Sri Lakshmi Narayana Institute of Medical Sciences

Date 02/05/2018

From
Dr.K.R.Jothikumar,
Professor and Head,
otorhinolaryngology,
SLIMS
Bharath Institute of Higher Education and Research,
Puducherry.

To
The Dean,
SLIMS
Bharath Institute of Higher Education and Research,
Puducherry.

Sub: Permission to conduct value-added course: : Hands on experience of Screening infants with OAE reg.

Dear Sir,

With reference to the subject mentioned above, the department proposes to conduct a value-added course titled: Simulation Based Training In Audiology on May 2018 to Aug 2018. We solicit your kind permission for the same.

Kind Regards

Dr.K.R. Jothikumar

FOR THE USE OF DEANS OFFICE

Names of Committee members for evaluating the course:
The Dean:
The HOD:
The Expert:

`

The committee has discussed about the course and is approved.

Dean

(Sign&Seal)

DEAN
Prof.K.BALAGURUNATHAN,M.S
(General surgeon)
SRI LAKSHMI NARAYANA
INSTITUTE OF MEDICAL SCIENCES
OSUDU PONDICHERRY

Dr.T.C VENKATARAMANAN
Reg. No: 72549
Professor ENT
Sri Lakshmi Narayana Institute of Medical Sciences
Osudu, Kudapakkam, Puducherry-605 502

SUBJECT EXPERT
(Sign &Seal)

Seal & Signature of the HOD
PROFESSOR & HOD
DEPARTMENT OF E.N.T
Sri Lakshmi Narayana Institute of Medical Sciences
PONDICHERRY - 605 502

OFFICE OF THE DEAN
Sri Lakshmi Narayana Institute of Medical Sciences
OSUDU, AGARAM VILLAGE, VILLIANUR COMMUNE, KUDAPAKKAM POST,
PUDUCHERRY - 605 502.
[Recognised by Medical Council of India, Ministry of Health letter No. U/12012/249/2005-ME (P -II) dt. 11/07/2011]
[Affliated to Bharath University, Chennai - TN]

Ref. No. SLIMS/Dean Off/VAC/024 **Date:03/05/18**

From
The Dean
Sri Lakshmi Narayana Institute of Medical sciences,
Pondicherry – 605502

To
The Registrar,
Bharath Institute of Higher Education and Research,
Chennai - 600073.

Respected Sir

Sub: Request for permission and approval of Syllabus for certificate course (Value Added course) for the academic year 2017-18 - Reg
Ref: Requesting letter received from Departments

*****

With reference to the above, herewith forwarding the proposed list of Value-added courses for necessary permission and approval of syllabus to conduct the same.

This is for your kind information and needful action.

Thankingyou

Yours faithfully

[**DEAN]**

DEAN
Prof.K.BALAGURUNATHAN,M.S
(General surgeon)
SRI LAKSHMI NARAYANA
INSTITUTE OF MEDICAL SCIENCES
OSUDU PONDICHERRY

Encl's:

1. Requesting letter received from department
2. Syllabus of thecourse
3. Details of faculty handlingcourse

Sri Lakshmi Narayana Institute of Medical Sciences, Puducherry

VALUE ADDED COURSE : Hands on experience of Screening infants with OAE

COURSE CO-ORDINATOR DETAILS

Faculty Name: Dr. K.Venkataramanan

Email ID:e n t s l i m s @ g m a i l . c o m

Bharath
INSTITUTE OF HIGHER EDUCATION AND RESEARCH
(Declared as Deemed - to - be - University under section 3 of UGC Act 1956)

Ref. No. BHIER/ VAC/B-02 **Date:05.05.2018**

From

The Registrar,
Bharath Institute of Higher Education and Research,
Chennai - 600073.

To

The Dean
Sri Lakshmi Narayana Institute of Medical sciences,
Pondicherry – 605502

Sir / Madam,

Sub: Approval of Syllabus to conduct certificate course (Value Added course) for the academic year 2017-2018 – Reg.

Ref: Ref. No. SLIMS/Dean Off/VAC /024 Dated: 03.05.2018

*****

With reference to the above, it is to inform that the proposal submitted to conduct Value Added Course has been accepted and approved by BIHER, council meeting. List of the VAC are mentioned below for the academic year 2017– 2018. The abstract of the VAC course completion detail should be submitted to the Registrar office.

Thanking you Yours faithfully

REGISTRAR

OFFICE OF THE DEAN
Sri Lakshmi Narayana Institute of Medical Sciences
OSUDU, AGARAM VILLAGE, VILLIANUR COMMUNE, KUDAPAKKAM POST,
PUDUCHERRY - 605 502.
[Recognised by Medical Council of India, Ministry of Health letter No. U/12012/249/2005-ME (P -II) dt. 11/07/2011]
[Affliated to Bharath University, Chennai - TN]

Circular

.

07/05/2018

Sub: Organising Value-added Course: Hands on experience of Screening infants with OAE **reg.**

With reference to the above mentioned subject, it is to bring to your notice that SLIMS,**Bharath Institute of Higher Education and Research**, is organising **"Hands on experience of Screening infants with OAE"**. The course content and registration form is enclosed below.

The application must reach the institution along with all the necessary documents as mentioned. The hard copy of the application should be sent to the institution by registered/ speed post only so as to reach on or before 15/05/2018. Applications received after the mentioned date shall not be entertained under any circumstances.

DEAN

DEAN
Prof.K.BALAGURUNATHAN,M.S
(General surgeon)
SRI LAKSHMI NARAYANA
INSTITUTE OF MEDICAL SCIENCES
OSUDU PONDICHERRY

Encl: Copy of Course content

VALUE ADDED COURSE

1. Name of the programme &Code

Hands on experience of Screening infants with OAE – A value added course for the medical students.
& **ENT 07**

.

2. Duration &Period

30 hrs & May 2018-Aug 2018

3. Information Brochure and Course Content of Value Added Courses

Enclosed as Annexure- I

4. List of students enrolled

Enclosed as Annexure- II

5. Assessment procedures:

Pre test and post test which includes 10 mcqs - *Enclosed as Annexure- III*

6. Certificate model

Enclosed as Annexure- IV

7. No. of times offered during the same year:

1 time May 2018- Aug 2018

8. Year of discontinuation:2018

9. Summary report of each program year-wise

Value Added Course- May 2018- Aug 2018					
Sl. No	**Course Code**	**Course Name**	**Resource Persons**	**Target Students**	**Strength & Year**
1	ENT 07	Hands on experience of Screening infants with OAE	1.Dr.Venkataramanm 2. Dr. Sreedhar.B 3.Dr. kalaiarasi.R	3rd year MBBS students	10 students & 2018

10. Course FeedBack

Enclosed as Annexure- V

RESOURCEPERSON
1. **Dr.K.R.Jothikumar**
2. **Dr.Sreedhar.B**

COORDINATOR
Dr.R.Venkataramanan

COURSE PROPOSAL

1. NAME OF THE PROGRAMME

Hands on experience of Screening infants with OAE– A value added course for the medical students.

2. AIM

Training the students to screen infants with OAE

3. OBJECTIVES

a) To provide hands on training for students in OAE for screening infants

4. METHODOLOGY

Students who are interested in participating in value added course are enrolled and the course is conducted for them during the non college hours for a period of 30 hours from May 2018 – Aug 2018 . This course is conducted every 6 months.

Course Audience: 3rd year MBBS students

Course Coordinator: Dr.K.Venkataramanan

Course Faculties with Qualification and Designation:

1.Dr.K.R. jothikumar

2.Dr. Sreedhar.B

3.Dr. Kalaiarasi.R

Schedule followed during the course

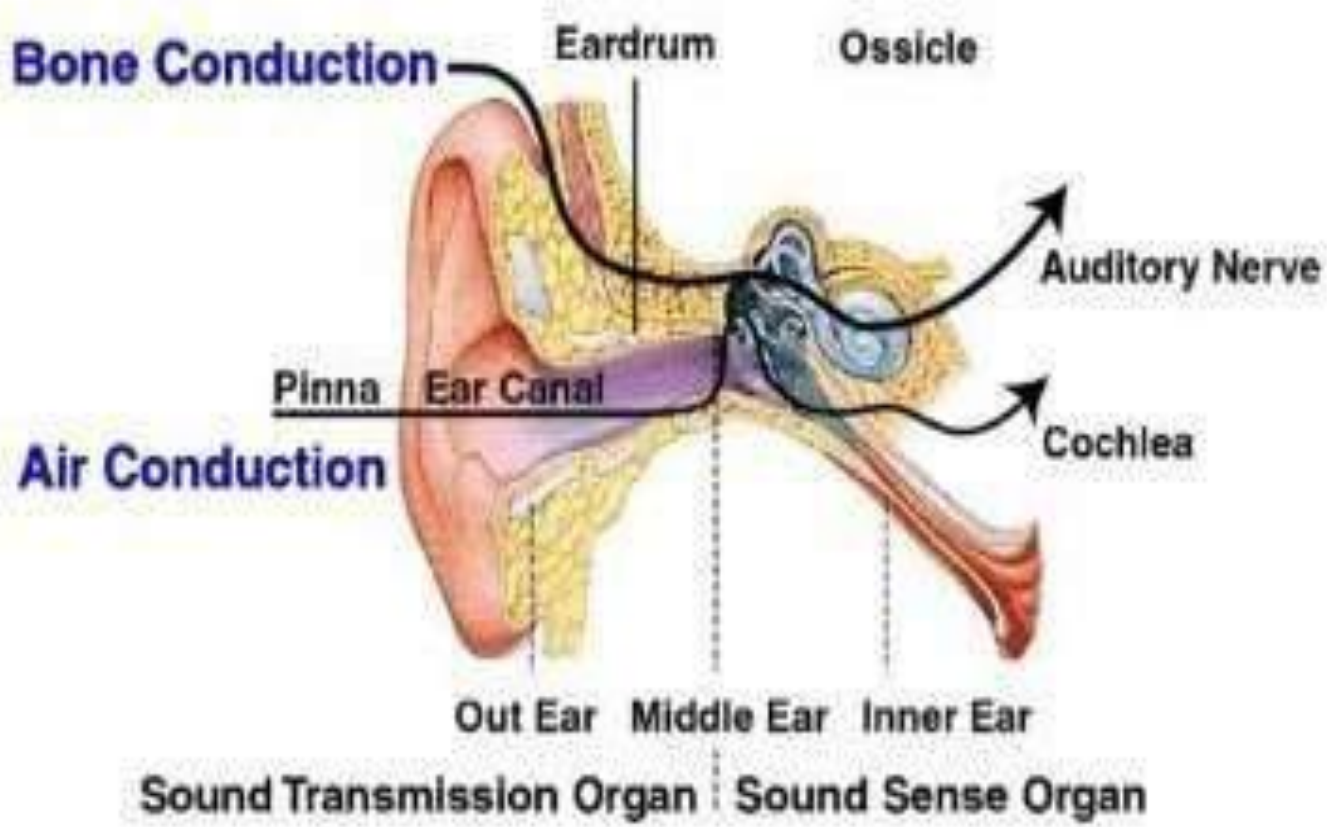
No	Topic	Title	Duration	Date and time
1	Hands on experience of Screening infants with OAE	Introduction on Otoacoustic Emission (OAE)	4hrs	4pm-6pm(19/5/18),4pm-6pm(24/5/18)
		Recording of OAE	4hrs	4pm-6pm(29/5/18),4pm-6pm(4/6/18)
		Lecture on different forms of OAE	5hrs	4pm-6pm(8/6/18),4pm-6pm(15/6/18),4pm-5pm(18/6/18)
		Interpretation of OAE and its limitations	5hrs	4pm-6pm(22/6/18),4pm-6pm(25/6/18),4pm-5pm(30/6/18)
		Demonstration of OAE	6hrs	4pm-6pm(3/7/18),4pm-6pm(10/7/18),4pm-6pm(15/7/18)
		Hands on training of OAE in screening infants and DOPS	6hrs	4pm-6pm(19/7/18),4pm-6pm(26/7/18),4pm-6pm(5/8/18)
		TOTAL	30HRS	

REFERENCE BOOKS: 1) SCOTT BROWN 7th edition

2) ANIRBAN BISWAS 3rd edition

OTOACOUSTIC EMISSIONS

HOW DO WE HEAR????



