臨床聽力學 (II)
Clinical Audiology (II)

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許權振

臨床聽力學 (II)

內容概要

聽覺生理

聽力檢查：行為(主觀) vs 生理(客觀)

臨床應用

- 聽力閾值測定
- 病變部位診斷
- 聽覺復/創健

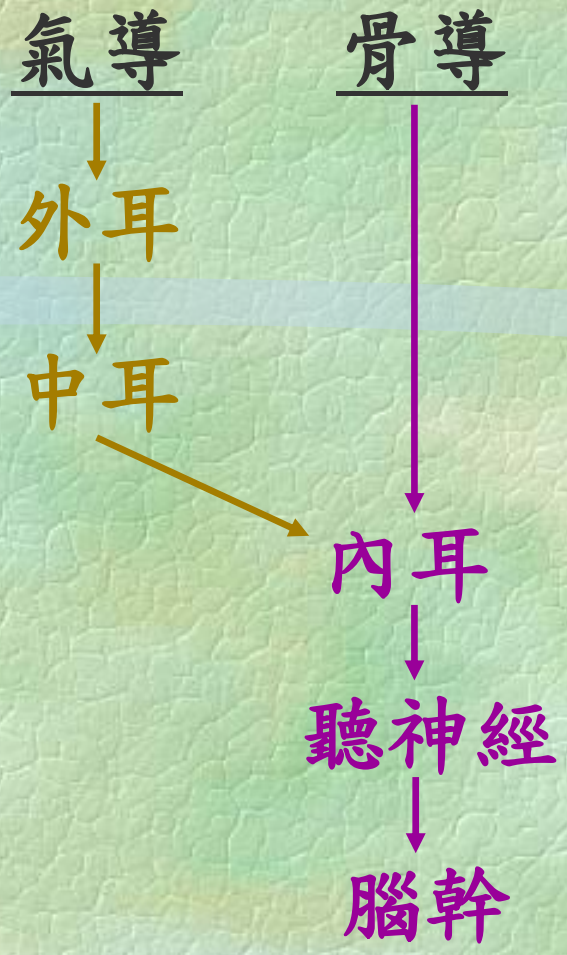
病變部位的診斷
Diagnosis of Sites of Lesions

病變部位的診斷

檢查模式

Conductive Mechenism

Sensorineural Mechanism



病變部位的診斷

末稍聽覺系統

感覺神經性聽力損失:

耳蝸、聽神經

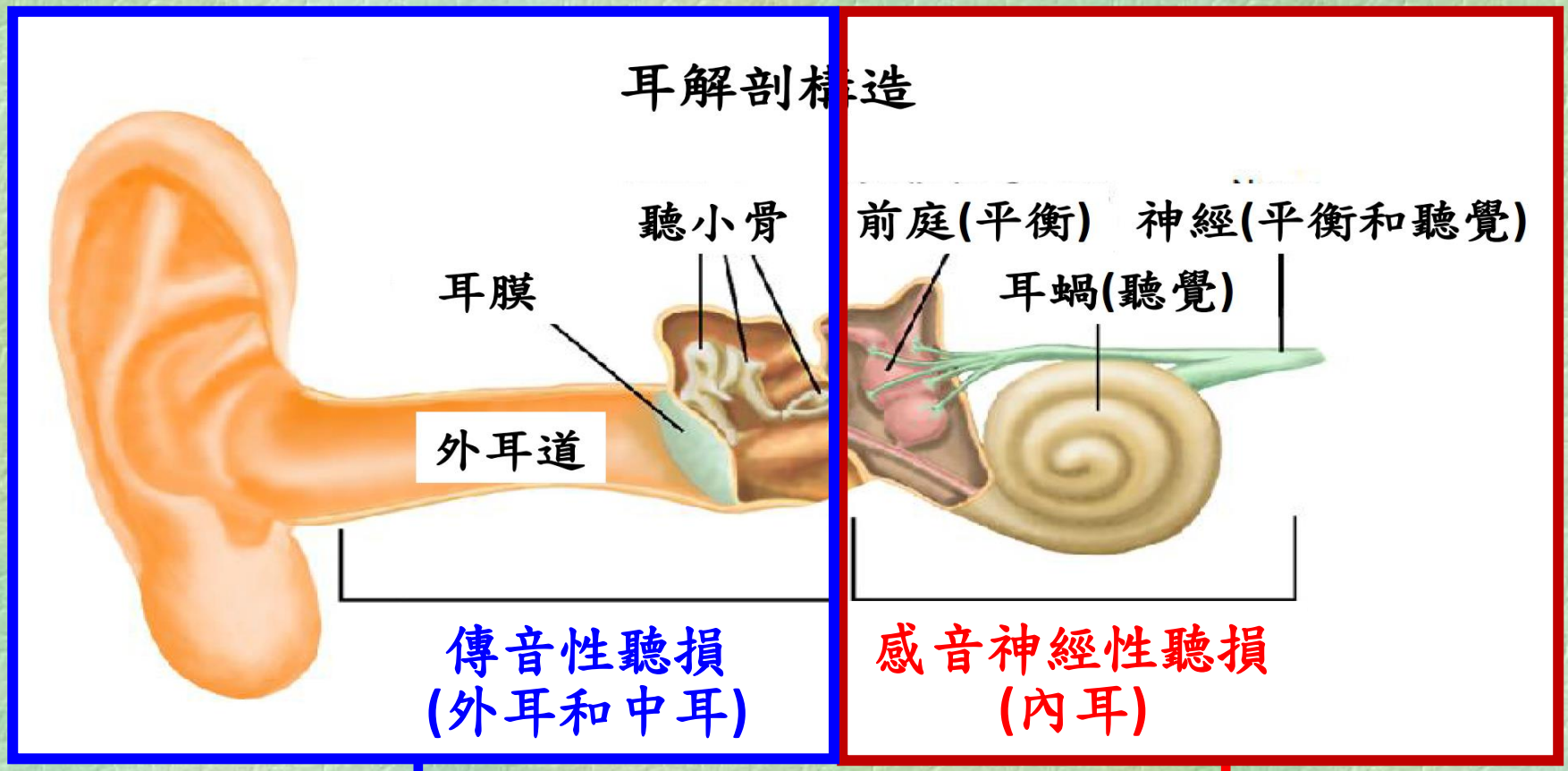
助聽器或人工耳蝸

傳音性聽力損失:

外耳、耳膜、中耳

藥物或手術治療

混合性聽力損失



- 外耳道耳垢、異物
- 外耳炎、中耳炎
- 外耳/中耳先天畸形

- 聽損基因變異、內耳畸形
- 內耳炎(巨細胞病毒、梅毒..)
- 早產、核黃膽、缺氧、耳毒性

病變部位的診斷

1. 音叉檢查 (Tuning Fork Tests)
2. 純音聽力檢查(Pure Tone Audiometry)
3. 語音聽力檢查(Speech Audiometry)
4. 特殊聽力檢查(Special Audiological Tests)
5. 腦幹聽性反應檢查(Auditory Brainstem Response)
6. 聽阻聽力檢查(Impedance Audiometry)
7. 耳聲傳射檢查(Oto-acoustic Emissions)
8. 耳蝸電圖(Electrocochleogram)

病變部位的診斷

生理聽力檢查(Physiological)

聽阻聽力檢查 (Impedance Audiometry):

Acoustic reflex

腦幹聽性反應檢查(ABR)*

耳蝸電圖(Electrocochleogram, ECoG)*

行為聽力檢查(Behavioral)

音叉聽力檢查

純音聽力檢查

特殊聽力檢查:

1. SISI test　2. STAT test　3. PIPB

病變部位的診斷

音叉檢查

Weber test (比較兩耳骨導) ~~W~~ ~~W~~

傳音性聽力損失: 偏患側

感覺神經性聽力損失: 偏健側

Rinne test (比較單耳氣、骨導) R_+ R_-

傳音性聽力損失：(–)

*512 Hz C^1 fork

病變部位的診斷
純音聽力檢查

純音聽力圖

- 氣骨導差(air-bone gap, ABG)
- 骨導閾值

聽力損失類型:

(1) 傳音性(conductive)
外耳、耳膜、中耳等病變

(2) 感覺神經性(sensorineural)
耳蝸或耳蝸後(聽神經、腦幹)病變

(3) 混合性(mixed)

