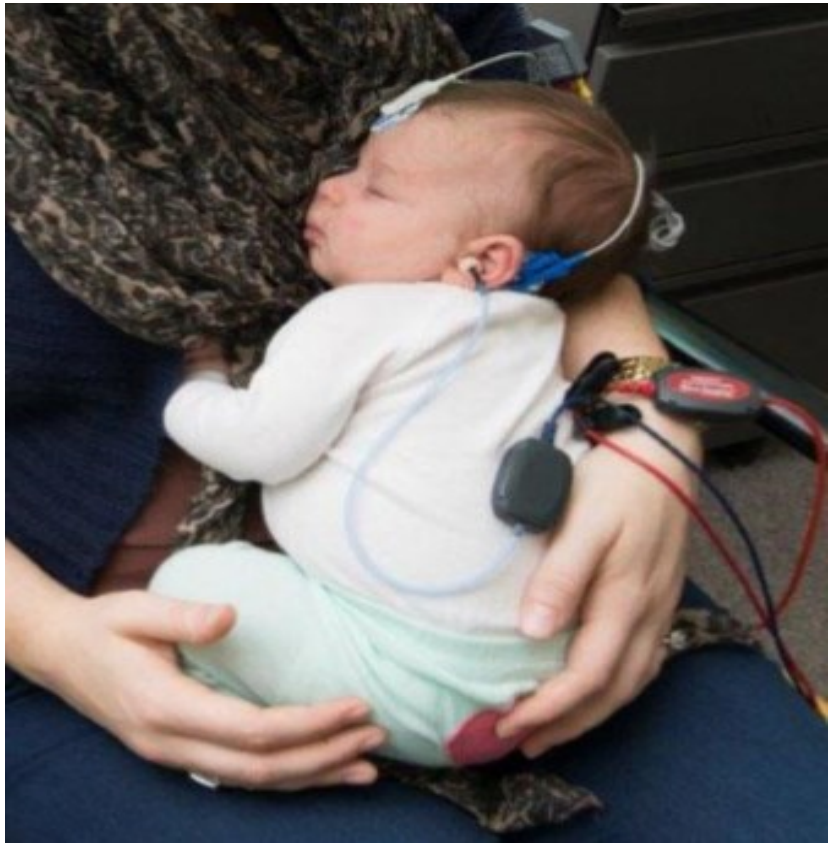
In the name of God

ABR Application & Interpretation in different degrees of hearing loss in children



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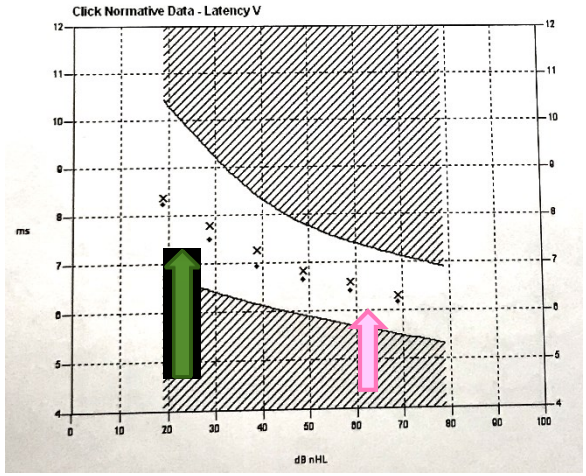
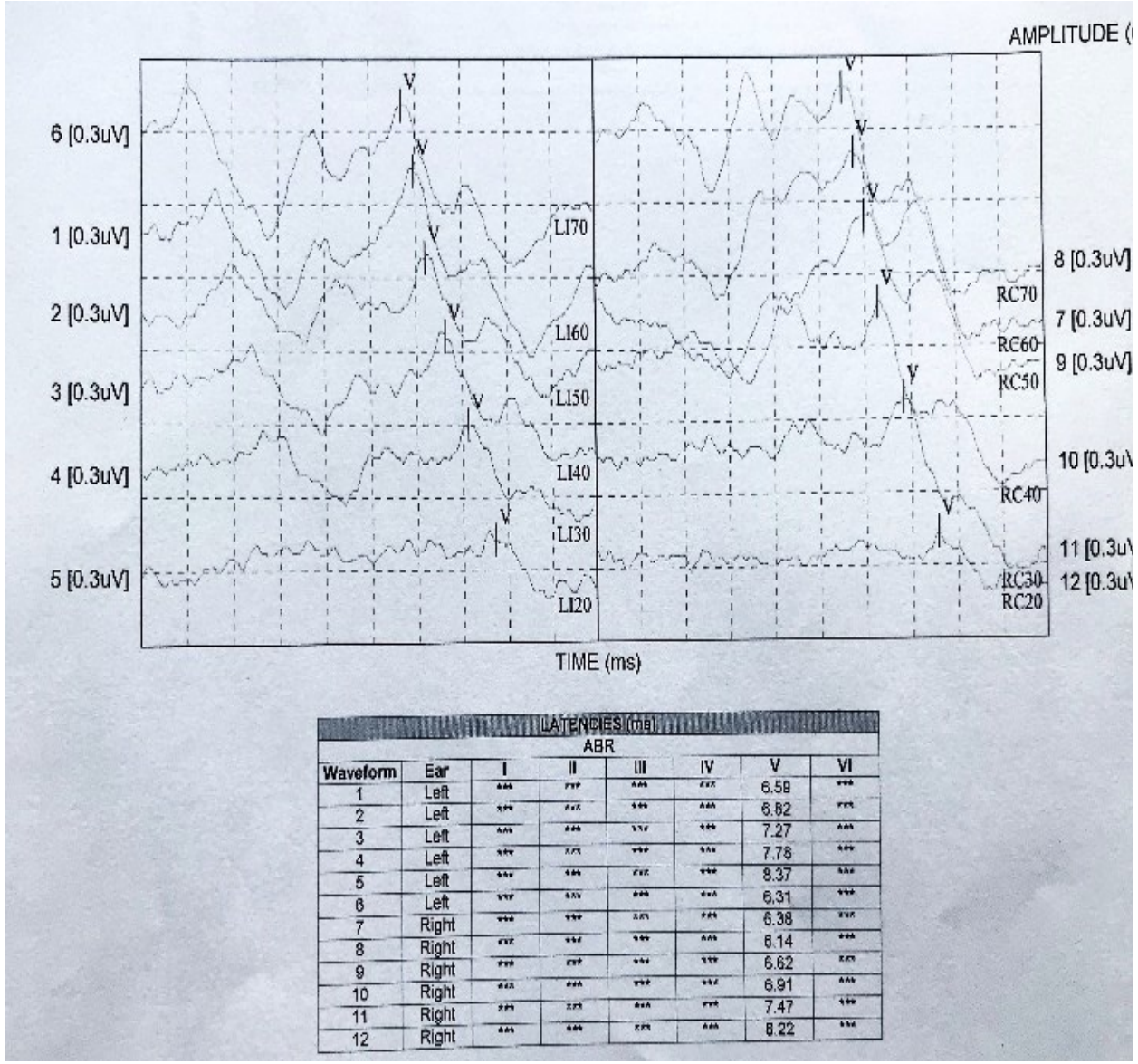
ABR test protocol for threshold estimation

- ✓ ABR should be started at high intensities with click stimulus via Air conduction
- ✓ Waveform inversion should be evaluated with changing polarity
- ✓ **Latency-Intensity function** is the key measure to detect the type of hearing loss
- ✓ Morphology and reproducibility of waves is important
- ✓ If necessary, continue the test with Tone burst and bone conduction ABR
- ✓ ASSR can help especially in case of severe to profound hearing loss



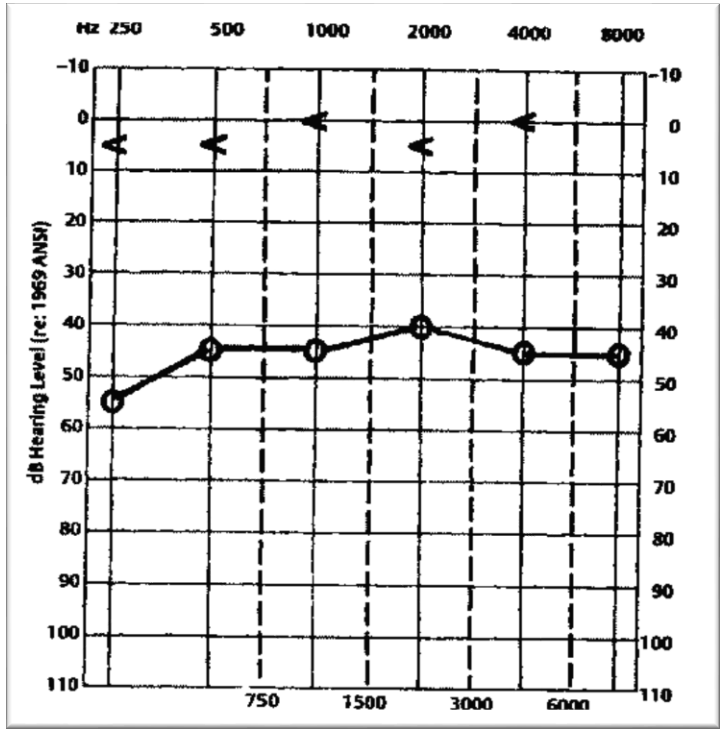


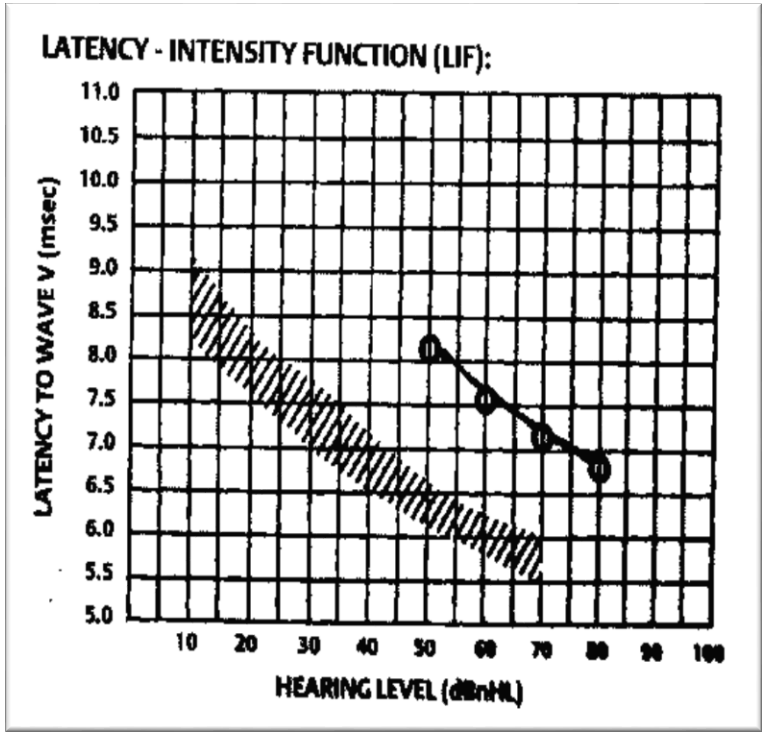
LATENCIES (ms)
ABR

Waveform	Ear	I	II	III	IV	V	VI
1	Left	***	***	***	***	6.58	***
2	Left	***	***	***	***	6.82	***
3	Left	***	***	***	***	7.27	***
4	Left	***	***	***	***	7.78	***
5	Left	***	***	***	***	8.37	***
6	Left	***	***	***	***	6.31	***
7	Right	***	***	***	***	6.38	***
8	Right	***	***	***	***	6.14	***
9	Right	***	***	***	***	6.62	***
10	Right	***	***	***	***	6.91	***
11	Right	***	***	***	***	7.47	***
12	Right	***	***	***	***	8.22	***

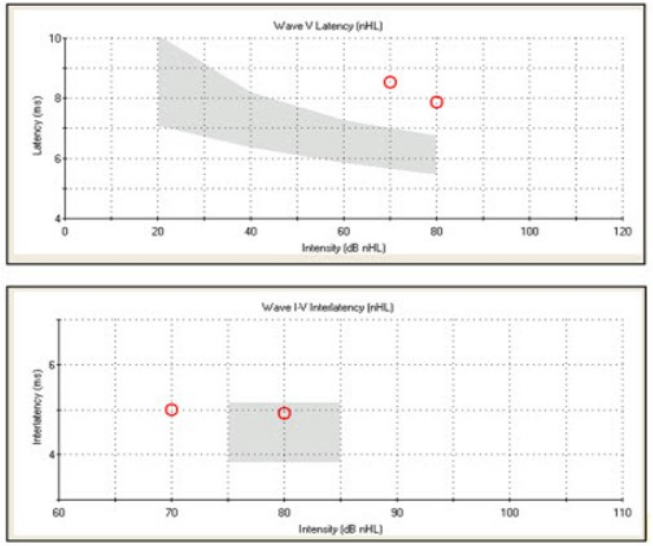
LIF in Conductive HL

- ✓Latency-intensity function (LIF) **slope → NL**
- ✓The latency of wave **V** at each intensity → prolonged
- ✓Shifted to the **right**, **proportionally to the ABG**