OAE

- **OAEs are low-intensity sounds/acoustic signals that are generated by the cochlea and propogate through the middle ear into the ear canal where they are recorded .**
- OAEs are probably not essential to hearing, but rather are the by- product of active processing by the outer-hair cell system.
- They are most probably generated by active mechanical contraction of the outer hair cells, spontaneously or in reponse to sound.
- OAEs reveal, with considerable sensitivity, the integrity of outer-hair cell function.

HISTORY

- 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.

“ KEMP ECHOES ”

MECHANISM OF OCCURRENCE

OAEs are considered to be related to the amplification function of the cochlea.

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.

Stimulus delivered to the ear → invokes movement of the basilar membrane, which in turn causes the OHCs to move, or be deflected.

When the OHCs move, their stereocilia bend in one direction or the other.

Ions rush in and rush out, changing the membrane potential within the hair cell. The changes in voltage across the plasma membrane lead to OHC length changes (shortening and lengthening), which are called electromotility.

The electromotility of the OHCs has a feedback effect on the basilar membrane, causing it to vibrate. Therefore, the electromotility of the OHCs is thought to be the mechanism which underlies OAEs.

- In addition to vibrating the basilar membrane, the motility of the OHCs causes an amplification of the signal, which is then passed to the IHCs.

- In turn, the IHCs send a signal to the brain and we then "hear."
- The OHC motility allows us to be more sensitive to softer sounds. This is called active processing within the cochlea.

- Without the amplification provided by the OHCs, the IHCs would only be triggered by relatively loud sounds. This is because loud sounds result in larger movements of the basilar membrane, and the IHCs are stimulated directly with little contribution or amplification from the OHCs. This is called passive processing.

PHYSIOLOGY

- When sound is used to elicit an emission, it is transmitted through the outer ear, where the auditory stimulus is converted from an acoustic signal to a mechanical signal at the tympanic membrane and is transmitted through the middle ear ossicles; the stapes footplate moves at the oval window, causing a traveling wave in the fluid-filled cochlea. The cochlear fluid's traveling wave moves the basilar membrane; each portion of the basilar membrane is maximally sensitive to only a limited frequency range.

- The arrangement is a tonotopic gradient . Regions closest to the oval window are more sensitive to high-frequency stimuli. Regions further away are most sensitive to lower-frequency stimuli. Therefore, for OAEs, the first responses returned and recorded by the probe microphone emanate from the highest-frequency cochlear regions because the travel distance is shorter. Responses from the lower-frequency regions, closer to the cochlear apex, arrive later.

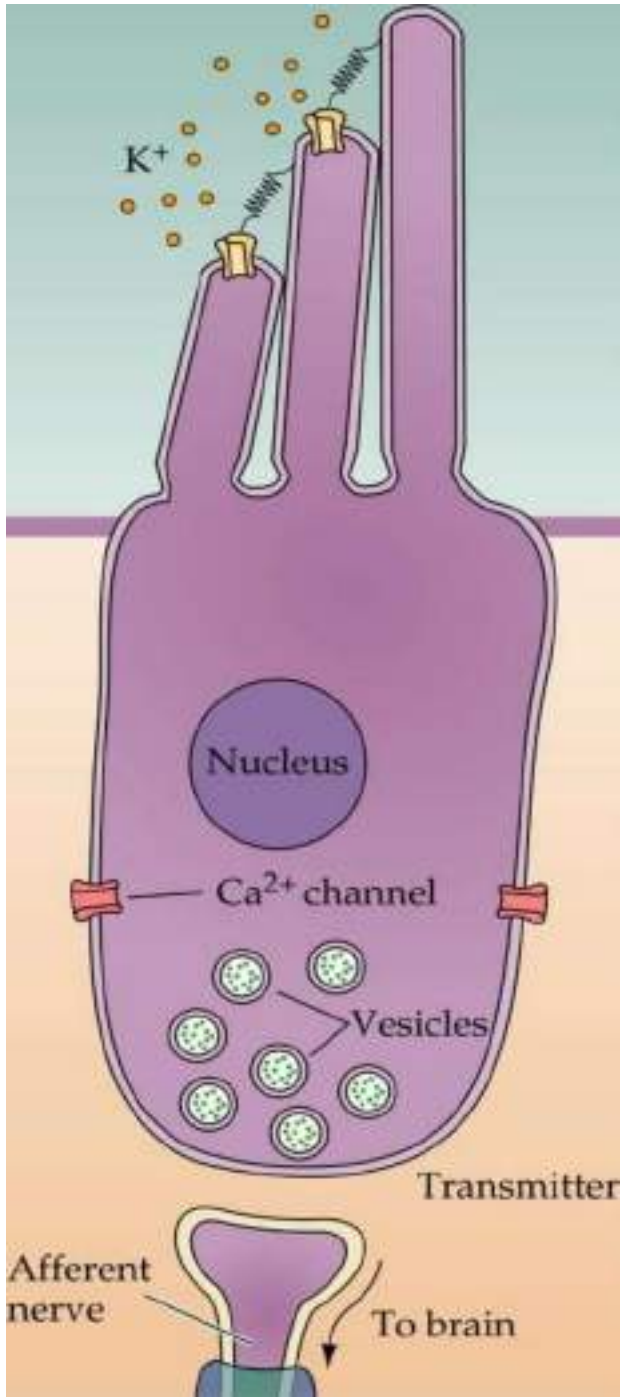
- When the basilar membrane moves, the hair cells are set into motion and an electromechanical response is elicited, while an afferent signal is transmitted and an efferent signal is emitted. The efferent signal is transmitted back through the auditory pathway, and the signal is measured in the outer ear canal. As described above, the responses from the high-frequency region arrive first, progressively followed by responses from lower-frequency regions.

Hair cell bathed in endolymph where electrical potential is +80mV (due to high K+)

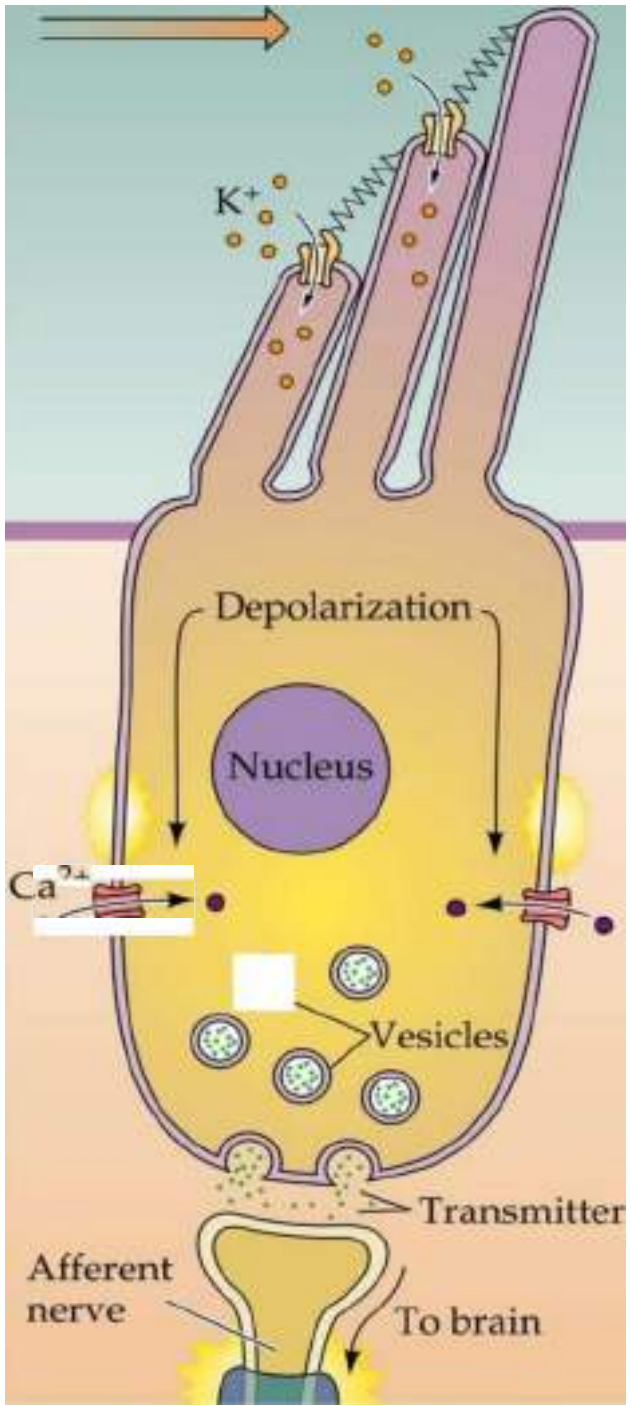
Inside the hair cell potential is – 45mV

Hence when K+ channels on hair cells open → influx of K+ into the hair cell from endolymph of scala media → depolarization of hair cell

(A)


K+
Nucleus
Ca2+ channel
Vesicles
Transmitter
Afferent nerve
To brain

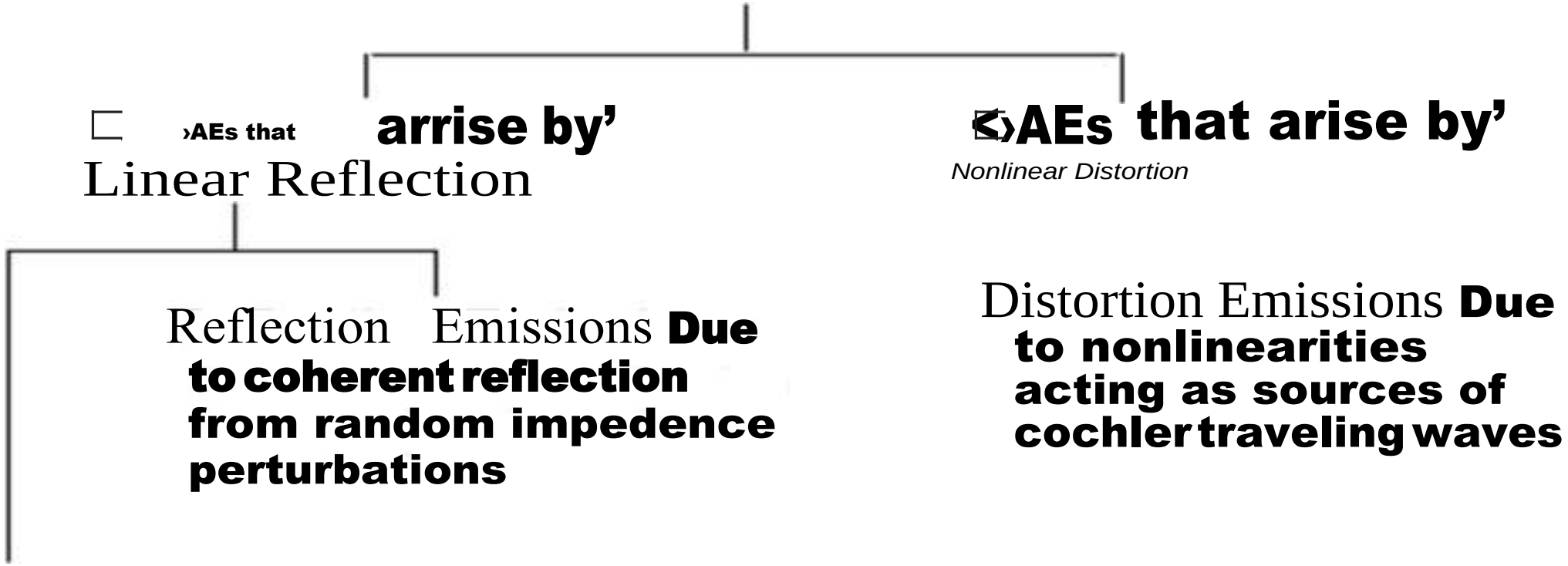
(B)

