplification.

Otoacoustic emissions are clinically important because they are the basis of a simple, non-invasive test for hearing defects in newborn babies and in children who are too young to cooperate in conventional hearing tests. Many western countries now have national programmes for the universal hearing screening of newborn babies. Periodic early childhood hearing screenings program are also utilizing OAE technology. One excellent example has been demonstrated by the Early Childhood Hearing Outreach initiative at the National Center for Hearing Assessment and Management (NCHAM), Utah State University which has helped hundreds of Early Head Start programs across the United States implement OAE screening and follow-up practices in those early childhood educational settings.

The primary screening tool is a test for the presence of a click-evoked OAE. Otoacoustic emissions also assist in differential diagnosis of cochlear and higher level hearing losses (e.g., auditory neuropathy).

Case series

2016

Forty-four patients with normal pressure hydrocephalus (23 idiopathic and 21 secondary cases) were included in a prospective observational study. The male:female sex ratio was 1.44, the age range was 21-87 years (mean age 64.3 years), and the range of the follow-up period was 1-3 years (mean 20 months). Patients were implanted with a Sophy SU8 adjustable valve as the ventriculoperitoneal shunt. The phase shifts of otoacoustic emissions in response to body tilt were measured preoperatively, immediately postoperatively, and at 3-6 months, 7-15 months, 16-24 months, and more than 24 months postoperatively. Three groups were enrolled: Group 1, 19 patients who required no valve opening-pressure adjustment; Group 2, 18 patients who required valve opening-pressure adjustments; and Group 3, 7 patients who required valve replacement.

In Group 1, phase shift, which was positive before surgery, became steadily negative after surgery and during the follow-up. In Group 2, phase shift, which was positive before surgery, became negative immediately after surgery and increasingly negative after a decrease in the valve-opening pressure. In Group 3, phase shift was positive in 6 cases and slightly negative in 1 case before revision, but after revision phase shift became significantly negative in all cases.

Otoacoustic emissions noninvasively reflect cerebrospinal fluid shunt function and are impacted by valve-opening pressure adjustments. Otoacoustic emissions consistently diagnosed shunt malfunction and predicted the need for surgical revision. The authors' diagnostic test, which can be repeated without risk or discomfort by an unskilled operator, may address the crucial need of detecting valve dysfunction in patients with poor clinical outcome after shunt surgery [1].

1)
Sakka L, Chomicki A, Gabrillargues J, Khalil T, Chazal J, Avan P. Validation of a noninvasive test routinely used in otology for the diagnosis of cerebrospinal fluid shunt malfunction in patients with normal pressure hydrocephalus. J Neurosurg. 2016 Feb;124(2):342-349. Epub 2015 Aug 21. PubMed PMID: 26295913.