Conductive moderate hearing loss case report

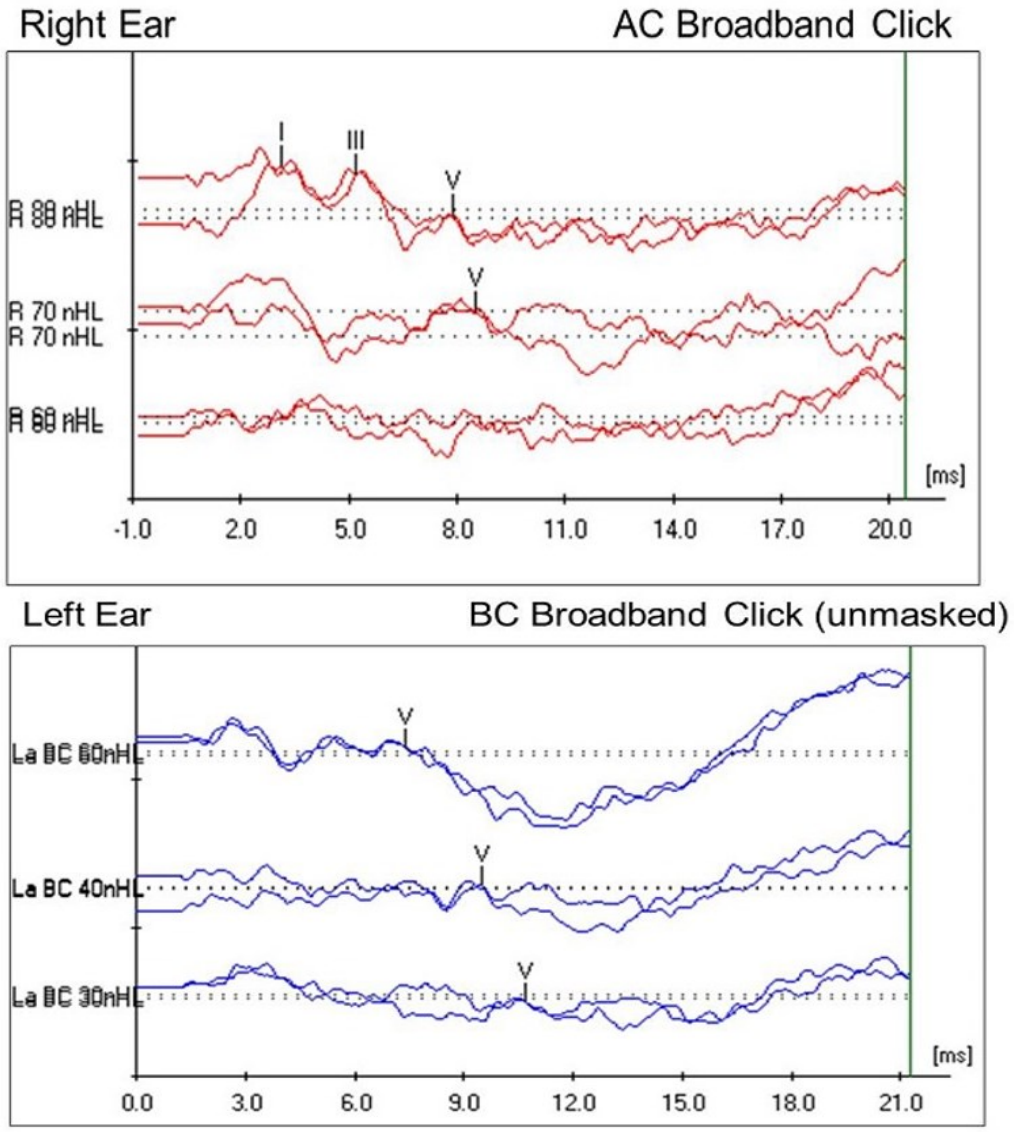


History:

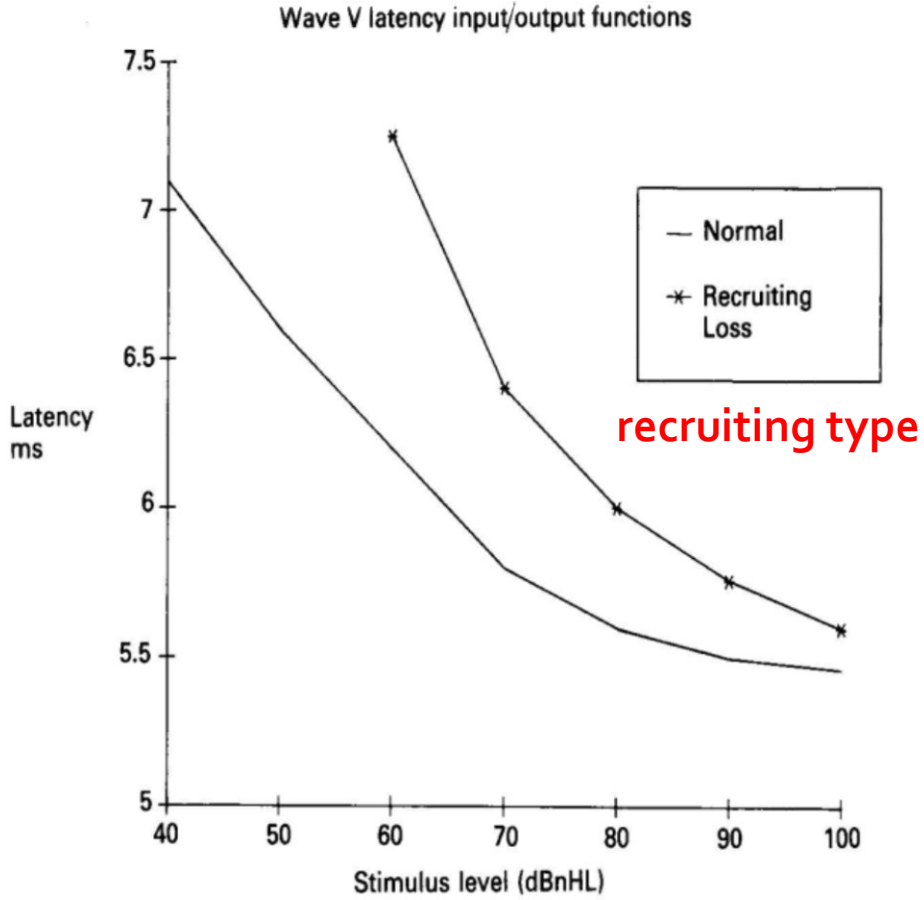
- three-week-old female
- failing hearing screening bilaterally
- born at 36 weeks
- prenatal diabetes
- bilateral microtia, left external auditory canal atresia
- Bilateral ossicular chain malformation was noted in CT scan

Audiologic evaluation:

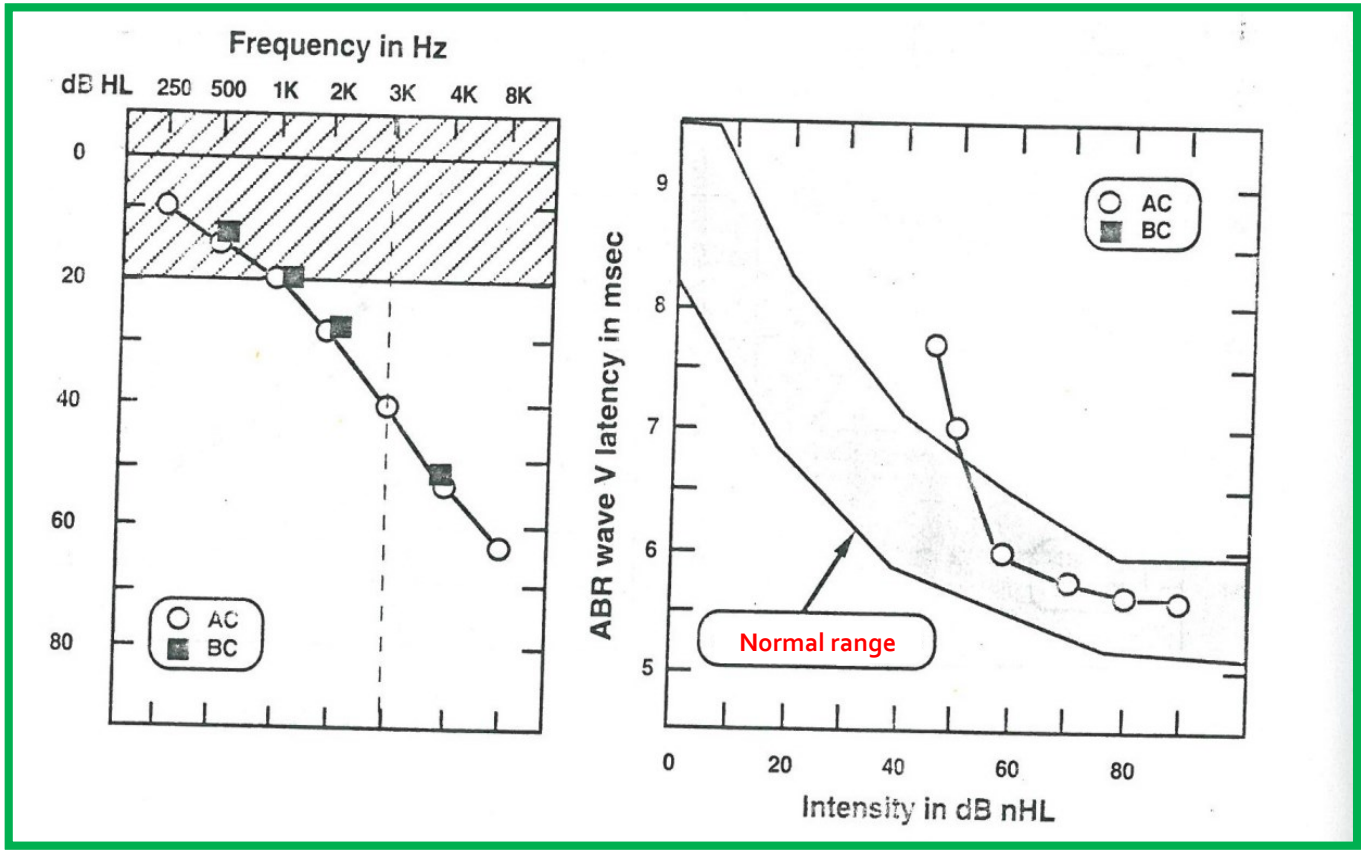
- ✓ **Tympanometry RE was Type B, LE C.N.T**
- ✓ **AC-ABR with click & Tone burst 500 Hz in RE (wave V was replicable down to 60 dB nHL.)**
- ✓ **BC-ABR with click & tone burst 500 Hz in LE (wave V present and replicable down to 25 dB nHL)**



Mild-to-moderate, high frequency sensory (cochlear) hearing loss with ABR



recruiting type



Sensory hearing loss

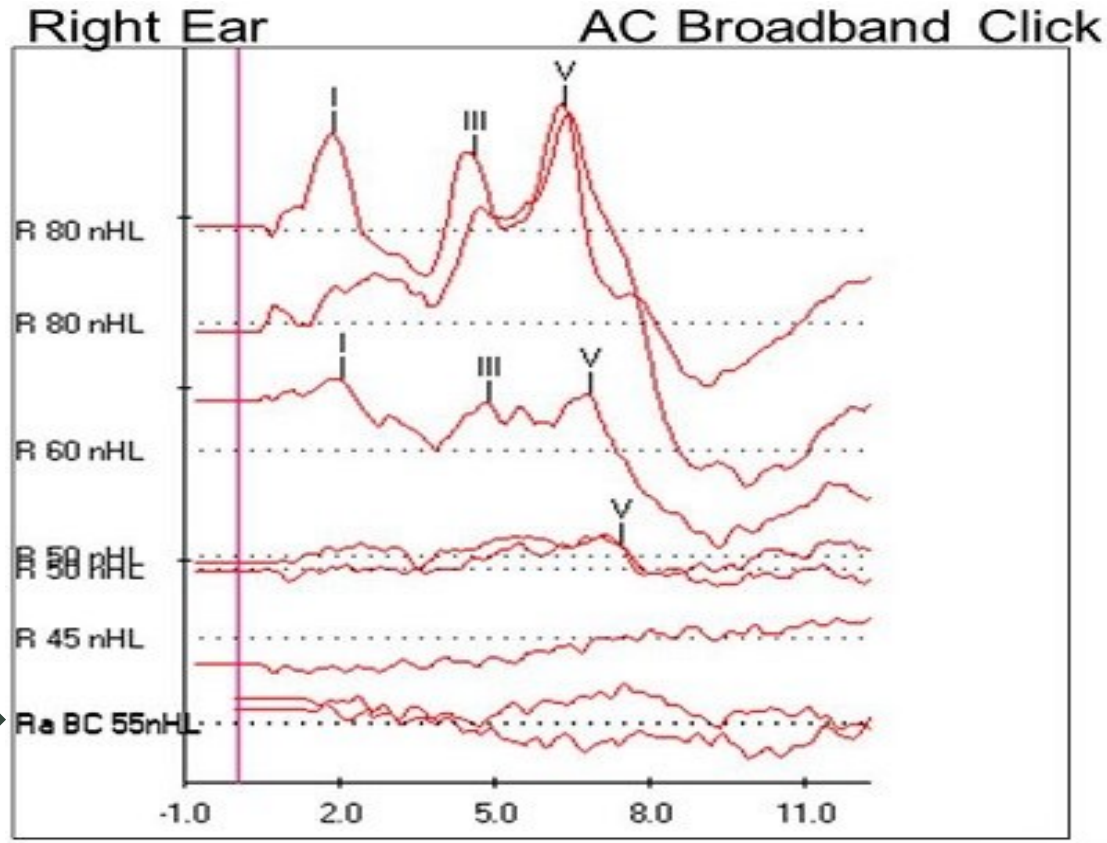
History:

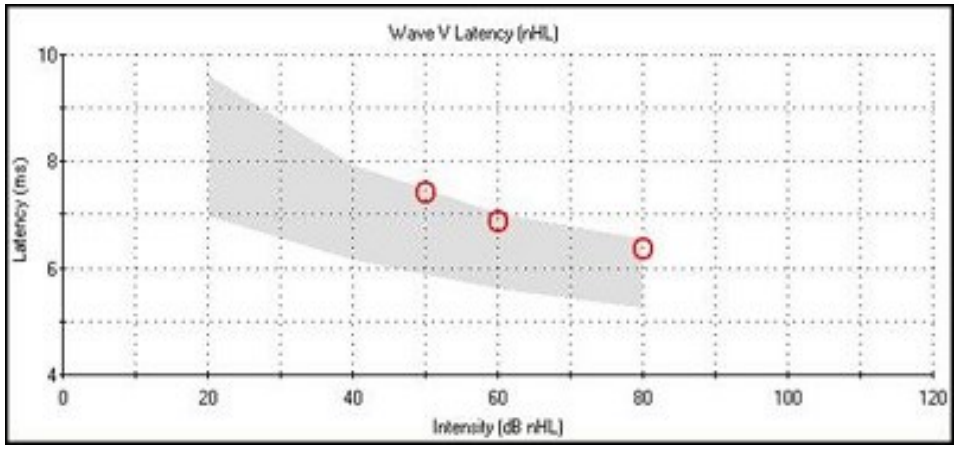
- nine-month-old female
- failing hearing screening bilaterally
- Parental reports of her babbling & normal development
- Full-term pregnancy without complications
- No family history of hearing loss and ear infection