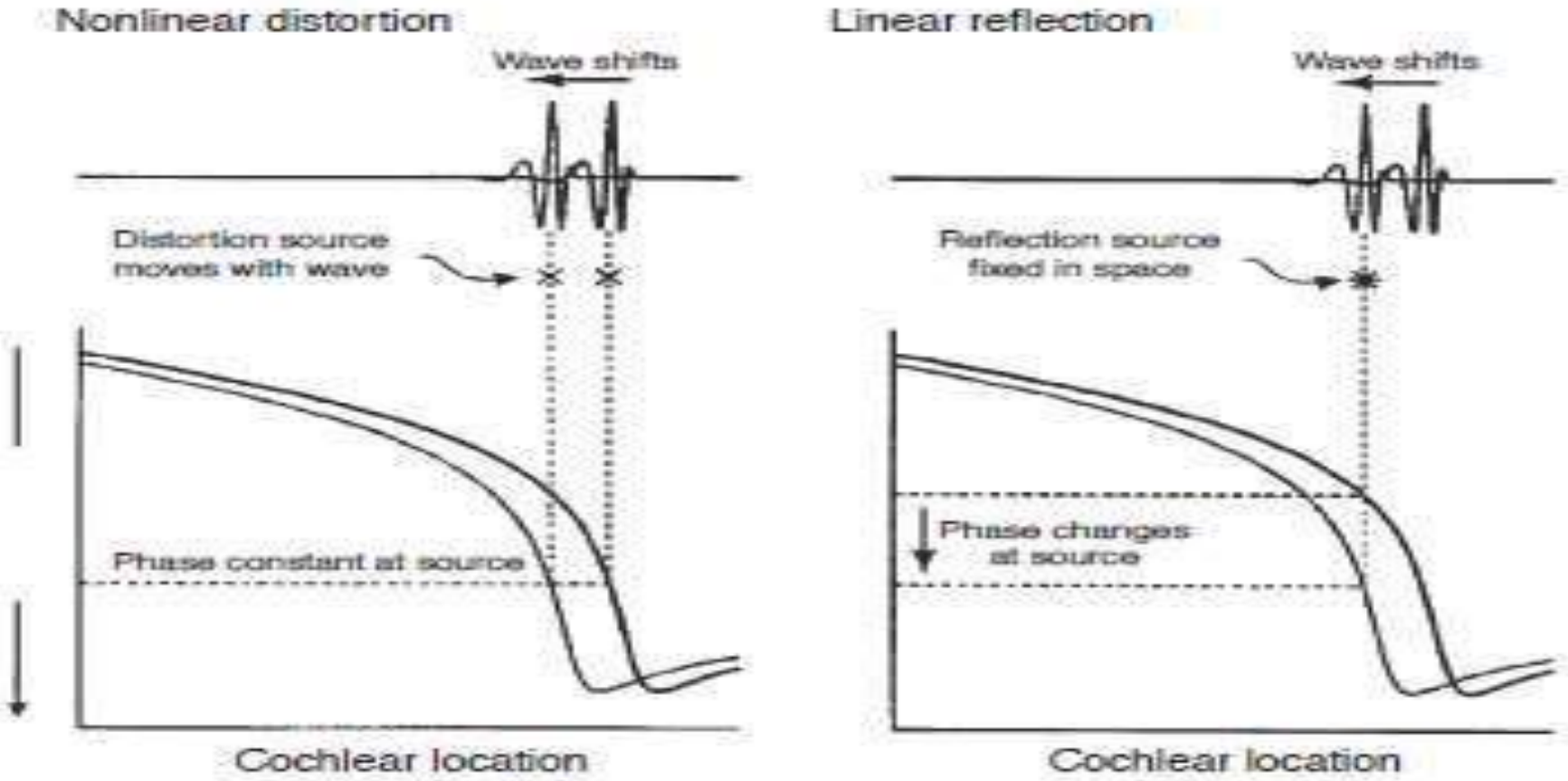

K+
Depolarization
Nucleus
Ca2+
Vesicles
Transmitter
Afferent nerve
To brain

- **More recent research from Shera, 2004, suggests that "OAEs appear to arise by at least two fundamentally different mechanisms within the cochlea: nonlinear distortion and linear reflection."**

- Shera has constructed a new taxonomy for OAEs based upon what he believes to be their mechanisms of generation.

MecFzaninrrs-Danecl Taxanarrsy’ fo OAEn Otoacousic Emissions





Figur e 19.1 Schematic illustrations of the phase behavior for emissions arising from either nonlinear distortion (**left panel**) or coherent linear reflection (**right panel**) mechanisms. In either panel, the f_2 traveling wave at two frequencies is shown, one peaking at a more apical location than the other (*top*) along with the corresponding phase lag versus the distance along the basilar membrane (*bottom*). The phase lag function for the more apical wave lies above that for the more basilar wave. For ease of viewing, the f_2 traveling waves have been exaggerated relative to the size of the stapes, the f_1 traveling waves are not shown, and the distortion and reflection sources are idealized as single points (*asterisks*). As seen in the panel on the left, as f_2 is changed to a higher frequency (more basal), the distortion source moves with the wave; therefore, the phase of the wave at the source remains constant as frequency is increased. In the right panel, as f_2 is changed to a higher frequency, the reflection source remains fixed; therefore, the phase at the source changes rapidly as frequency is increased. (Reprinted with permission from Kalluri R, Shera C. (2001) Distortion-product source unmixing: a test of the two-mechanism model for DPOAE generation. *J Acoust Soc Am*. 25 (2), 86–97; ©2001, American Institute of Physics.)

- Nonlinear distortion emissions are attributed directly to the action of OHCs.
- The source of nonlinear distortion, or “wave- fixed,” emissions is believed to follow the traveling wave envelope of the stimulus (e.g., Shera and Guinan, 1999).
- Therefore, because the shape of the traveling wave does not change significantly as the stimulus is swept in frequency, the phase at any point moving with the traveling wave envelope will not change significantly.
- Thus, nonlinear distortion emissions are characterized by gradual phase changes as the stimulus frequencies are increased.

- Refection, or “place-fixed,” emissions are characterized by phase that rotates rapidly with changes in stimulus frequency. These emissions are proposed to be the result of the incoming traveling waves scattering off of random impedance perturbations in the mechanics of the cochlea or impedance mismatches present at or near the largest displacement of the traveling wave (e.g., Shera and Guinan, 1999).

- Shera and Guinan (1999) explain the nonlinear behavior of refection emissions, such as compressive growth functions, as the result of level-dependent amplification of the forward and reverse traveling waves because of the action of the cochlear amplifier. In this way, refection emissions, although not generated by the action of OHCs, would be acted on by these forces and would, therefore, still be vulnerable to changes in OHC function.

- OAEs measured in the ear canal are thought to be a combination of energy from both mechanisms (Knight and Kemp, 2000; Shera and Guinan, 1999). At this time it is not known whether emissions arising from the two mechanisms might be used differently to provide in formation about cochlear function.

OHC IN OAE

- Two hypotheses regarding the OHCs' role in the cochlear amplifier have been explored: Somatic motility of OHCs and nonlinear mechanics of the OHC stereocilia bundle.
- OHCs demonstrate rapid changes in length in response to electrical stimulation (Ashmore, 1987; Brownell et al., 1985).
- "Prestin" is the molecular motor responsible for somatic OHC motility (Zheng et al., 2000).
- Reduced OHC length, absence of OHC motility, and IHC and OHC loss in the basal portion of the cochlea were observed in mice when the prestin gene was deleted.

- OAEs measured in nonmammalian species, whose hair cells are not capable of somatic motility, have been attributed to active hair bundle movements of the hair cell stereocilia (Ricci et al., 2000).

TYPES

SPONTANEOUS

EVOKED

Transient-evoked OAEs (TEOAEs)

Distortion-product OAEs (DPOAEs)

Stimulus frequency OAEs (SFOAE)

TYPES OF OAE

- Spontaneous otoacoustic emissions (SOAEs) - Sounds emitted without an acoustic stimulus (ie, spontaneously).
- Transient otoacoustic emissions (TOAEs) or transient evoked otoacoustic emissions (TEOAEs) - Sounds emitted in response to an acoustic stimuli of very short duration; usually clicks but can be tone-bursts.
- Distortion product otoacoustic emissions (DPOAEs) - Sounds emitted in response to 2 simultaneous tones of different frequencies.
- Sustained-frequency otoacoustic emissions (SFOAEs) - Sounds emitted in response to a continuous tone.

PREREQUISITES

- Unobstructed outer ear canal
- Seal of the ear canal with the probe
- Optimal positioning of the probe
- Absence of middle ear pathology : Pressure equalization (PE) tubes alone probably will not interfere with results. However, if emissions are absent, results should be interpreted with caution.
- Functioning cochlear outer hair cells
- A quiescent patient: Excessive movement or vocalization may preclude recording.
- Relatively quiet recording environment: A sound booth is not required, but a noisy environment may preclude accurate recording.

- Visual inspection, and preferably tympanometric measurement prior to OAEs recordings, will help determine if middle ear and external ear abnormalities might reduce or block acoustic transmission of OAEs from the cochlea to the microphone, and in the case of TEOAEs and DPOAEs, of the evoking sound to the cochlea.

- Reduction of ambient noise picked up by the microphone is achieved by a tight fit of the probe into the ear canal.

- Patient -generated sounds can be minimized by instructing the patient to be still and not to talk during testing.