Audiologic evaluation:

- ✓ **SAT was around 50 dB for both ears**
- ✓ **Tympanometry and ipsilateral AR at 1000 Hz were intact**
- ✓ **Failed TEOAE**
- ✓ **AC-ABR with click**
- ✓ **No response was noted at the output limits (55 dB nHL) of the BC-ABR**

BC

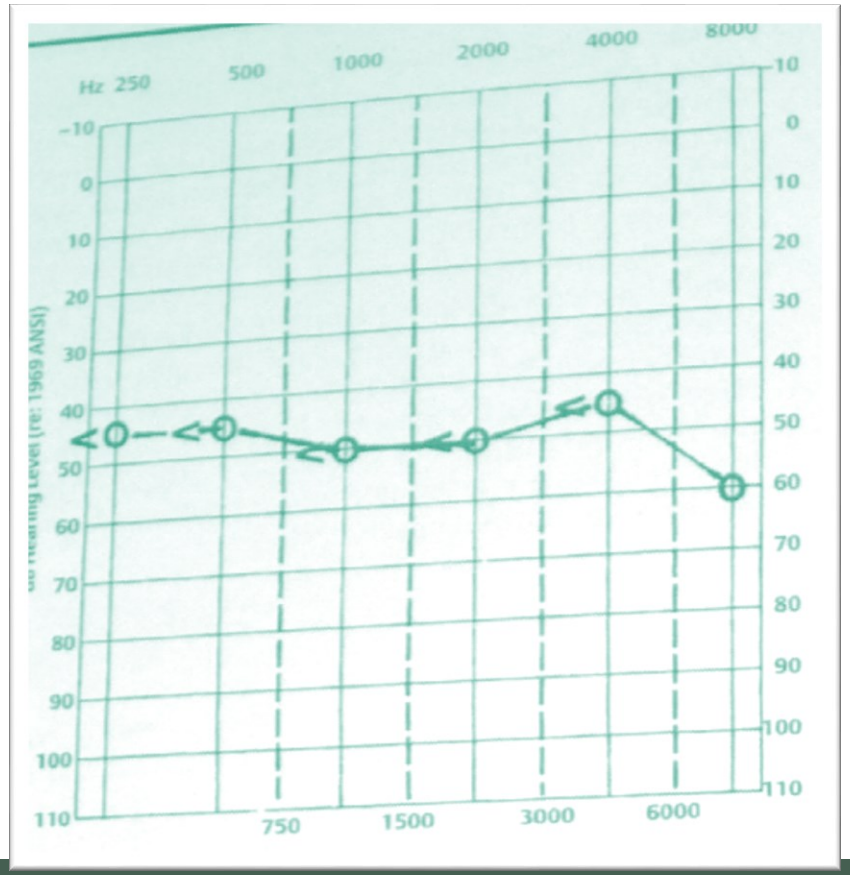


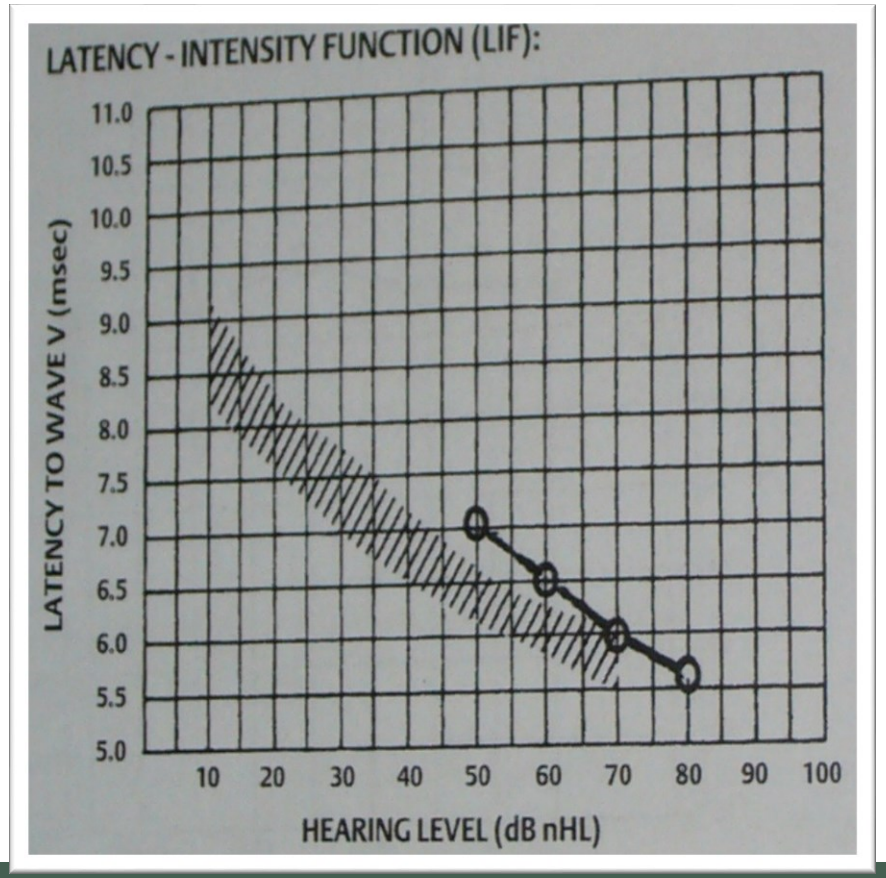


Tone burst ABR was recommended to estimate frequency-specific thresholds and define the configuration of the hearing loss

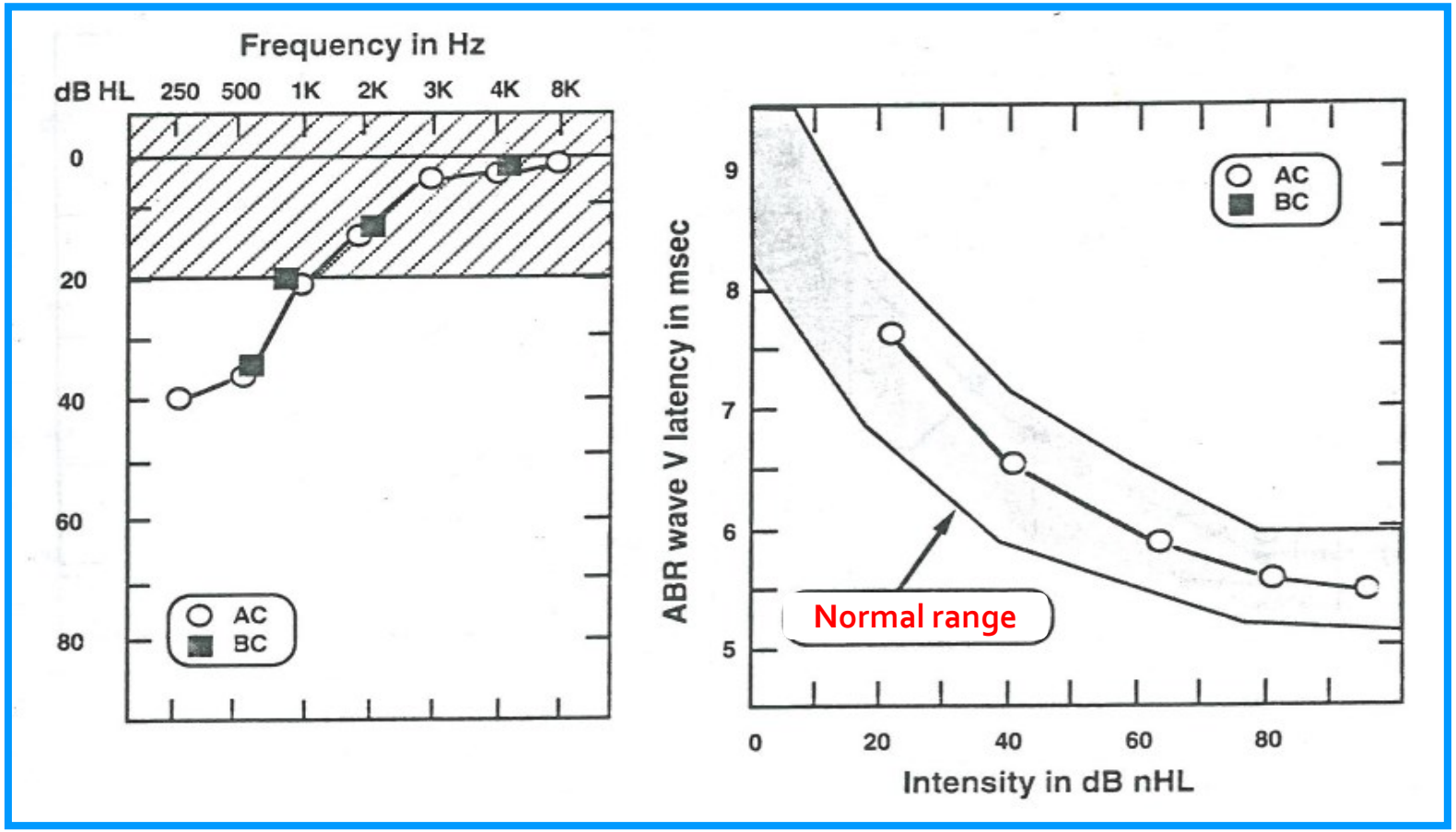
Sensory Flat hearing loss

- ✓Wave V latencies show **NO** or **LESS** prolongation compared with conductive HL.
- ✓LIF lies close to normal curve





Low frequency sensory (cochlear) hearing loss with normal ABR

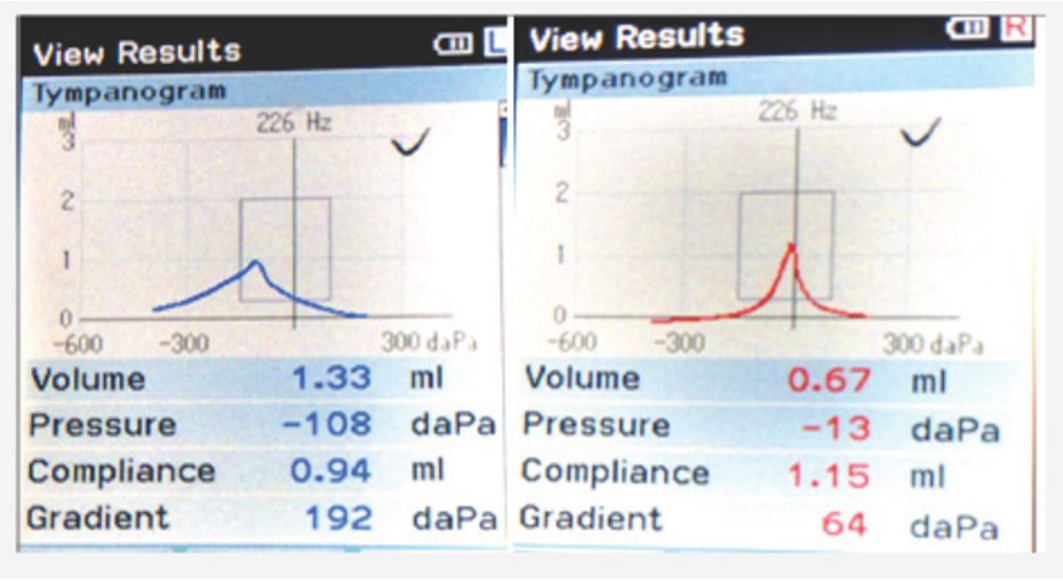


در این نوع افت شنوایی علاوه بر محرک کلیک، باید از محرک تون برست به ویژه در فرکانس های پایین مانند ۵۰۰ و ۱۰۰۰ هرتز استفاده نمود.

Sensorineural hearing loss

History:

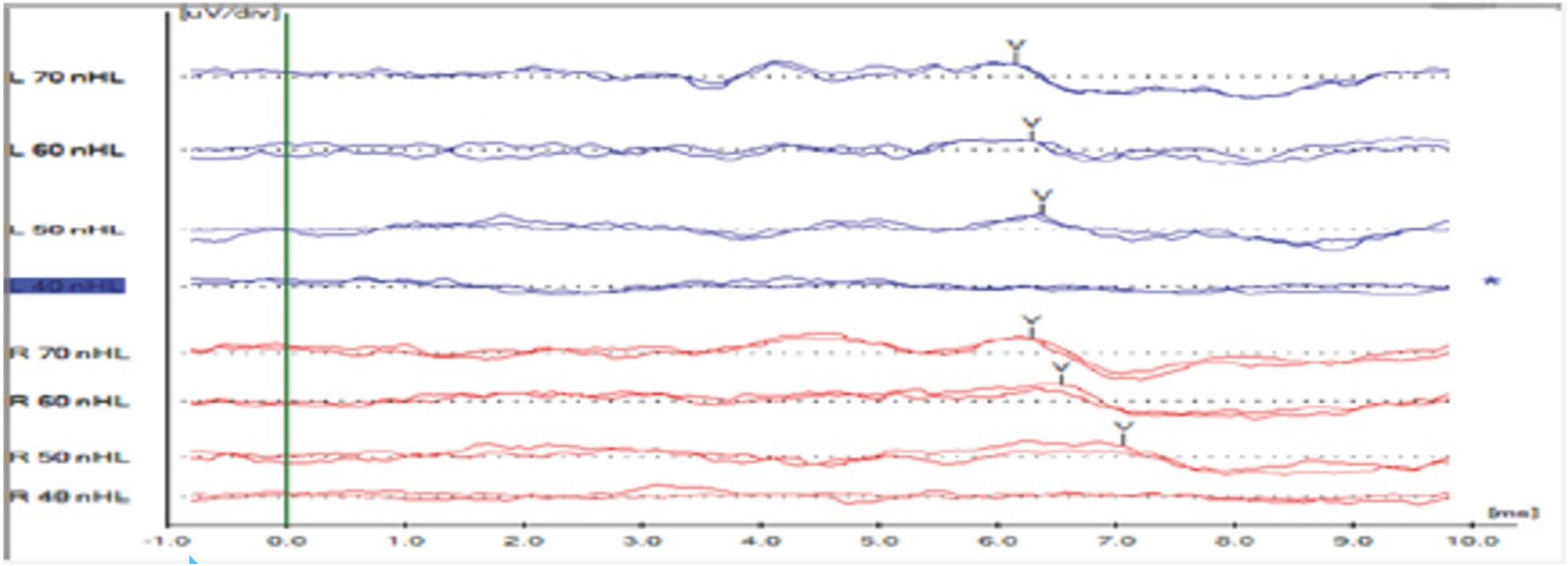
- ✓ 6 year old male with Laurence-Moon Biedl (LMB) syndrome (an autosomal recessive genetic disorder)
- ✓ characterized by varying degrees of hearing impairment, mild to moderate MR, obesity, retinitis pigmentosa, extra digits on the hands and feet
- ✓ delayed speech and language development



Audiologic evaluation:

- ✓ **Otoscopic evaluation**
- ✓ **Tympanometry: normal**
- ✓ **TEOAE: failed & DPOAE: passed**
- ✓ **AC-click ABR**

	F1	F2	DP frequency	DP	NF	DP/NF(dB)	Pass/Refer
Left Ear	844	984	703	13.8	-16.8	30.7	Pass
	1688	2016	1359	13.7	-15.4	29.1	Pass
	2484	3000	1969	14.2	-23.6	37.8	Pass
	3328	3984	2672	14.9	-18	32.8	Pass
	4172	5016	3328	16.5	-16.8	33.4	Pass
	5016	6000	4031	8.4	-12	20.4	Pass
Right Ear	844	984	703	13.8	-10.4	24.2	Pass
	1688	2016	1359	12.3	-14.7	27	Pass
	2484	3000	1969	14	-23.1	37.1	Pass
	3328	3984	2672	15	-16.9	31.9	Pass
	4172	5016	3328	17.2	-16.4	33.6	Pass
	5016	6000	4031	11.5	-14.7	26.2	Pass



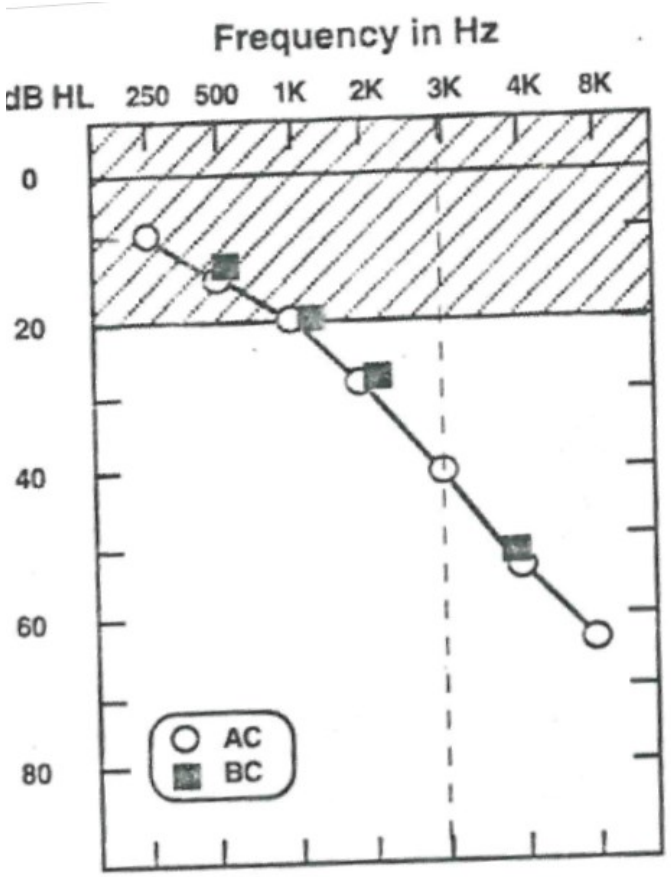
Latency- intensity function is used to differentially diagnosis conductive hearing loss and sensorineural pathology.

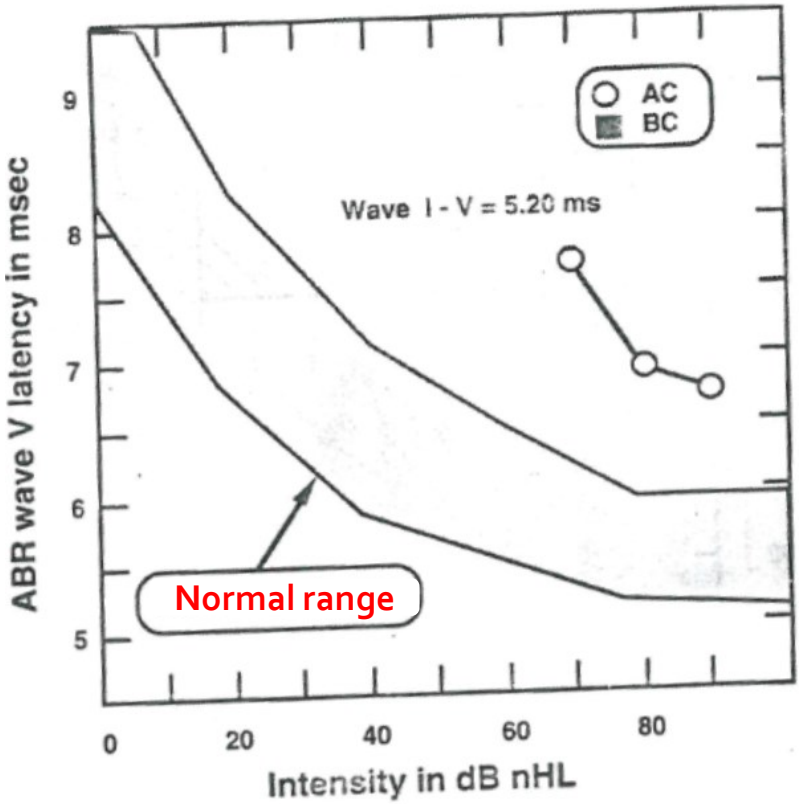
Studies reported that an increase in absolute latency of 0.3 ms as intensity decreases by 10dB is observed in normal hearing and cochlear pathologies .

Latency of Vth peak at different intensity level.

	Intensity	Absolute latency for Left Ear	Absolute latency for Right Ear
1.	70dBnHL	6.15ms	6.28ms
2.	60dBnHL	6.28ms	6.53ms
3.	50dBnHL	6.3ms	7.07ms

Mild-to-moderate , high frequency retrochochlear hearing loss





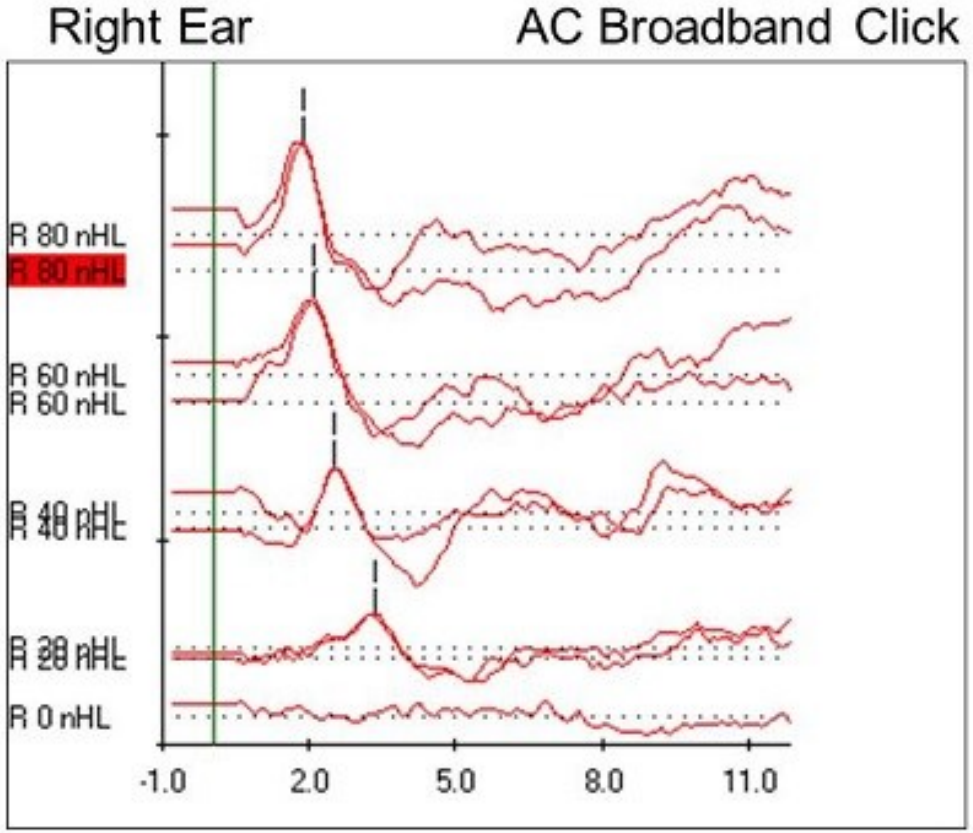
Brainstem dysfunction

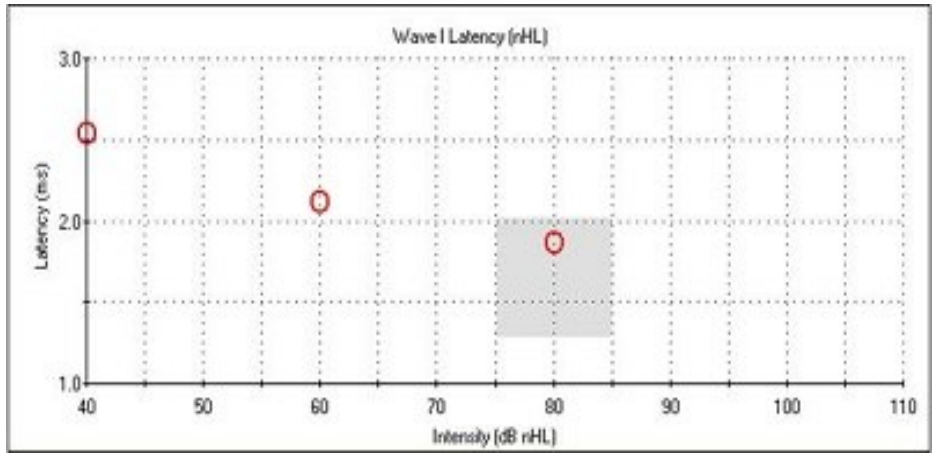
History:

- two-month-old female
- failing hearing screening bilaterally
- born at 38 weeks with a normal birth weight.
- myelomeningocele, Chiari II malformation, perinatal intraventricular hemorrhage, central apnea, and long-term ventilation and tracheostomy.
- MRI findings include: no recognizable fourth ventricle, cerebellar tissue was herniated into the upper cervical spinal

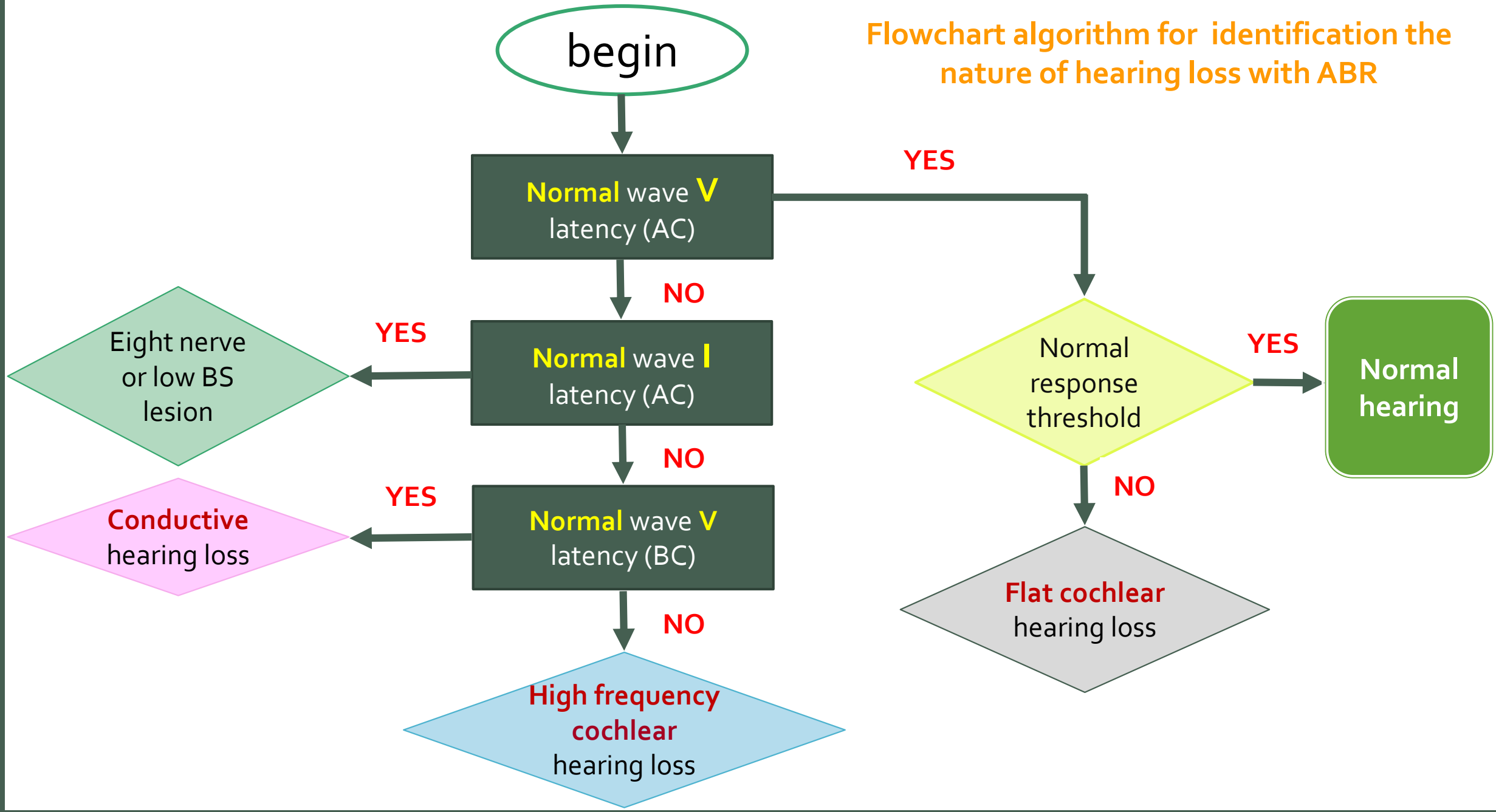
Audiologic evaluation:

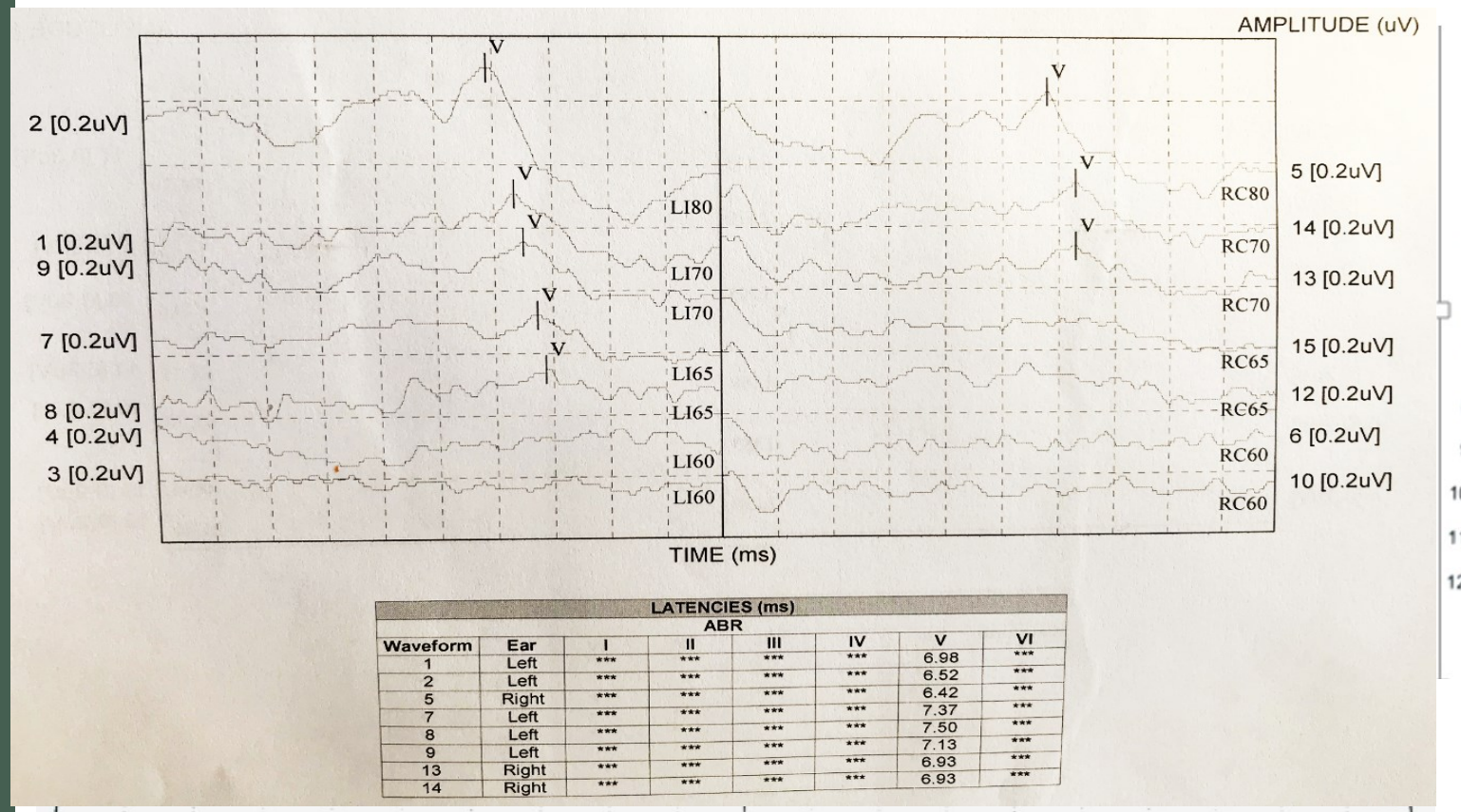
- ✓ **AC-ABR with click with clearly identifiable wave I and normal absolute latency of wave I.**
- ✓ **Normal results in high frequency tympanometry, TEOAE & DPOAE**





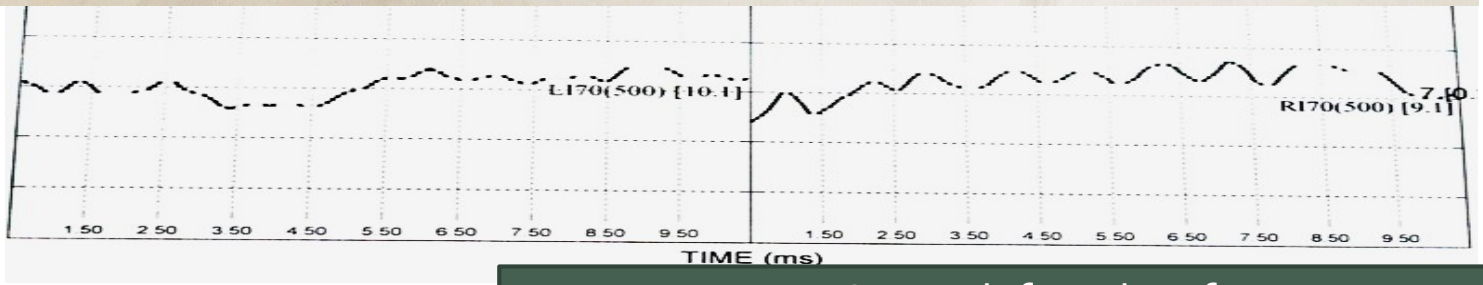
Flowchart algorithm for identification the nature of hearing loss with ABR

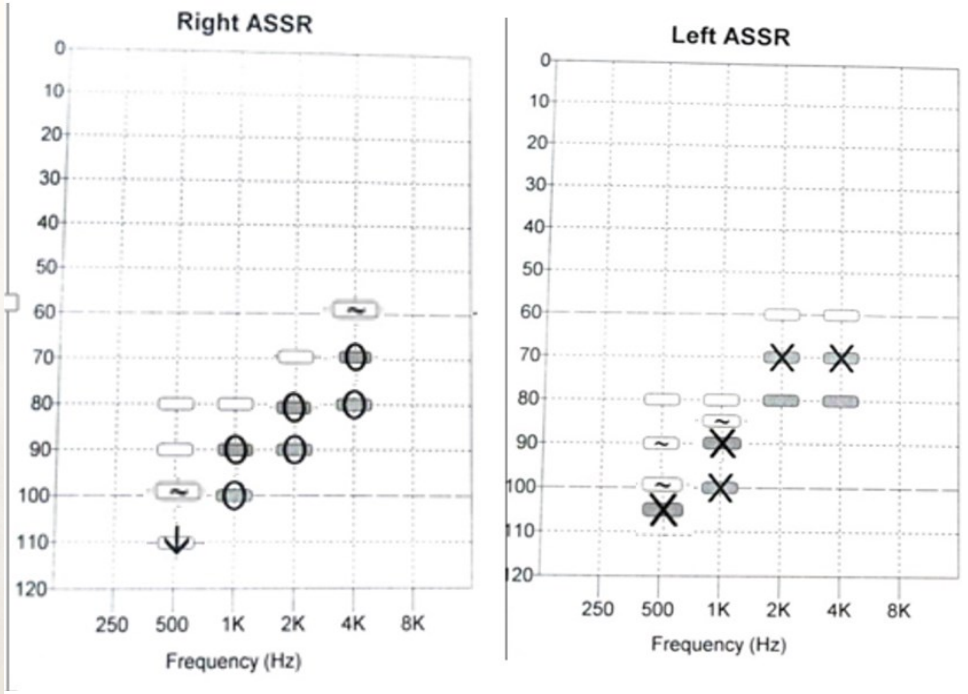


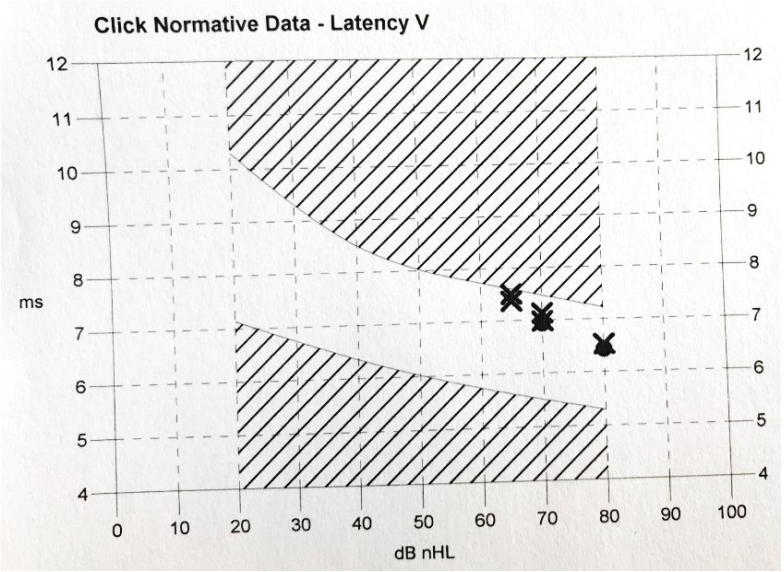


LATENCIES (ms)
ABR

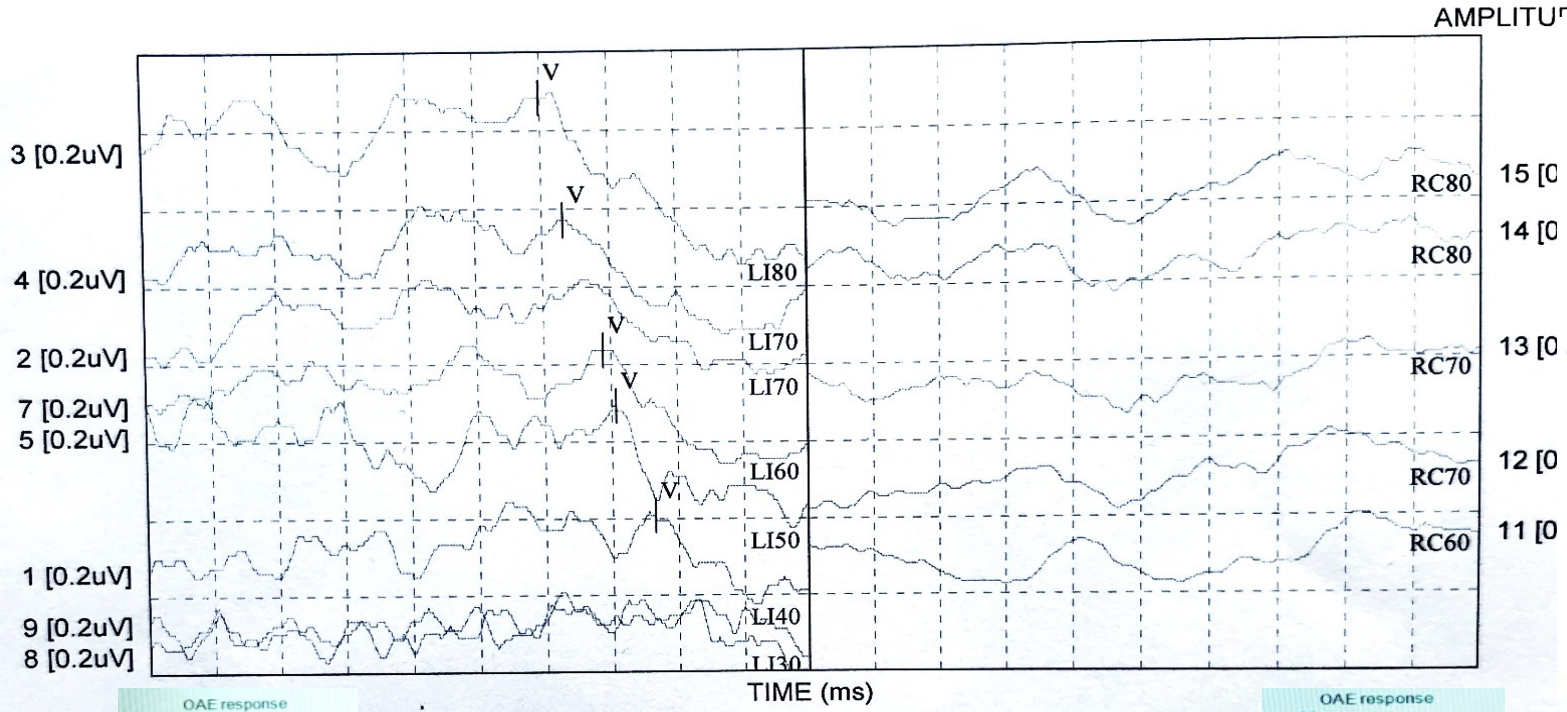
Waveform	Ear	I	II	III	IV	V	VI
1	Left	***	***	***	***	6.98	***
2	Left	***	***	***	***	6.52	***
5	Right	***	***	***	***	6.42	***
7	Left	***	***	***	***	7.37	***
8	Left	***	***	***	***	7.50	***
9	Left	***	***	***	***	7.13	***
13	Right	***	***	***	***	6.93	***
14	Right	***	***	***	***	6.93	***