PROCEDURE

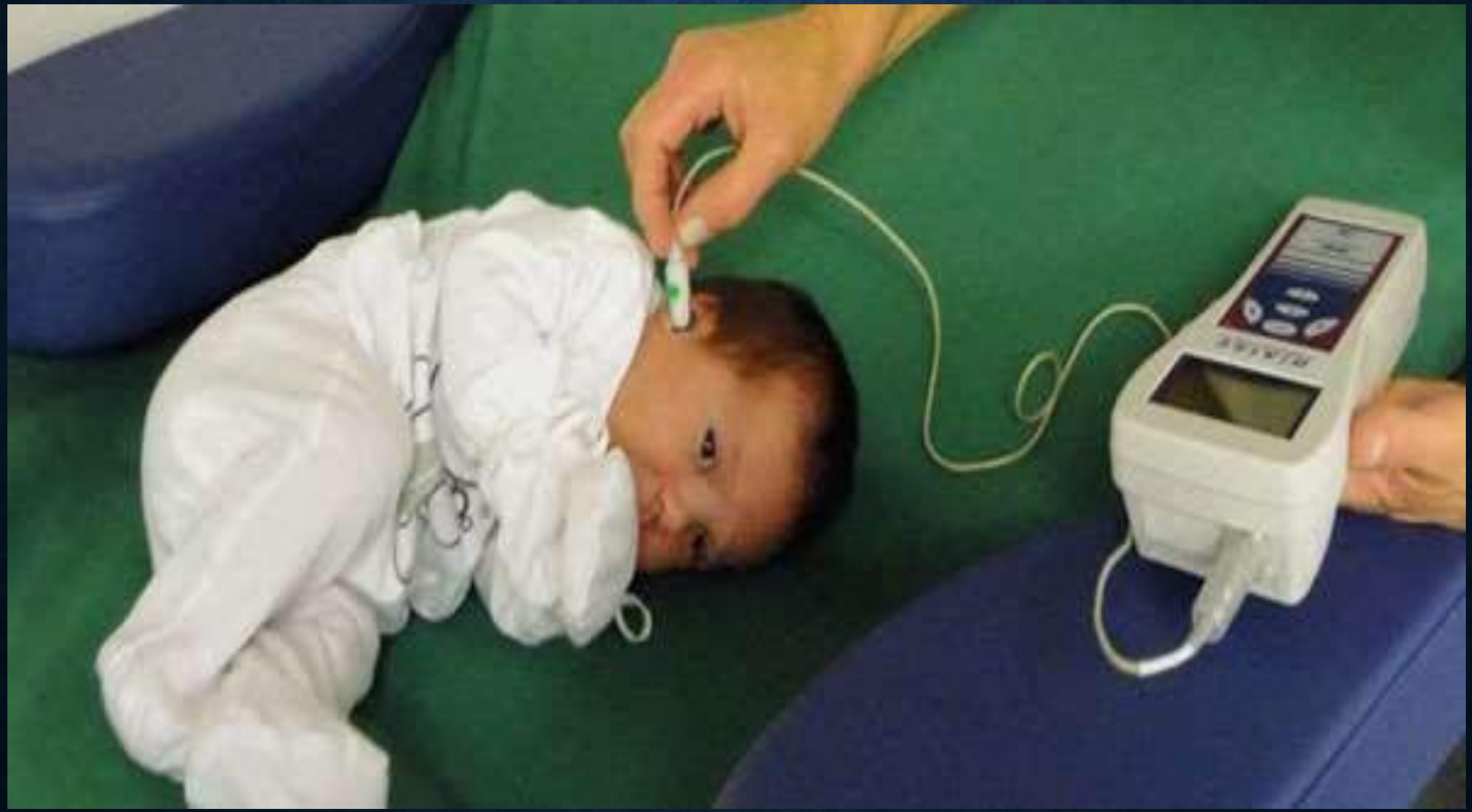
Approach Considerations :

- Insert a probe with a soft flexible tip in the ear canal to obtain a seal. Use different probes for neonates and adults; the probes are calibrated differently because of the significant difference in ear canal volume. The smaller ear canal results in a higher effective sound pressure level (SPL), thus a different probe is used to correct for the difference.
- Multiple responses are averaged. All OAEs are analyzed relative to the noise floor; therefore, reduction of physiologic and acoustic ambient noise is critical for good recordings.

- All four types of OAEs are recorded with a sensitive, low noise microphone that is placed in the sealed external ear canal.

- When OAEs are evoked, the sealed probe includes a tube for sound delivery to the ear canal, in addition to the recording microphone.

- **The microphone records all sounds in the ear canal, and these include, in addition to OAEs, the sound evoking the OAEs when TEOAEs or DPOAEs are recorded, as well as other patient-generated and ambient sounds.**



‘SOFT-TIPED PROBE
(HOCSlFG TRANSDHCEAS)

SM MUL US
GVERATI•:ΓN

SIGNAL
AW4LYSIS

SPONTANEOUS OAE

- Spontaneous OAEs (SOAEs) are narrowband signals that occur in the ear canal without the introduction of an eliciting signal.

- Spontaneous emissions are present in over half of all normal-hearing ears and absent in all ears at frequencies where sensorineural hearing loss exceeds approximately 30 dB.

- It appears that SOAEs originate from outer-hair cells corresponding to that portion of the basilar membrane tuned to their frequency.

SOAE

- A sensitive, low-noise microphone housed in a probe is used to record SOAEs.
- The probe is secured in the external auditory canal with a flexible cuff.
- Signals detected by the microphone are routed to a spectrum analyzer, which provides frequency analysis of the signal.
- Usually the frequency range of interest is sampled several times, and the results are signal averaged to reduce background noise.
- SOAEs, when they occur, appear as peaks of energy along the frequency spectrum.

SOAE

- This nonevoked response is usually measured in narrow bands (< 30 Hz bandwidth) of frequencies recorded in the external ear canal.

- No stimulus is required.

- Obtain multiple recordings to ensure replicability and to distinguish the response from the noise floor.

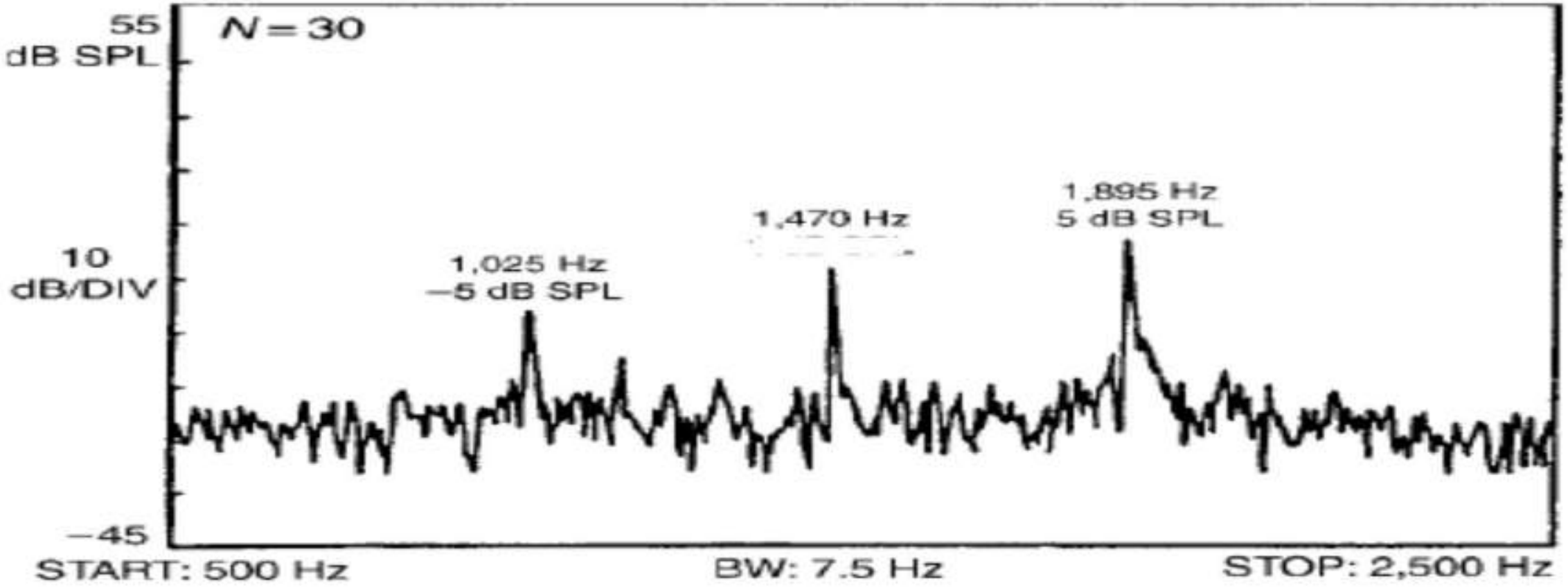


Figure 19.2 An example of SOAEs measured from a normal-hearing human. Three SOAEs are measurable. ("4Iu*diiat4.*xzd ttavt€ *s-it1z yriuxzisaicwi* ficwixz Li*i*aL*ttxm— Martin BL, Whitehead ML, Martin GK (1991) Clinical applications of otoacoustic emissions. *JSpeech Hear Res.* 34 (5), 964–981; © 1991, American Speech-Language-Hearing Association.)

INTERPRETATION

- In general, SOAEs occur in only 40-50% of individuals who have normal hearing.

  For these adults, the range is about 30-60%; in neonates with normal hearing, the range is approximately 25-80%.

- The presence of SOAEs usually is considered a sign of cochlear health, but the absence of SOAEs is not necessarily a sign of abnormality.
- When present in humans, SOAEs usually occur in the 1000- to 2000-Hz region (500-Hz to 7000-Hz frequency range); amplitudes are between 5 and 15 dB SPL.
- SOAEs typically are bilateral rather than unilateral. If unilateral, they are more likely to be present in the right rather than in the left ear. SOAEs occur more often in females than in males (across all ages). (BASED ON STUDIES)

SOAE

- **Because SOAEs are absent in many ears with normal hearing, clinical applications have not been forthcoming.**

- Efforts to relate SOAEs to tinnitus have revealed a relationship in some, but not many subjects who have both.

EVOKED OAE

- Evoked OAEs are elicited by a stimulus and occur during and after signal presentation.

- Evoked OAEs bear a close resemblance to the eliciting signal.

- There are several classes of evoked OAEs, two of which have proven to be useful clinically: transient-evoked OAEs (TEOAEs) and distortion-product OAEs (DPOAEs)

TEOAE

- TEOAEs are elicited with transient signals or clicks.
- Series of click stimuli are presented, usually at an intensity level of about 80-85 dB SPL.
- Output from the microphone is signal averaged, usually within a time window of 20 milliseconds.
- TEOAEs occur about 4 milliseconds following stimulus presentation and continue for about 10 milliseconds.

TEOAE

- In humans, a delay between stimulus offset and onset of the evoked emissions varies between 4 ms, for high frequencies, and 20 ms for low frequencies.
- This temporal separation helps in visual identification and separation of the transient -evoked emissions from the stimulus that evoked them, that is also recorded.
- Thus, TEOAEs are typically presented as an amplitude/time plot of the acoustic waveform recorded from the ear canal.
- TEOAEs greater than 20 dB sound pressure level (SPL) can be recorded from newborns, while responses from children and adults range between 10 and 15 dB SPL.