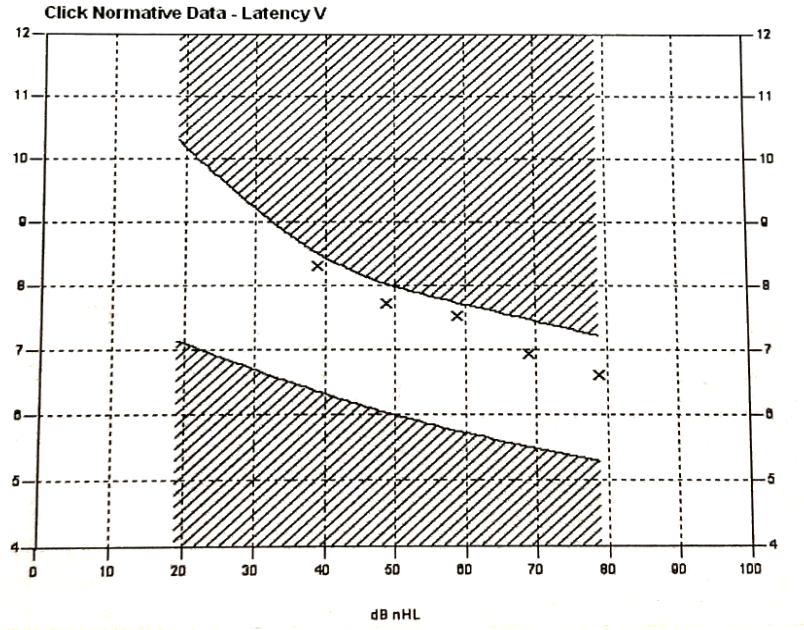


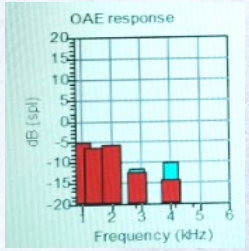




16 month female infant
Consanguineous marriage
Full-term
Normal Tympanometry

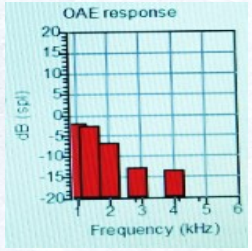


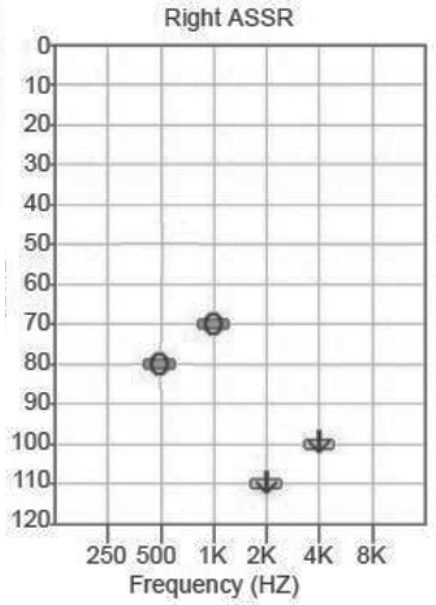


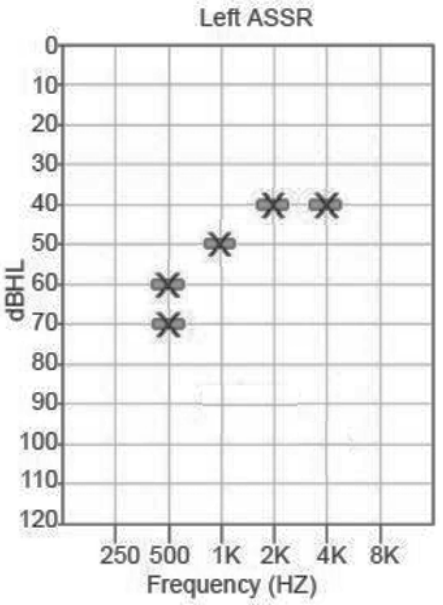


LATENCIES (ms)
ABR

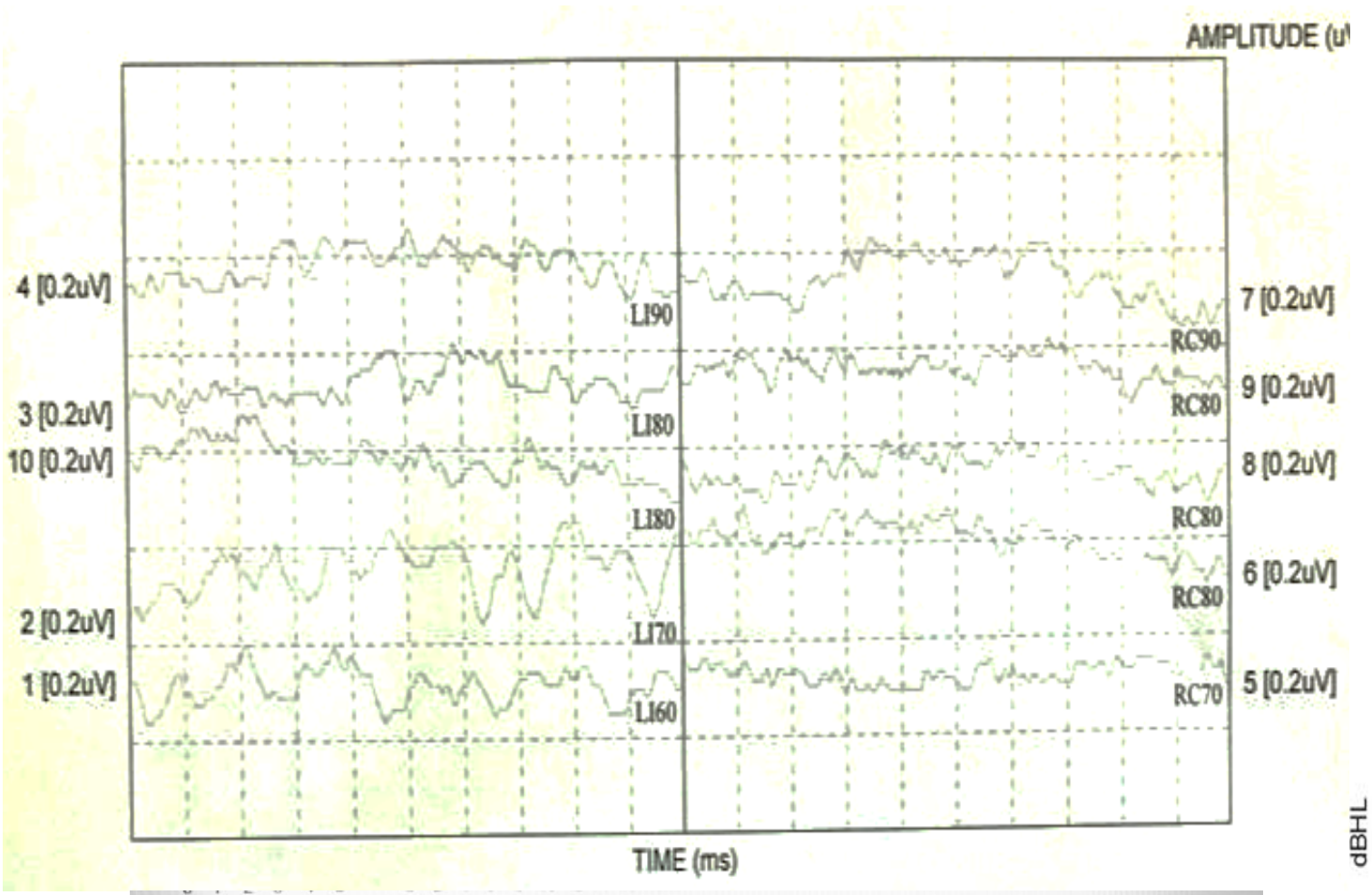
Waveform	Ear	I	II	III	IV	V	VI
1	Left	***	***	***	***	8.30	***
3	Left	***	***	***	***	6.60	***
4	Left	***	***	***	***	6.94	***
5	Left	***	***	***	***	7.52	***
7	Left	***	***	***	***	7.71	***



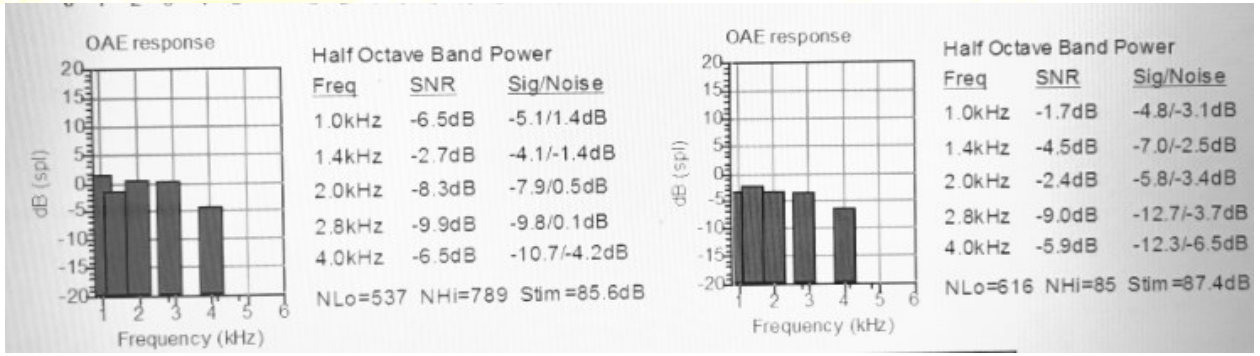


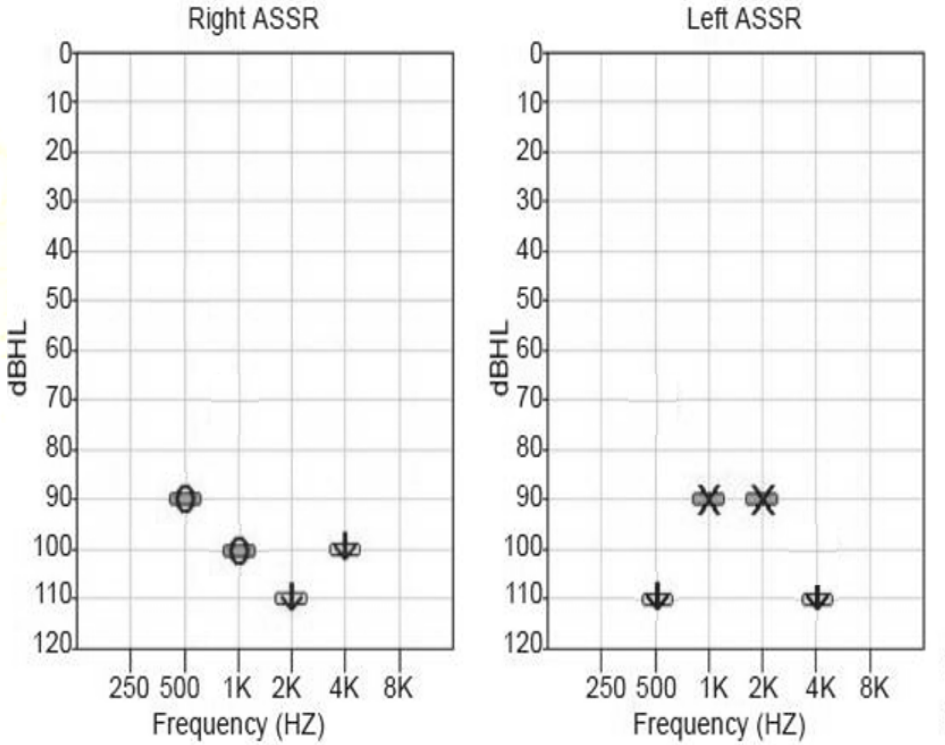


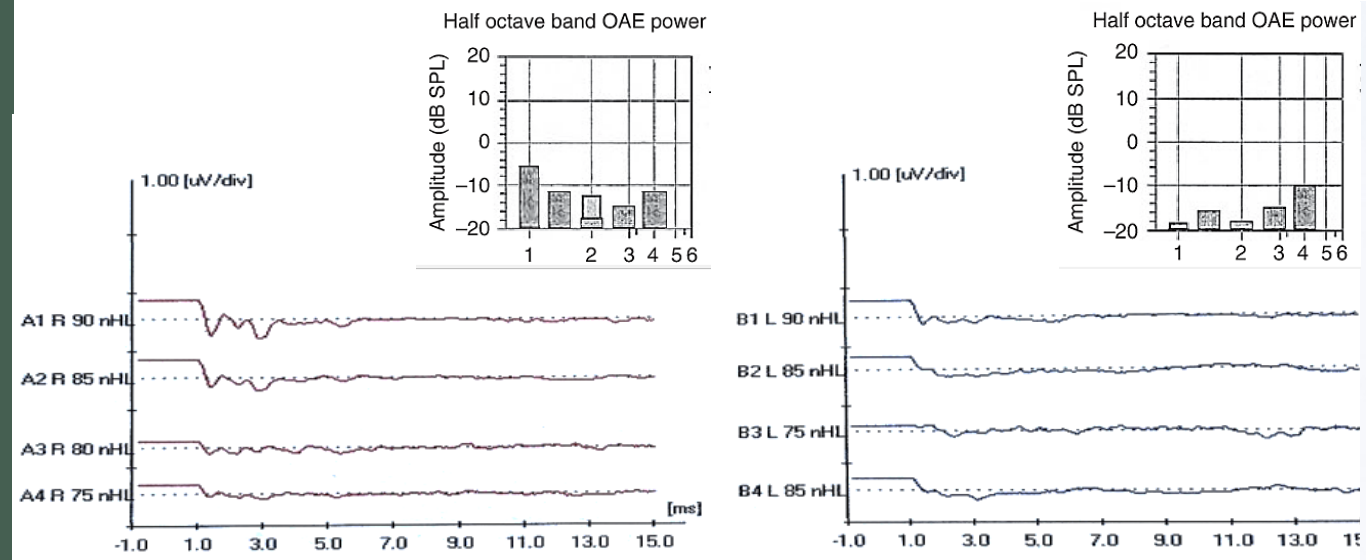
5 months female infant
Seizure & pneumonia
Brain scan was normal
preterm & Low birth weight
Type An in tympanometry



39 months female infant
Respiratory system problems
40 days in NICU
preterm
Low birth weight
Consanguineous marriage