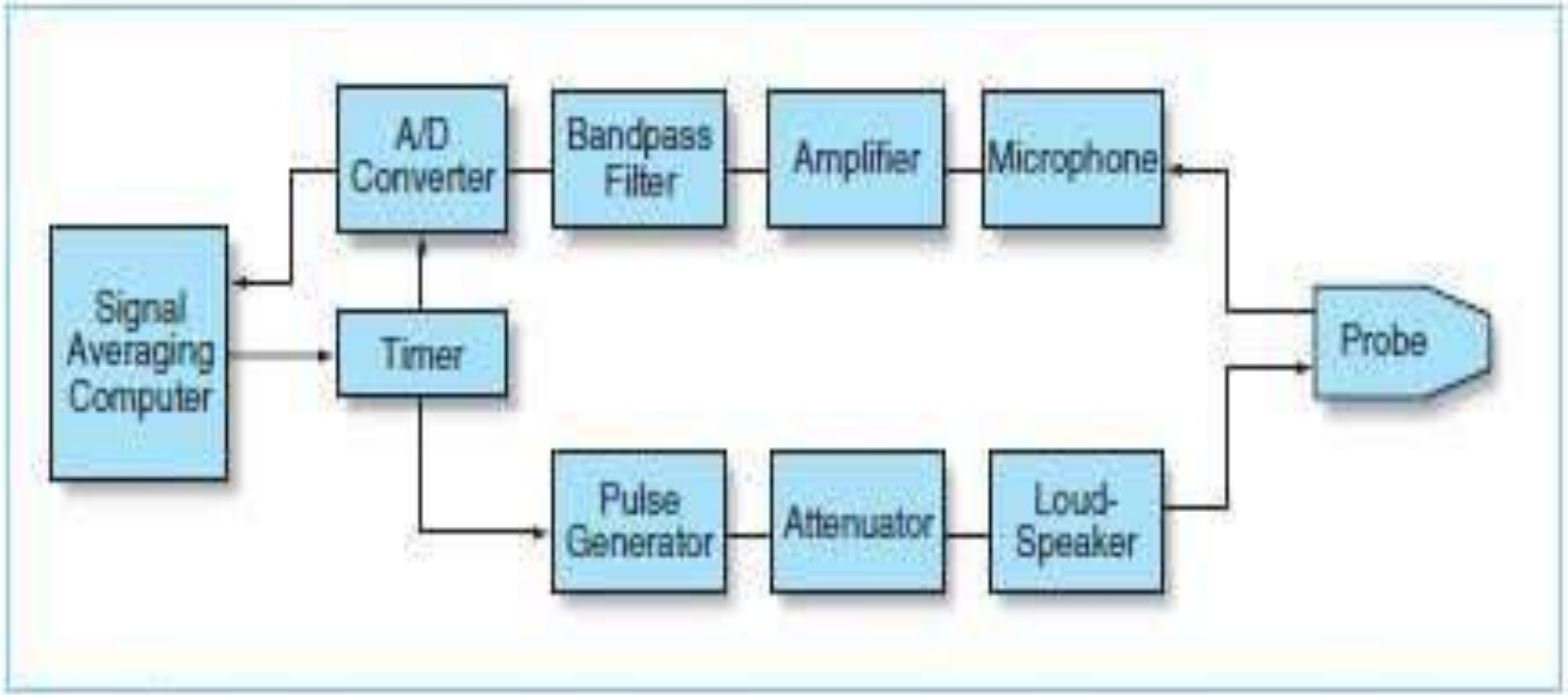
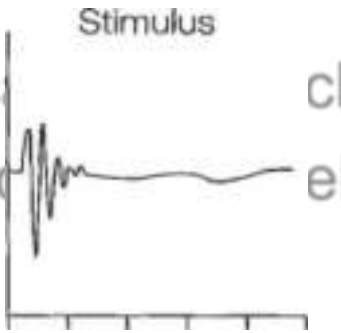
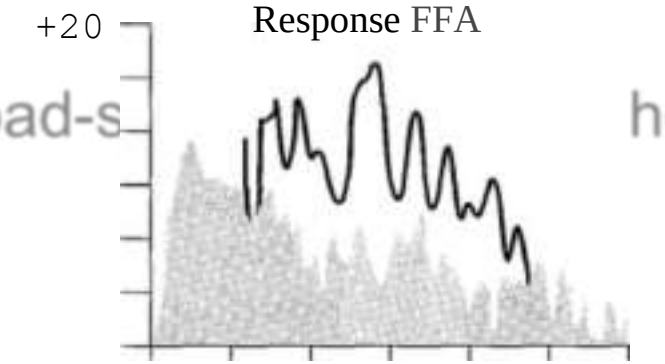


FIGURE 9-11 Schematic representation of the instrumentation used to elicit and measure transient-evoked OAEs.





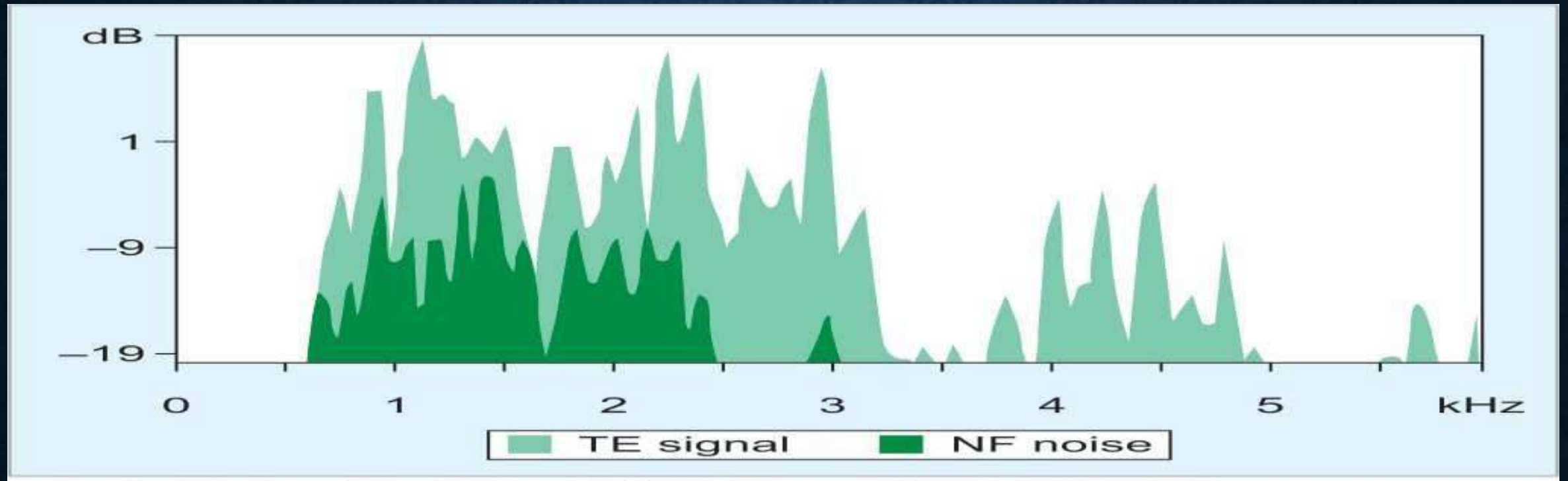
- Bec ck is a broad-s he response is similarly broad in spec ell.
- By convention, these waveforms are subjected to spectral analysis, the results of which are often shown in a graph depicting the amplitude-versus-frequency components of the emission.
- One important aspect of TEOAE analysis is the reproducibility of the response. This similarity or reproducibility of successive samples of a response is expressed as a percentage, with 100% being identical.

- If the magnitude of the emission exceeds the magnitude of the noise, and if the reproducibility of the emission exceeds a predetermined level, then the emission is said to be present.

- TEOAEs are recorded in the range of 250–4000 Hz for children and from 500 to 6000 Hz for adults at a stimulus level of approximately 80 dB SPL.

- TEOAE results may be confounded by the presence of background noise and are not utilized as often as DPOAEs due to this phenomenon.

- These emissions are recorded between stimulus presentations; therefore, TEOAEs evaluate the outer hair cell status in a resting state.



Left: 23-Apr-13: Stab: 99% : TE test: 13D23T01. TE

Frq(kHz)	Repor(%)	TE(dB)	NF(dB)	TE-NF(dB)	Result
1.0	94	15.1	0.7	14.4	—
1.5	73	12.2	4.1	8.1	—
2.0	91	15.5	1.5	14.0	—
3.0	99	11.4	−6.3	17.7	—
4.0	96	5.0	−11.0	16.0	—
1.2-3.4	83	18.2	6.3	11.9	—

Fig. 2.12: Transient emissions recorded from 1000 to 4000 Hz. Note that the reproducibility percentage is higher than 70% at all frequencies and the TE-NF (transient emission-noise floor) ratio is of sufficient amount (10 dB for adults, 15–20 dB for children, at all frequencies.30 This TEOAE test would be considered a “pass” overall. GREEN COLOR – NOISE FLOOR)

RESULT (NORMAL)

- TE (dB) > -3dB SPL
- TE – NF > +3dB SPL

TEOAE

- Advantages
  - Reliable
  - Fast
- Disadvantages
  - Poor at higher frequencies
  - TEOAE results may be confounded by the presence of background noise

DPOAE

DPOAEs occur as a result of nonlinear processes in the cochlea.

When two tones are presented to the cochlea, distortion occurs in the form of other tones that are not present in the two-tone eliciting signals.

- These distortions are combination tones, or harmonics, that are related to the eliciting tones in a predictable mathematical way.

- The two tones used to elicit the DPOAE are, by convention, designated f1 and f2.
- The most robust distortion product occurs at the frequency represented by the equation 2f1 –f2.

- The primary tones (fl and f2) are separated in frequency within one-third octave (typically f2 = fl x 1.2) and the distortion product is then typically at a frequency of 2fl - f2 (the cubic-difference tone).

- DPOAEs are also found at other frequencies (e.g. f2 - fl, 2f2 - fl, 3fl - 2f2), but 2fl – f2 has most often been used because it is the largest.

- Because DPOAEs are separated in frequency from the eliciting stimuli, they can be recorded in the presence of the stimulating tones and separated from them by spectral analysis.

- Although they are reliably recorded from all normal humans, their magnitude is very small (5-15 dB SPL), approximately 60-70 dB below the level of the stimuli used to evoke them. DPOAEs are attributed to nonlinearity of motion of the outer hair cells, particularly at low stimlus levels.

- Because the 2fl - f2 DPOAEs have been shown to originate from the region of the cochlea that maximally responds to the primary tones, DPOAEs are typically presented in a magnitude/frequency plot, in which frequency is determined by f2 (at low levels) or the geometric mean of fl and f2, and magnitude is determined for the DPOAEs at the 2fl - f2 frequency bin. Such a plot is called a DP-gram and it has been shown to correlate with the functional integrity of the cochlea.

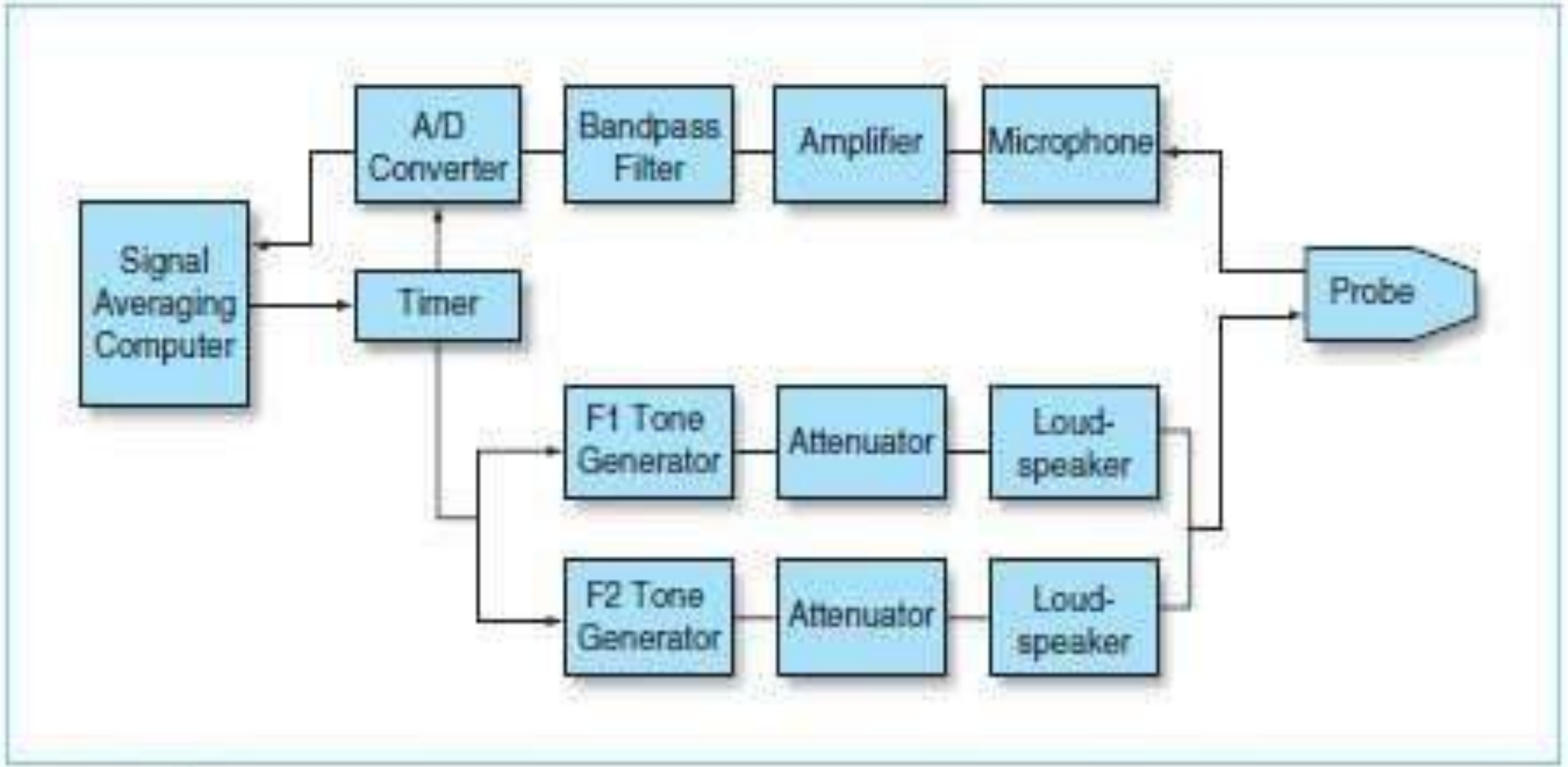


FIGURE 9-13 Schematic representation of the instrumentation used to elicit and measure distortion-product OAEs.

- DPOAEs are typically depicted as the amplitude of the distortion product (2f1—f2) as a function of frequency of the f2 tone.

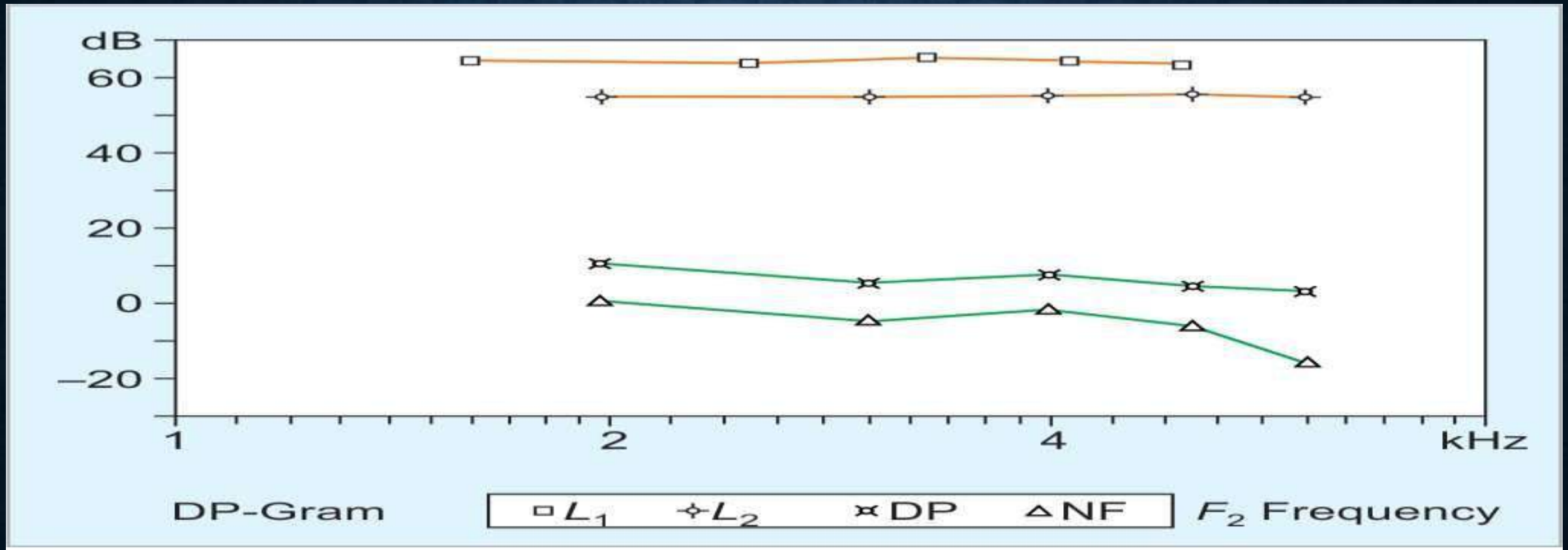
- If the amplitude exceeds the background noise, the emission is said to be present.

- If an emission is present, it is likely that the outer-hair cells are functioning in the frequency region of the f2 tone.

- In a clinical setting, the primary tones used to elicit the OAEs are typically in a frequency ratio of 1.1 to 1.3; and the levels may be equal or may be separated by 10 dB.

- For example, the first row of frequencies and levels shown in Figure 2.14 below are F1 = 4922 Hz and F2 = 6000 Hz (F1:F2 ratio = 1.2) and the levels are separated by 9.9 dB (L1 = 63.8 dB and L2 = 54.9 dB). The cubic distortion product should be observed at 3884 Hz.

- This test measures responses from narrow regions of the cochlea when the outer hair cells are active. DPOAEs are most reliable when recorded in the frequency range from 750 to 16,000 Hz.



Left: 10-Nov-11: Pass: 2-6 kHz Screen, 3/5 for Pass: 11K10D01.OAE

L_1(dB)	L_2(dB)	F_1(Hz)	F_2(Hz)	GM(Hz)	DP(dB)	NF(dB)	DP-NF(dB)	Result
63.8	54.9	4922	6000	5434	4.9	–16.2	19.1	Pass
64.9	55.6	4125	5016	4549	4.4	–6.4	10.8	Pass
65.7	55.4	3281	3984	3616	7.5	–1.6	9.1	Pass
64.3	55.2	2484	3000	2730	5.1	–4.8	9.9	Pass
64.8	55.1	1594	1969	1771	10.4	0.6	9.8	Pass

Fig. 2.14: Distortion product emissions recorded from 2000 to 6000 Hz. Note the *L*1 and *L*2 values are 65 and 55 dB, respectively. The output shown above also reports the geometric mean (GM) of *F*1 and *F*2, which is a value in between the *F*1 and *F*2. Note the DP-NF ratio is well above 6 dB at all frequencies and the DP itself is above –6 dB. This patient would be considered to have "passed" the test.

RESULT (NORMAL)

- DP (dB) > -6dB SPL
- DP – NF > +6dB SPL

- A determination of a “pass” versus “refer” depends on the protocol employed by each clinical setting and/or recording instrument.

- For DPOAEs many audiologists will accept a reproducibility rate of anywhere from 50% to 70% for an emission to be considered present, in addition to the ratio of emission over noise floor. The program employed for recording DPOAEs generates a wave reproducibility value that is expressed as a percentage.

- The closer this reproducibility value is to the preset determining value, the stronger the emission.

DPOAE

- Generally present when hearing thresholds are below 50dB.

DPOAEs can test higher frequencies than TEOAEs, making them more sensitive to the frequency area affected first.

DPOAE v/s TEOAE

- DPOAEs allow greater frequency specificity and can be used to record at higher frequencies than TEOAEs. Therefore, DPOAEs may be as particularly useful for early detection of cochlear damage as they are for ototoxicity and noise-induced damage. Reliability of DPOAEs is greatest above 1000 Hz.

- For infant hearing screening, both DPOAEs and TOAEs are used. TEOAEs have been used clinically for a longer period and are more established regarding association with behavioral audiometric thresholds.

- Depending on the methodology employed, DPOAEs often can be recorded in individuals with mild- to-moderate hearing losses for whom TEOAEs are absent; however, the accuracy of DPOAEs in estimating actual hearing sensitivity is not fully resolved (research continues in this area).

SUSTAINED/STIMULUS-FREQUENCY OTOACOUSTIC EMISSIONS

- SFOAEs are responses recorded to a continuoustone.
- Because the stimulus and the emission overlap in the ear canal, the recording microphone detects both.
- Therefore, interpretation depends on reading a complicated series of ripples in the recording.
- At present, SFOAEs are not usedclinically.

PTA VS OAE

• Pure-tone (PT) audiometry measures throughout the outer ear, middle ear, cochlea, cranial nerve (CN) VIII, and central auditory system.

• OAEs measure only the peripheral auditory system, which includes the outer ear, middle ear, and cochlea. The response only emanates from the cochlea, but the outer and middle ear must be able to transmit the emitted sound back to the recording microphone.

• OAEs cannot be used to fully describe an individual's auditory thresholds, but they can help question or validate other threshold measures (eg, in suspected functional [feigned] hearing loss), or they can provide information about the site of the lesion.

➢ Nonpathologic problems that can cause absence of OAEs :

- Poor probe tip placement or poor seal: Most current equipment alerts clinicians to these problems.
- Cerumen occluding the canal or blocking a probe port.
- Debris and foreign objects in the outer ear canal.
- Vernix caseosa in neonates: This is common immediately after birth.
- Uncooperative patient: Usually, recordings simply are not obtained.

➢ Pathologic problems that can cause absence of OAEs :

Outer ear :

- Stenosis
- OtitisExterna
- Polyp

Tympanic membrane : Perforation of the eardrum (PE tubes do not necessarily prevent good recordings.)

Middle ear :

- Otosclerosis
- Middle eardisarticulation
- Cholesteatoma
- Bilateral otitis media : Even in the presence of normal cochlear function, OAEs generally are absent in the presence of otitis media.

OAE testing is best conducted after the otitis media has cleared. If the patient cannot be tested later, when the otitis has cleared, no harm exists in attempting to record OAEs.

If OAEs are present (as in a very small percentage of patients with otitis media), that information could be useful. If they are absent (as in most patients with otitis media), no conclusions about cochlear function can be drawn.

Cochlea :

Exposure to ototoxic medication or noise exposure (including music): OAE changes may precede threshold changes in the conventional frequency range.

Any other cochlear pathology.

Conditions that do not affect OAEs :

CN VIII pathology: If CN VIII pathology also affects the cochlea (eg, vestibular schwannoma that decreases cochlear vascular supply), OAEs are affected.

Central auditory disorder

Conditions that elicit abnormal OAEs and normal behavioral thresholds :

Tinnitus : OAEs may be abnormal in the frequency region of the tinnitus.

Excessive noise exposure (may cause increase or decrease in amplitude): No clear correlation to noise-induced threshold changes is noted.

Ototoxicity

Vestibular pathology

Conditions that elicit normal OAEs and abnormal behavioral thresholds :

Functional hearing loss

Attention deficits

Autism

Possibly, inner hair cell damage but normal outer hair cells (reported for animals but no human reports yet)

Auditory neuropathy: This includes central auditory nervous system dysfunction and CN VIII auditory dysfunction.