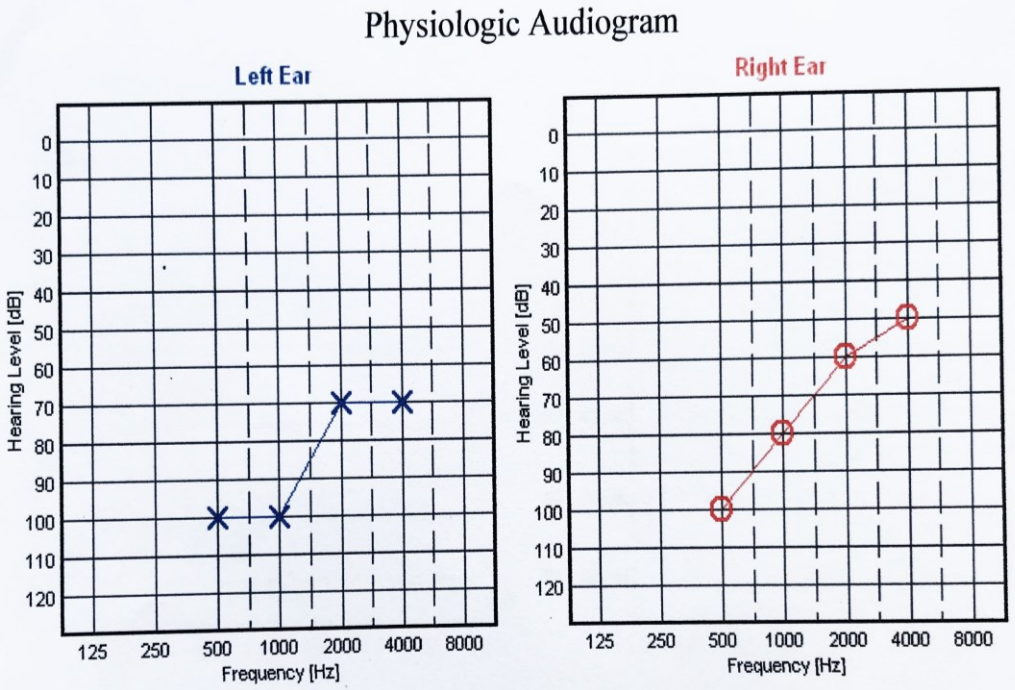




Collection Parameters						Latencies (ms)					Interlatencies (n		
Wave	Transducer	Ear	Intensity	Type	Frequency	I	II	III	IV	V	I-III	III-V	I-
A1	Insert Earphones	Right	90dB nHL	Click	N/A								
A2	Insert Earphones	Right	85dB nHL	Tone Burst	500								
A3	Insert Earphones	Right	80dB nHL	Click	N/A								
A4	Insert Earphones	Right	75dB nHL	Click	N/A								
B1	Insert Earphones	Left	90dB nHL	Click	N/A								
B2	Insert Earphones	Left	85dB nHL	Tone Burst	500								
B3	Insert Earphones	Left	75dB nHL	Click	N/A								
B4	Insert Earphones	Left	85dB nHL	Click	N/A								

2 year old male
Full-term
No history of hearing loss or genetic disease
Normal Tympanometry result

Results:



Left Ear p-value Table

Transducer type: Air Conduction

Channel: Channel 1

	500	1000	2000	4000
8/30/2020 2:00:53 PM				
Channel 1 Forehead/Nape				
110 (IE)	0.005	0.000		
100 (IE)			0.043	0.000
100 (IE)	0.382	0.119		
90 (IE)			0.044	0.000
80 (IE)			0.013	0.000
70 (IE)			0.984	0.192

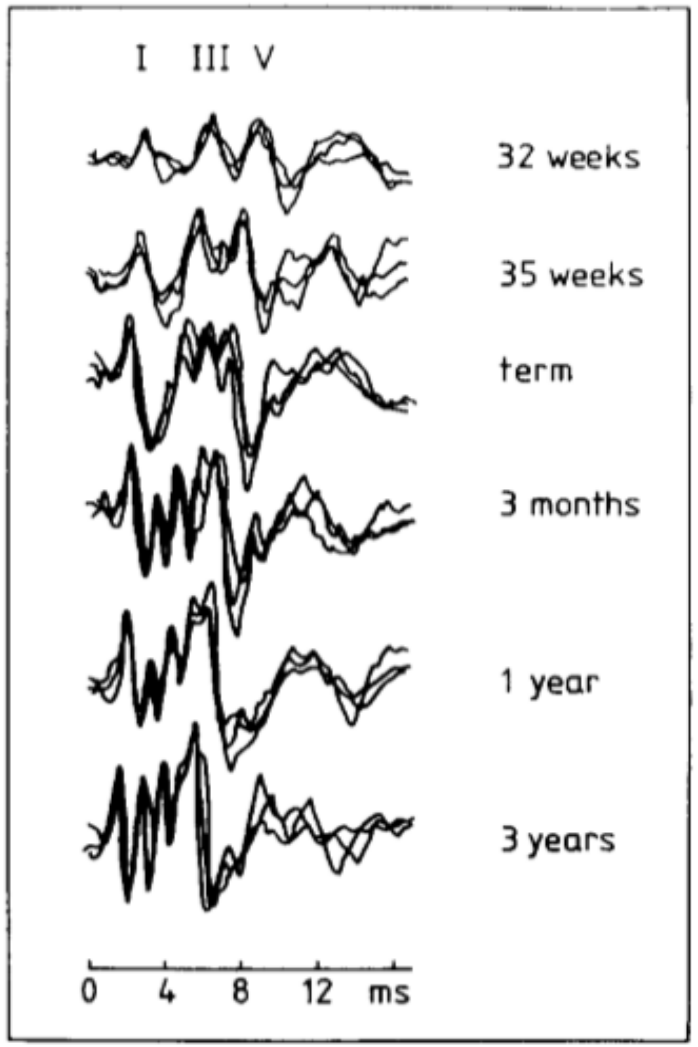
Right Ear p-value Table

Transducer type: Air Conduction

Channel: Channel 1

	500	1000	2000	4000
8/30/2020 2:00:53 PM				
Channel 1 Forehead/Nape				
110 (IE)	0.000			
100 (IE)			0.005	0.000
100 (IE)	0.120	0.000		
90 (IE)		0.006		
90 (IE)			0.001	0.000
80 (IE)		0.278	0.021	0.000
70 (IE)			0.017	
60 (IE)			0.477	
60 (IE)			0.160	0.022
50 (IE)				0.484

ABR maturation in infants



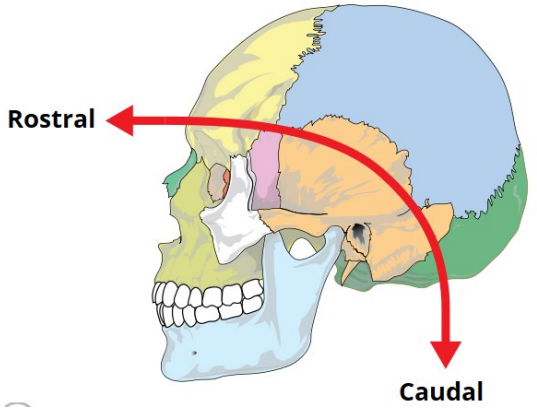
. Examples of ABR wave forms in infants of various age.

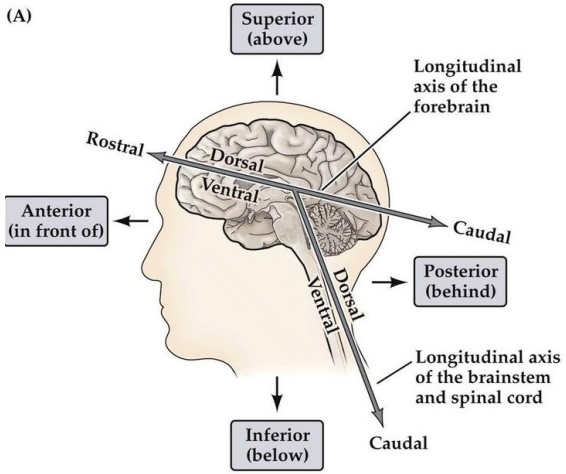
موج I

- ✓ تغییر پذیری آن کمترین است
- ✓ در ۳ ماهگی زمان تاخیر آن معادل زمان تاخیر بزرگسالان است.

موج V

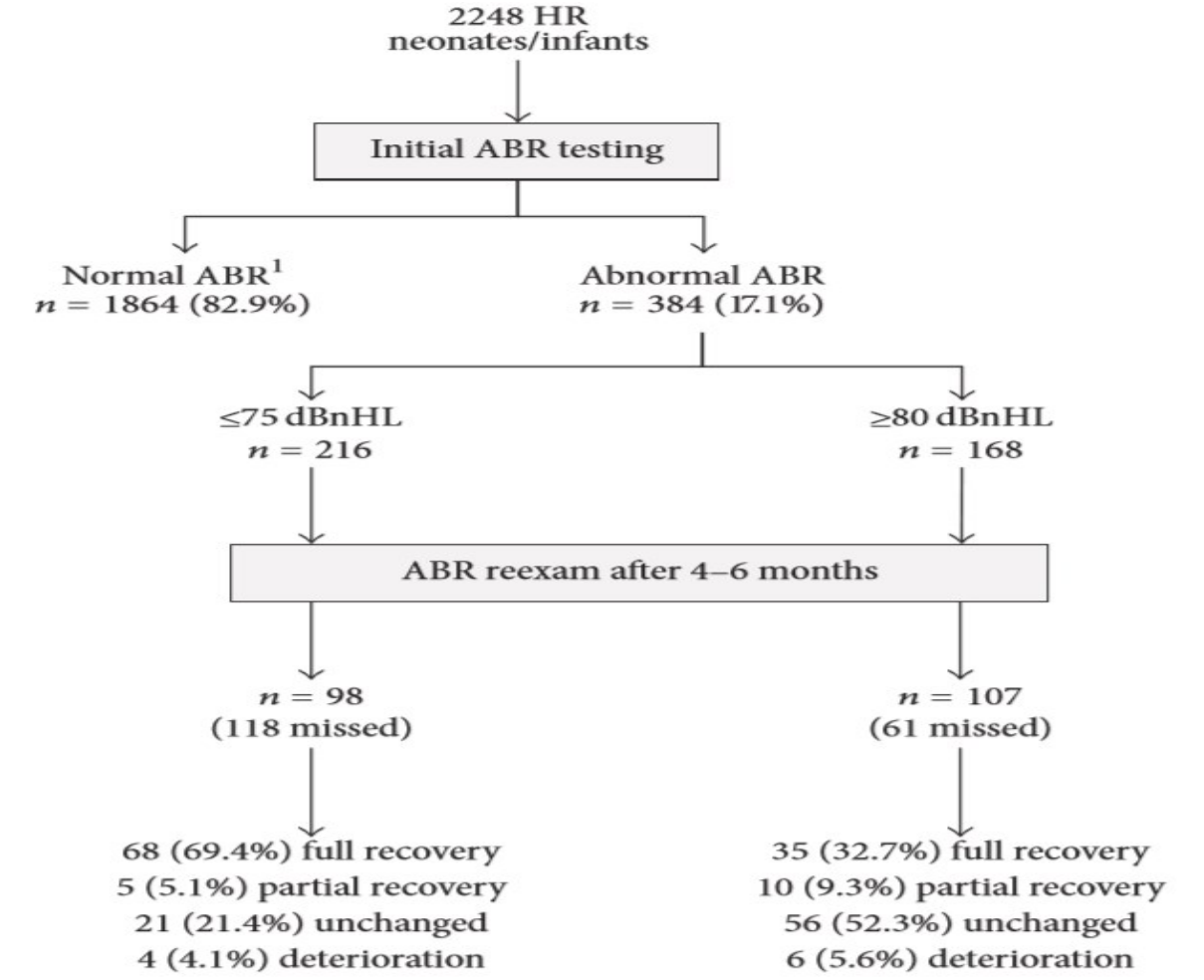
- ✓ نسبت به قلل دیگر زمان تاخیر این قله طی روند رشد کاهش شدیدی دارد (حدود ۲ میلی ثانیه)
- ✓ در سن ۱۸ تا ۳۶ ماهگی به حالت تکاملی خود می رسد.





Age effect on LIF in neonates

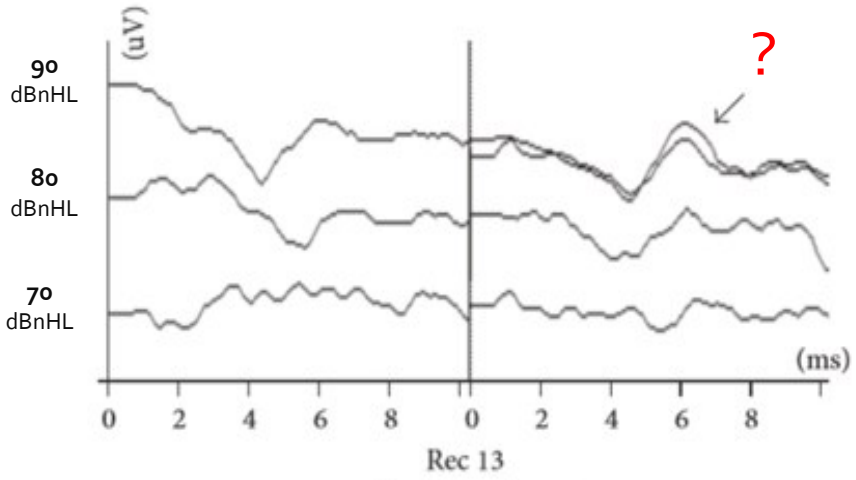
تغییرات زمان نهفتگی در نوزادان به ازای هر ۱۰ دسی بل تغییر شدت، ۰/۳ تا ۰/۴ میلی ثانیه است.



Schematic flow chart of the results of the study. [1]Replicable waveform at 40 dBnHL within the expected latencies.

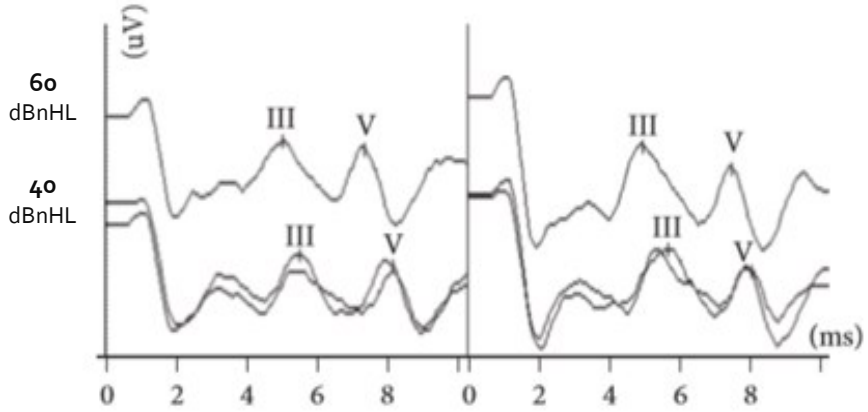
Loannis Psarommatis, Charalampos Voudouris, Loannis Kapetanakis, Faselida Athanasiadi, and Konstantinos Douros. Recovery of Abnormal ABR in Neonates and Infants at Risk of Hearing Loss. International Journal of Otolaryngology. Received 25 December 2016; Revised 19 February 2017; Accepted 5 March 2017; Published 4 April 2017.