APPLICATIONS

- The primary purpose of otoacoustic emission (OAE) tests is to determine cochlear status, specifically hair cell function.
- This information can be usedto

screen hearing (particularly in neonates, infants, or individuals with developmental disabilities).

partially estimate hearing sensitivity within a limited range.

differentiate between the sensory and neural components of sensorineural hearing loss.

test for functional (feigned) hearing loss.

The information can be obtained from patients who are sleeping or even comatose because no behavioral response is required.

APPLICATIONS

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. The primary screening tool is a test for the presence of a click-evoked OAE.

OAEs in Patients with Tinnitus :

Tinnitus has been theorized to originate in both the cochlea (LePage, 1995) and the central auditory system (Reyes et al., 2002). In select patients, the frequency of perceived tinnitus can coincide with a patient's recorded spontaneous OAE (SOAE) frequencies; however, this is not true for everyone, and generally speaking, the relationship between tinnitus and SOAEs has not been found statistically significant (Ceranic et al., 1998).

The relationships between tinnitus and DPOAE and TEOAE are even less clear. Ceranic and colleagues (1998) reported that in patients with tinnitus, OAEs are not easily detectable or are abnormal at the tinnitus frequency region, even in patients with normal hearing.

- Another study reported that in comparison to otologically normal subjects (patients without tinnitus), DPOAE amplitudes were consistently reduced among tinnitus patients, even if the patient had audiometrically normal hearing. The decrement in DPOAEs among tinnitus patients was most pronounced in the 4000-7000 Hz region (Shiomi et al., 1997); however, this is not always the case.

- Rosanowski and colleagues (1997) divided tinnitus patients into those with hearing loss and those without, and they found no consistent TEOAE results between the two groups.

- The relationships between otoacoustic emissions and tinnitus have been explored. Several studies suggest that in about 6% to 12% of normal-hearing persons with tinnitus and SOAEs, the SOAEs are at least partly responsible for the tinnitus.

- Studies have found that some subjects with tinnitus display oscillating or ringing EOAEs, and in these cases, it is hypothesized that the oscillating EOAEs and tinnitus are related to a common underlying pathology rather than the emissions being the source of the tinnitus.

- With conflicting results, it is not prudent to conclude that OAEs give objective evidence of tinnitus; more research in this area is needed.

- Perhaps the most promising area for the use of OAEs with patients with tinnitus is in the area of tinnitus monitoring.

- Recording OAEs before, during, and after tinnitus retraining therapy may show objective improvements in addition to subjective reports.

➢ OAEs in NIHL :

OAEs can be used to provide objective confirmation of cochlear dysfunction in patients with normal audiograms.

Similarities between the hearing losses in musicians and industrial workers confirm that excessive exposure to music can affect the ear as much as industrial noise exposure (Hall, 2000).

OAE findings can be associated with cochlear frequency specificity; therefore, difficulty hearing can be confirmed with OAEs, even in the presence of a normal audiogram.

OAEs can provide an early and reliable warning sign of cochlear dysfunction due to noise/music exposure before any problem is evident on the audiogram.

- Studies have found that exposure to noise can cause a decline in OAE responses.

- Studies have revealed that hearing thresholds and OAE results were significantly lower among the workers who were exposed to higher levels of noise.

- It has been found that DPOAE's have provided the most information for detecting mild hearing loss in high frequencies when compared to transient evoked otoacoustic emissions (TEOAE). This is an indication that DPOAE's can help with detecting an early onset of noise-induced hearing loss.

➢ Ototoxicity Monitoring :

- Over the past decade, three main approaches have emerged for monitoring the effects of ototoxic medications: basic audiologic assessment, high frequency audiometry (HFA; 10-18 kHz), and OAEs .

- Ototoxic drugs exert their effect on OHC function (although not solely on OHCs), and OAEs are OHC dependent. With ototoxicity, OAEs have been shown to decrease simultaneously with changes in HFA thresholds and before changes appear in the conventional audiometric frequencies .

- Although both TEOAEs and DPOAEs can be used to monitor the effects of ototoxic medications, DPOAEs have some distinct advantages over TEOAEs.

DPOAEs test higher frequencies than TEOAEs, making them more sensitive to the frequency area affected first.

DPOAEs can be recorded in the presence of more hearing loss than TEOAEs. Therefore, if a hearing loss already exists, that patient is still able to be monitored (so long as their hearing loss is not too great), which means DPOAEs can monitor more people.

DPOAEs can provide some indication of degree and configuration of the hearing loss .

- During ototoxicity monitoring, the patient should have OAE testing completed at baseline and before each administration of the ototoxic medication.

- A logical question about using OAEs to monitor for ototoxicity is what constitutes a significant change in OAE amplitude from one test session to another. Although reports vary, there is no agreed upon universal dB SPL amount that indicates a "significant change" from one test session to the next.
-
- A change of 2.4 dB was reported as a significant decrease by Stavroulaki et al. (2002). Clinical experience suggests that changes of 3-6 dB SPL from one test session to the next (while all other test parameters are held constant, or an attempt at that is made) are generally accepted as significant and indicate a change in cochlear function.

- OAEs are a good clinical choice in monitoring for ototoxicity because they are quick, which is important for testing children as well as a population who may not feel well due to therapies.
- OAEs are cost efficient.
- Because they can show a change in cochlear function before it appears on the audiogram, further testing can be avoided unless OAE testing suggests a need.
- The biggest limitation to OAEs for this population is that they are very sensitive to middle ear dysfunction, which is common in children and in those who are immuno-compromised.
- Although OAEs are being employed for ototoxicity monitoring, they are rarely used in isolation. A change in OAEs from one test session to the next is a strong indicator for the need for more conventional and HFA testing.

➢ Using OAEs in Differential Diagnoses :

OAEs arise from the peripheral auditory system; therefore, a logical conclusion is that they will be present in cases of retrocochlear pathology. In most cases this is true; however, neoplasms in the internal auditory canal and/or posterior fossa may impinge on the internal auditory artery and compromise blood flow to the cochlea. This will affect the presence of OAEs.

Among various studies, the proportion of patients with retrocochlear pathology showing normal OAEs is about 20% (Hall, 2000). Probably the most common use of OAEs in the diagnosis of retrocochlear pathologies is in the diagnosis of auditory neuropathy (also called auditory dysynchrony or auditory neuropathy spectrum disorder (ANSD)).

AUDITORY NEUROPATHY

The advent of otoacoustic emissions (OAE) recordings opened a new area of auditory investigation in auditory neuropathy.

Classic auditory neuropathy is characterized by the presence of OAEs or enlarged cochlear microphonics, abnormal auditory brainstem response (ABR) findings, and, often, absent or abnormal behavioral responses to sound.

OAEs may be absent and an auditory neuropathy still may exist if concomitant cochlear disorder is present. Also OAEs may often disappear over time in auditory neuropathy patients.

Following conditions may be associated with pediatric auditory neuropathy :

- Hyperbilirubinemia
- Neurodegenerative diseases
- Neurometabolic diseases
- Demyelinating diseases
- Hereditary motor sensory neuropathologies (eg, Charcot-Marie-Tooth diseases with deafness)
- Inflammatory neuropathy
- Hydrocephalus
- Severe and/or pervasive developmental delay
- Ischemic-hypoxic neuropathy
- Encephalopathy
- Meningitis
- Cerebral palsy

➢ OAEs and Meniere's Disease :

Patients with Meniere's disease can essentially be divided into four categories.

- Van Hufflen et al. (1998) reported that in patients with little hearing loss, OAEs are present, which is expected.
- When patients have pure-tone thresholds greater than 60 dB HL, OAEs are absent, which is again expected.
- In patients with Meniere's disease who have hearing thresholds in the intermediate range (30 to 60 dB HL), two categories of patients emerge: patients with relatively large OAEs and patients without measurable emissions. It is this intermediate group that warrants further discussion.
- In patients with hearing loss of 25-30 dB or greater, OAEs should clearly be absent. However, several studies and authors have recorded OAEs with normal or even greater than expected amplitude values, even with thresholds exceeding 30 dB HL (van Hufflen et al., 1998).

- It has been hypothesized that these different patterns of OAEs in patients with Meniere's may be a reflection of more than one specific site of lesion (Hall, 2000).

- It is possible that for these patients with audiometric hearing losses greater than 30 dB HL and present OAEs that the audiometric data is not reflecting OHC activity. Rather, the presence of OAEs in these patients suggests that the OHCs have been spared and the poor hearing thresholds are IHC dysfunction or a disruption at the level of the afferent synapses to IHC and OHC (Hall, 2000).

- Another possibility to explain this phenomenon is that these findings may be a reflection of the various stages in the pathophysiological mechanism involved in Meniere's disease (van Hufflen et al., 1998).

- In other words, the damage from the Meniere's has not yet reached the OHCs.

- Van Hufflen et al. also demonstrated in their 1998 study that OAEs in the contralateral ear with normal hearing in patients with Meniere's disease had smaller OAE amplitudes than persons with normal hearing. They hypothesized that this could indicate an early manifestation of bilateral Meniere's disease.

➢ OAEs and intraoperative monitoring :

- Although not a new concept, using OAEs in the operating room is probably not a common practice in many places.

- However, OAEs can be used to monitor the cochlear function in CP angle tumour (Eg: acoustic neuroma) resection surgery.

- When using OAEs for any reason in the operating room, keep in mind that room noise and electrical artifact could interfere with collection.
- Microcoagulation of small vessels, tumour debulking, compression / stretch of internal auditory canal contents etc. affected OAE.

➢ OAEs and hearing aid fittings :

- The concept behind this lies in the ability of OAEs to identify regions of the cochlea with damage, which can assist in programming a hearing aid.
- When OAEs are absent, we assume hearing loss of greater than about 25 dB HL at the frequency where the emission is absent. In difficult to test patients, or any patient for which we cannot obtain audiometric threshold data, the absence of an OAE gives us some idea of hearing levels.
- In conjunction with ABR, we can use this data to program amplification for these patients.
- Absent OAEs in conjunction with audiometric thresholds of 70 dB HL or greater can be an indicator of a cochlear dead region, which in turn can influence the hearing aid selection and programming.

BIOMETRIC IMPORTANCE :

- In 2009, Stephen Beeby of The University of Southampton led research into utilizing otoacoustic emissions for biometric identification.

- Devices equipped with a microphone could detect these subsonic emissions and potentially identify an individual, thereby providing access to the device, without the need of a traditional password.

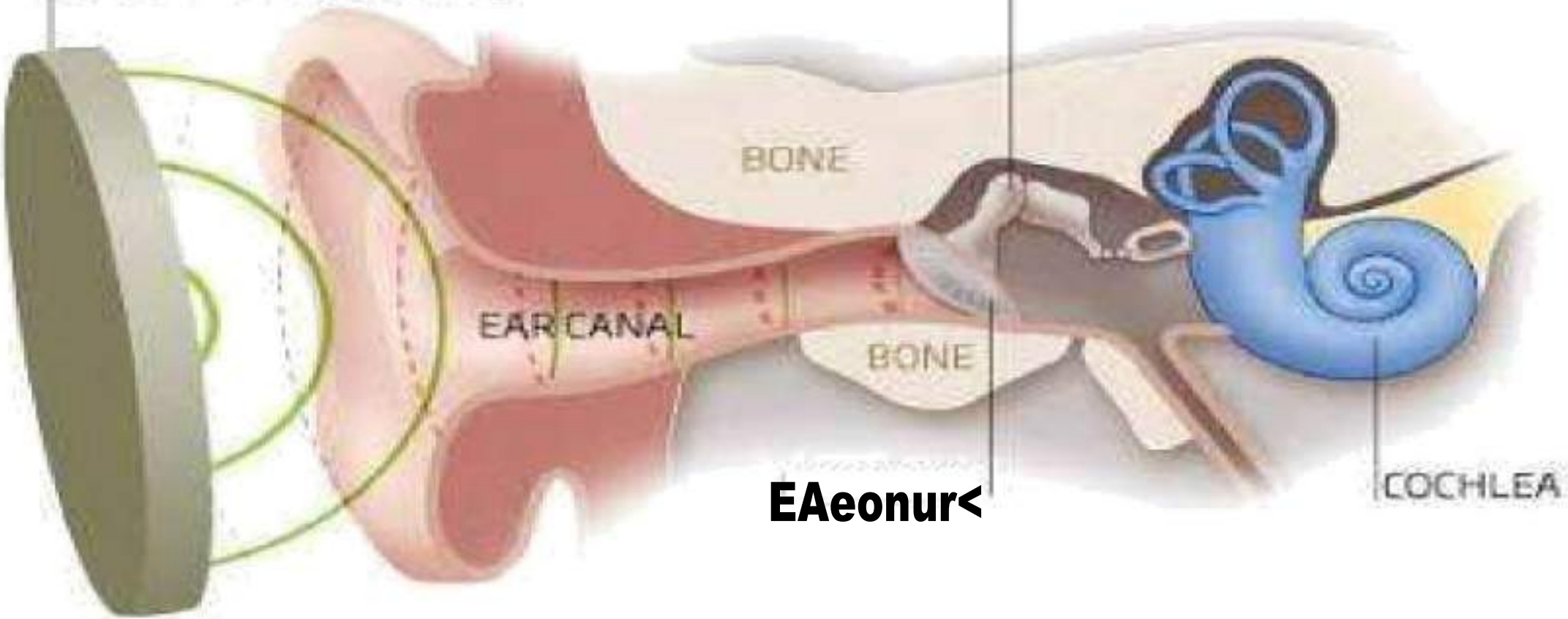
- It is speculated, however, that colds, medication, trimming one's ear hair, or recording and playing back a signal to the microphone could subvert the identification process.

Ear identification scan

A series of clicks played into the ear qenerates a faint but distinctive soun4 in return, which varie5 ac€OF@leg to the «nique imernal shape of the gerson's ear

”"f>P gAKg R AND tjl,T g/¥ -

5EN5fT rvE P•éIC ROPHDNE



EAeonur<

Although OAEs in the cochlea may all be alike, each person's unique middle ear system and external ear change the characteristics of the OAE.

Thus, an individual's OAE may be used as an "acoustic fingerprint" to unlock that person's phone or iPod!

" BETTER THAN KEEPING PATTERN AND NUMBERS TO LOCK THE SCREEN AND FORGETTING IT "

ADVANTAGES

- OAEs indicate that OHC function is normal, which, in most cases, correlates with normal hearing sensitivity.
- OAE testing is objective and does not require a behavioral response from a patient. Thus, it is also used to rule out functional hearing loss.
- Noninvasive .
- Easy to do and quick.
- Provides rapid results.
- OAE also tells us to some extent that the conductive mechanism of the ear is functioning properly. This includes proper forward and reverse transmission, no blockage of the external auditory canal, normal tympanic membrane movement, and a functioning impedance matching system.

LIMITATIONS

OAE testing does not evaluate the inner hair cells (IHC), nVIII, ascending central auditory pathway, or auditory processing function.

Surrounding sounds can distort readings .

False negatives – middle & external ear pathology.

Presence of OAE doesn’t guarantee a normal neural pathway, confirmation of which again needs BERA.

???????

- Proper Relationship between OAE and TINNITUS ?
- OAE and hearing loss in Meniere’s disease ?

Annexure 5

Bharath Institute of Higher Education and Research

SLIMS

1	U15MB275	DEVANAND .M
2	U15MB276	DEVANATHAN. R
3	U15MB277	DHANA PRIYA .P
4	U15MB278	DHANALAKSHMI. M
5	U15MB279	DHANUSH .R
6	U15MB280	DHANUSH KODALI
7	U15MB281	DHIVYA KUMARI .P
8	U15MB282	DIVYA .S
9	U15MB283	DIVYA DHARSHINI .N
10	U15MB284	EVANGELINE PRETTY .G

ANNEXURE 3

SRI LAKSHMI NARAYANA INSTITUTE OF MEDICAL SCIENCES

PUDUCHERRY

TOPIC: otoacoustic emission **(ENT 07)**
STUDENT NAME:
UNIVERSITY NO:

1. Screening test for neonates in icu:

a.Transient evoked OAE b.Distortion product OAE
c.Automated OAE d.ASSR

2. Otoacoustic emsion are done when following is damaged

a. Outer hair cells b. ressiener's membrane

c. inner hair cells d. otolithic membrane

3. True statement about OAE

a. spontaneous oae is absent in 50% normal individuals
b. absent in retro cochlear lesion
c. Absent in hearing loss less than 30 db
d. All of the above

4.OAE arise from
a.Inner hair cells b. Outer hair cell
c. Both inner and outer d. Macula

5. Initial screening test for new born hearing disorder
a. ABR b. OAE
c. Free field audiometer d. Visual reinforcement audiometer

6. In neonate the most sensitive audiometric screening is
a. electrococheagrphy b.OAE c.BERA d.Tymhanomtery

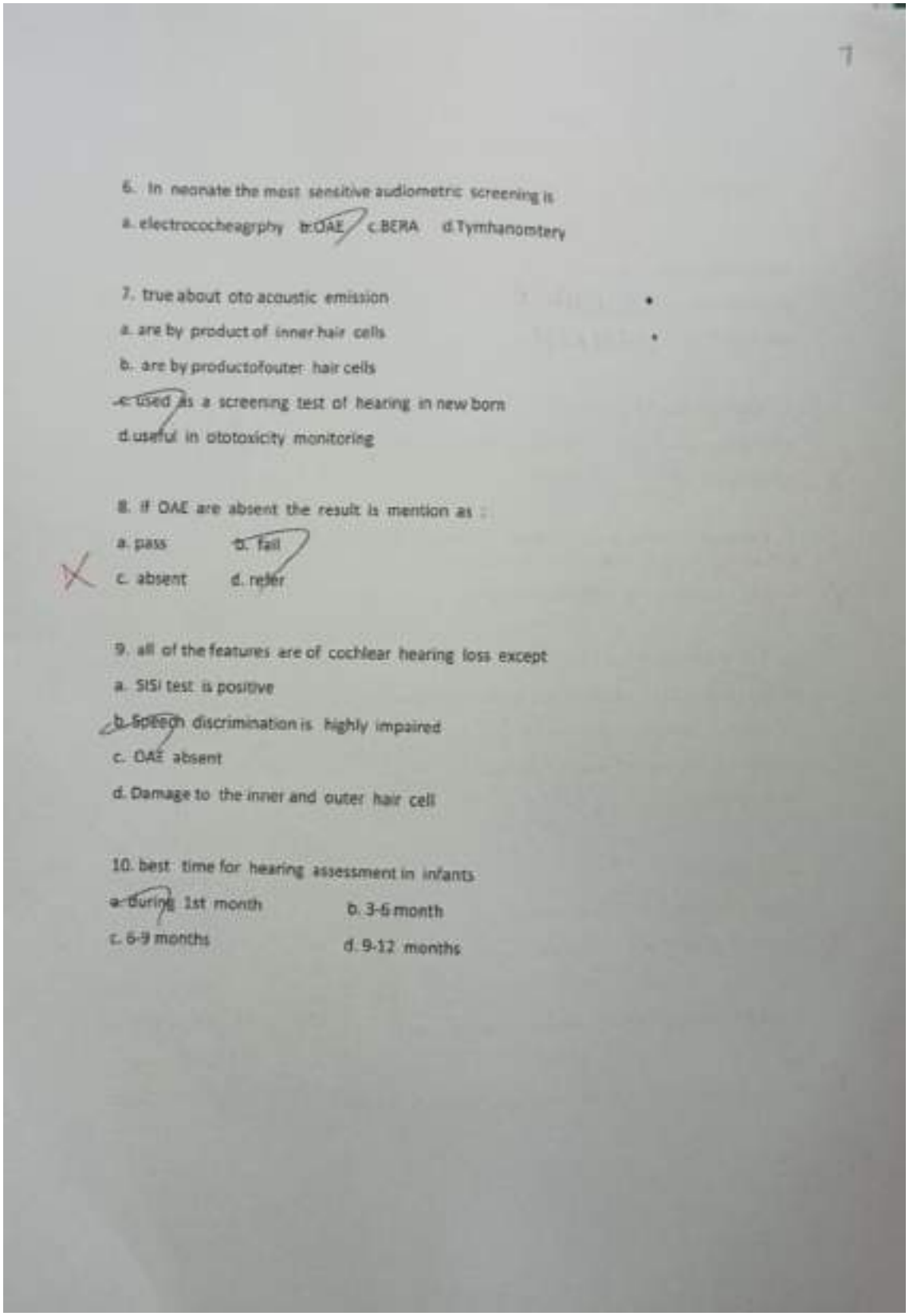
7. true about oto acoustic emission
a. are by product of inner hair cells
b. are by productofouter hair cells
c. used as a screening test of hearing in new born
d.useful in ototoxicity monitoring

8. If OAE are absent the result is mention as :
a. pass b. fail
c. absent d. refer

9. all of the features are of cochlear hearing loss except
   a. SISI test is positive b. Speech discrimination is highly impaired
   c. OAE absent d. Damage to the inner and outer hair cell

10. best time for hearing assessment in infants
a. during 1st month b. 3-6 month
c. 6-9 months d. 9-12 months

PRE TEST



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ANNEXURE 3

SRI LAKSHMI NARAYANA INSTITUTE OF MEDICAL SCIENCES

PUDUCHERRY

TOPIC: otoacoustic emission (ENT 07)

STUDENT NAME: Dhanush R

UNIVERSITY NO: U1SMB279.

5

1. Screening test for neonates in icu:

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X c. Automated OAE d. ASSR

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c. 6-9 months d. 9-12 months

ANNEXURE 3

SRI LAKSHMI NARAYANA INSTITUTE OF MEDICAL SCIENCES

PUDUCHERRY

TOPIC: otoacoustic emission (ENT 07)

STUDENT NAME: Divya . S

UNIVERSITY NO: U15MB282.

4

1. Screening test for neonates in icu:

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4 OAE arise from

a.Inner hair cells b. Outer hair cell

X c. Both inner and outer d. Macula

5. Initial screening test for new born hearing disorder

a. ABR b. OAE

c. Free field audiometer d. Visual reinforcement audiometer

POST TEST

6. In neonate the most sensitive audiometric screening is

a. electrocochleagrphy b.OAE c.BERA d.Tymhanomtery

7. true about oto acoustic emission

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b. are by productofouter hair cells

c. used as a screening test of hearing in new born

d.useful in ototoxicity monitoring

8. If OAE are absent the result is mention as :

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c. absent d. refer

9. all of the features are of cochlear hearing loss except

a. SISI test is positive

b. Speech discrimination is highly impaired

c. OAE absent

d. Damage to the inner and outer hair cell

10. best time for hearing assessment in infants

a. during 1st month b. 3-6 month

c. 6-9 months d. 9-12 months