ABR Restoration case 1



(a) ABR at day 27

(b) OAEs at day 27



(c) ABR at 20 months

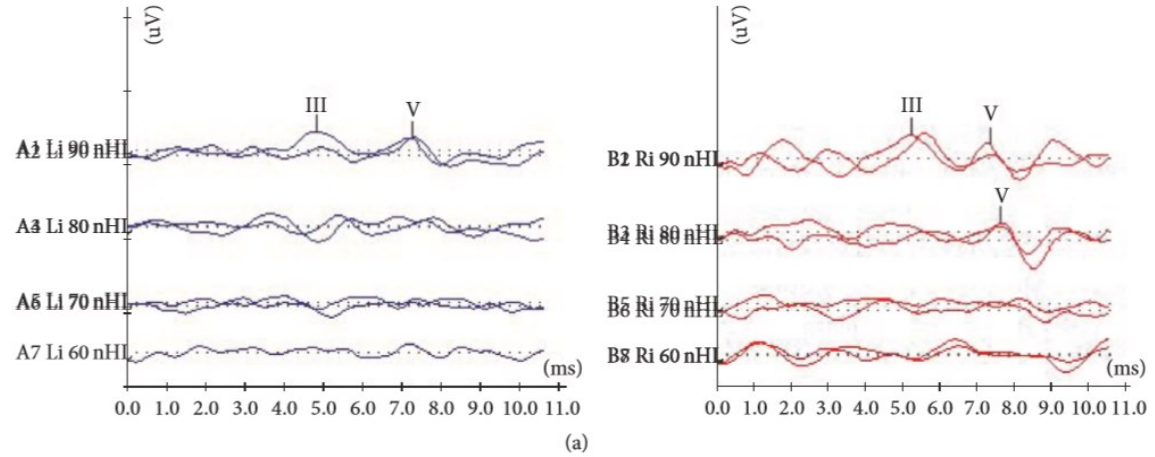
Audiological data of a HR infant

Risk indicators:
low birth weight, hyperbilirubinemia, phototherapy.

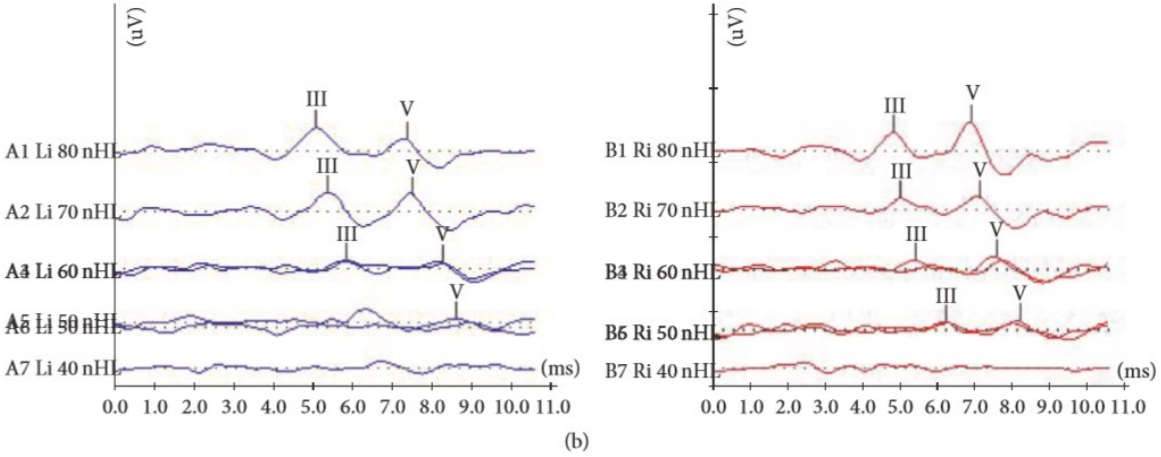
A) Initial ABR recordings in day 27
B) Normal OAE bilaterally at the same session
C) Last ABR at the age of 20 month, typical & replicable waveform

Information from parents & CPA validated the Restoration of ABR

ABR Restoration case 2



(a)



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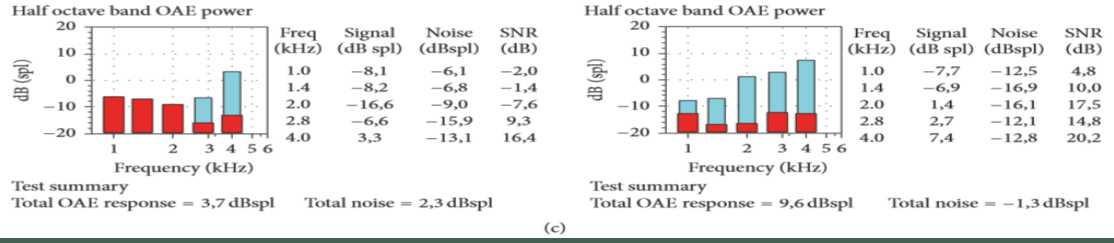
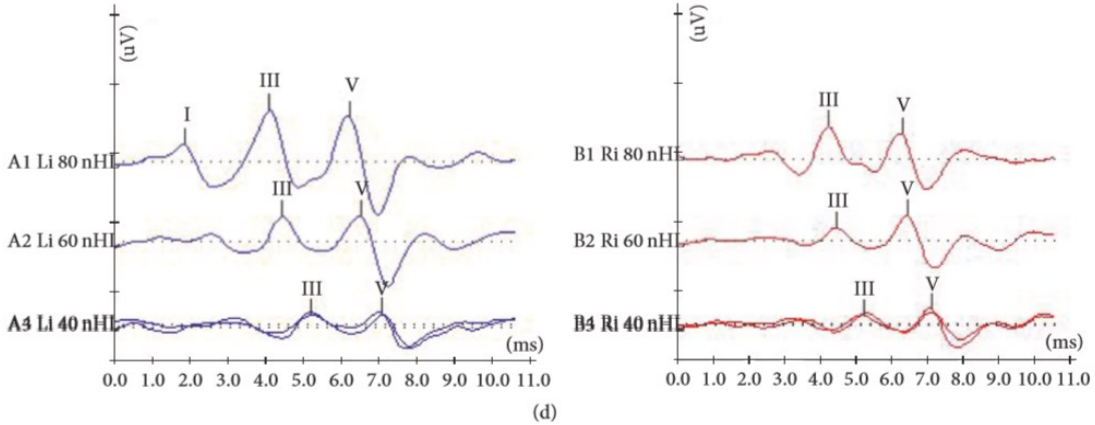
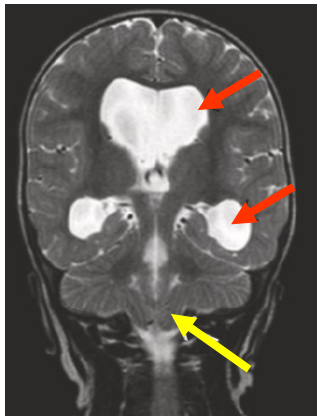


(c)



(d)



Serial ABR measurements, OAE and MRI findings of an infant with type I Chiari malformation

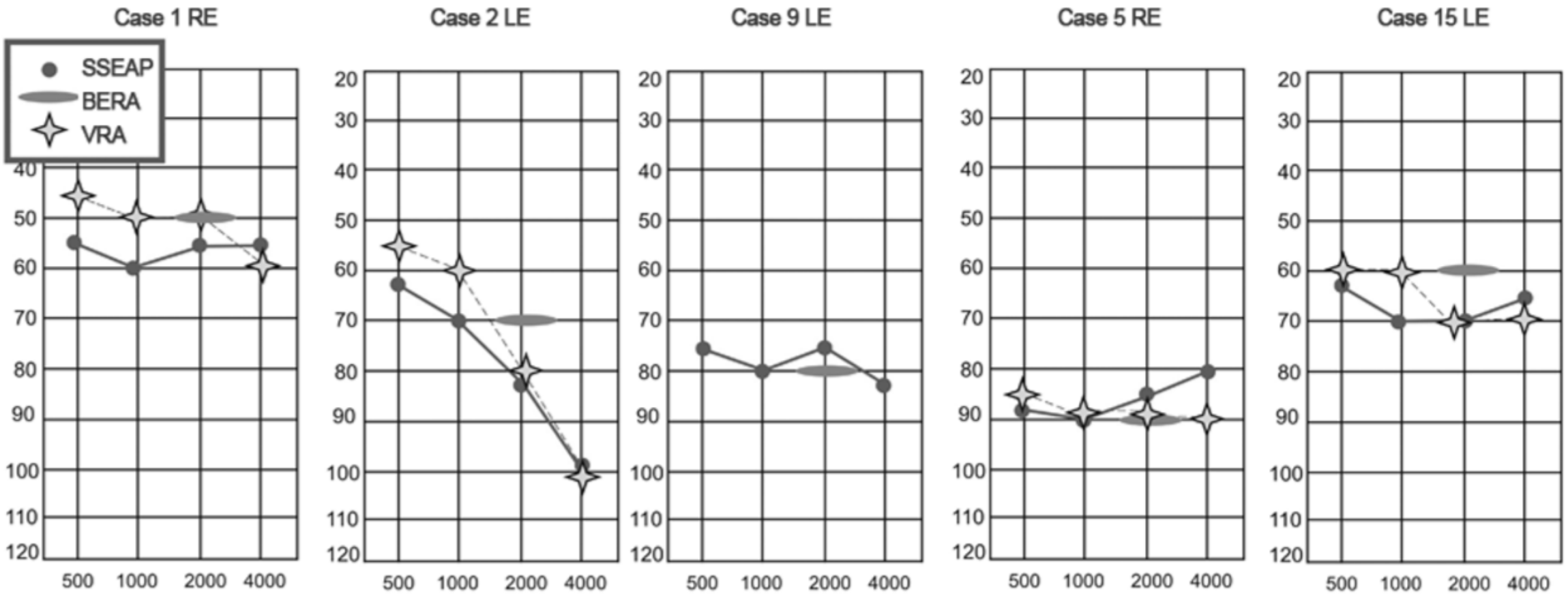
A) Initial ABR (age 2.5 months)
B) ABR at 5 months later
C) Normal OAE bilaterally
D) Last ABR at the age of 7.5 month. replicable ABR waveform at 40 dBnHL bilaterally
E) MRI at 7 months,
F) Coronal MRI image at the age of 7 months, enlargement of lateral ventricles (red arrows) and herniated cerebell artonsils (yellow arrow).

In infants suffering from diseases which can harm CNS

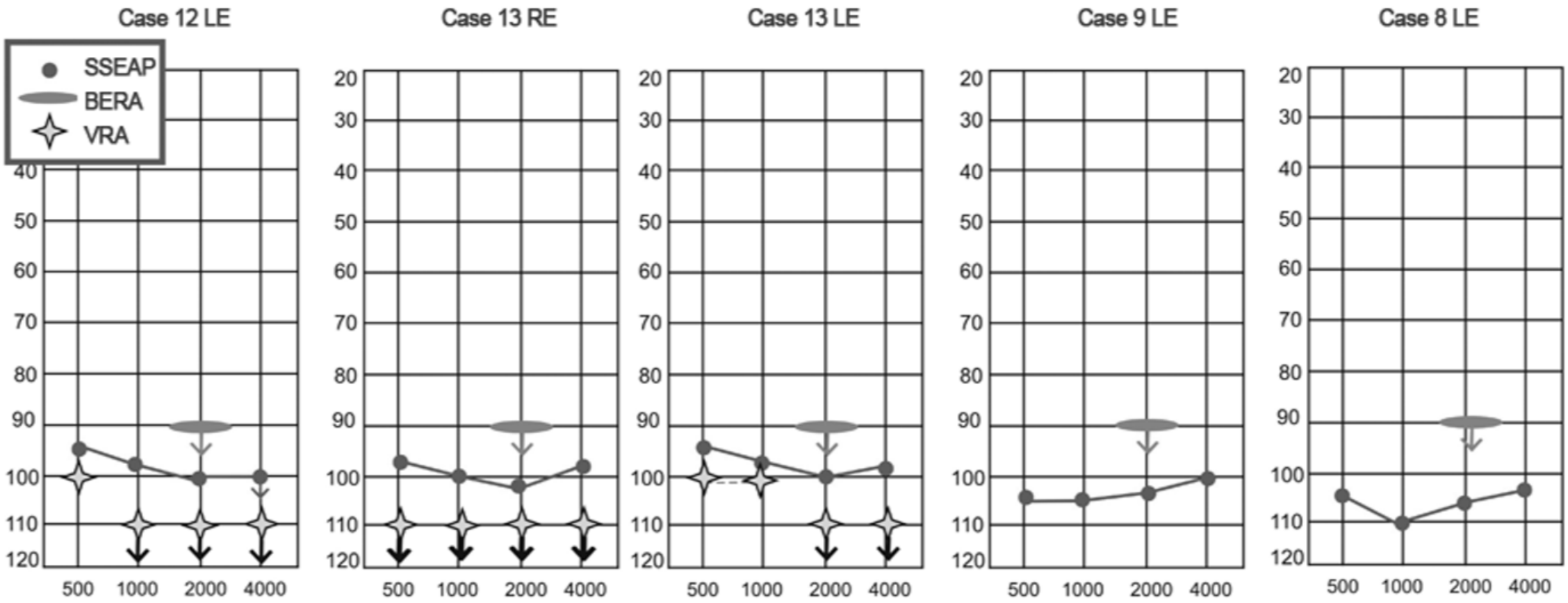
(birth head trauma, hyperbilirubinemia, CNS infection, neurological and metabolic diseases, anoxia, etc.),

sequential ABR, and imaging studies to monitor the progression of brain myelination are recommended.

Particularly, infants with **Auditory Neuropathy** profile should be treated less aggressively, in view of the fact that partial or complete ABR recovery is more likely to take place during the following months.



In general, the click has its power concentrated between 2 and 4 kHz, indicating hearing loss for the high frequencies; however, in cases of descending hearing loss, its broad band nature may represent the low frequencies.



the ASSR indicated a residual hearing in the absence of ABR recordings


از توجه شما سپاسگزارم
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