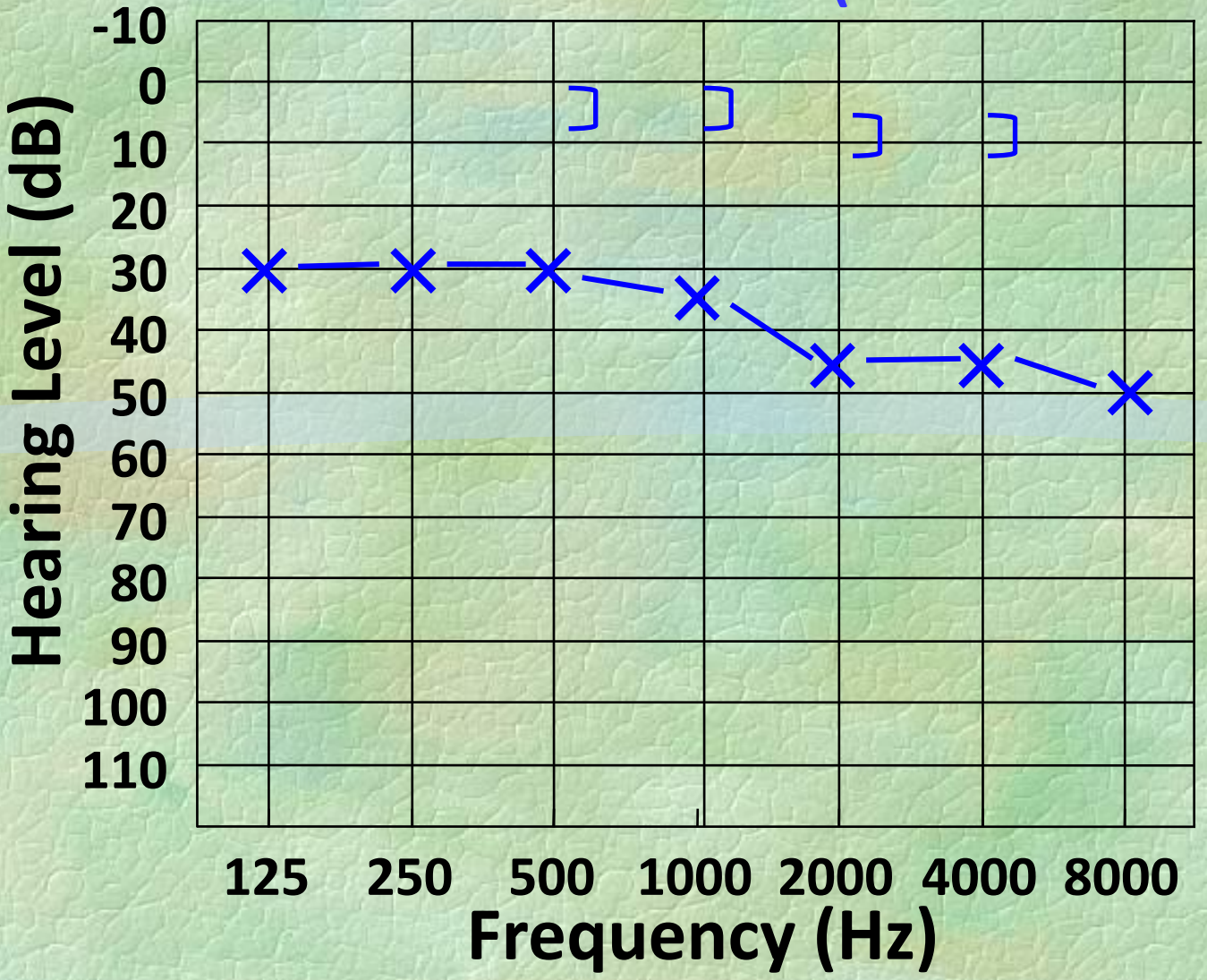
純音聽力圖判讀

ABG (+)

BC normal

傳音性聽損

(Conductive HL)



急性中耳炎
Acute Otitis Media

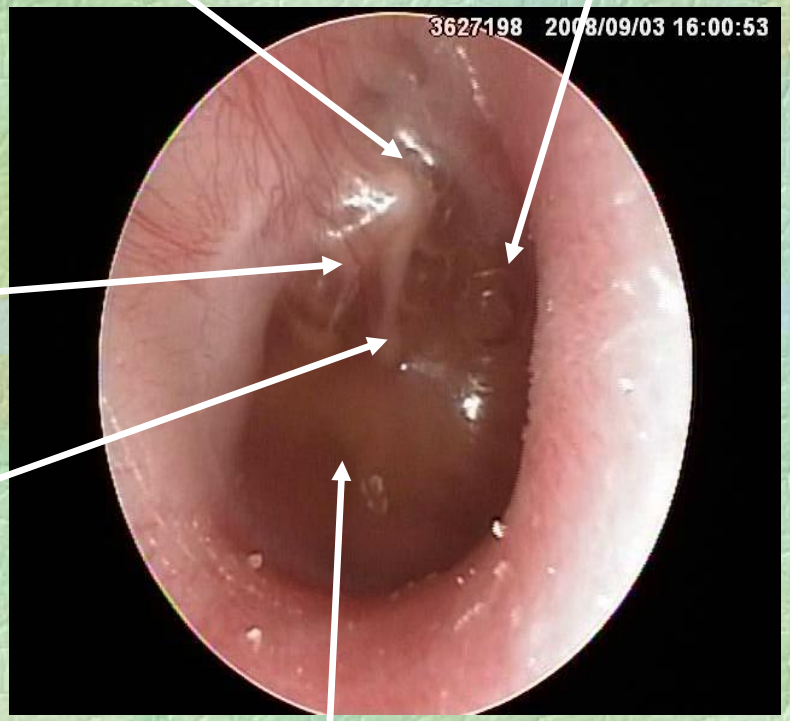
主訴：流鼻水、咳漱、咽喉痛，2天
左耳痛，2天; 發燒 (+)

bulla　handle of malleus　congestion

積液性中耳炎
Otitis Media with Effusion

short process of malleus

air-bubble



I-S joint

umbo of malleus

drum: retracted and amber color

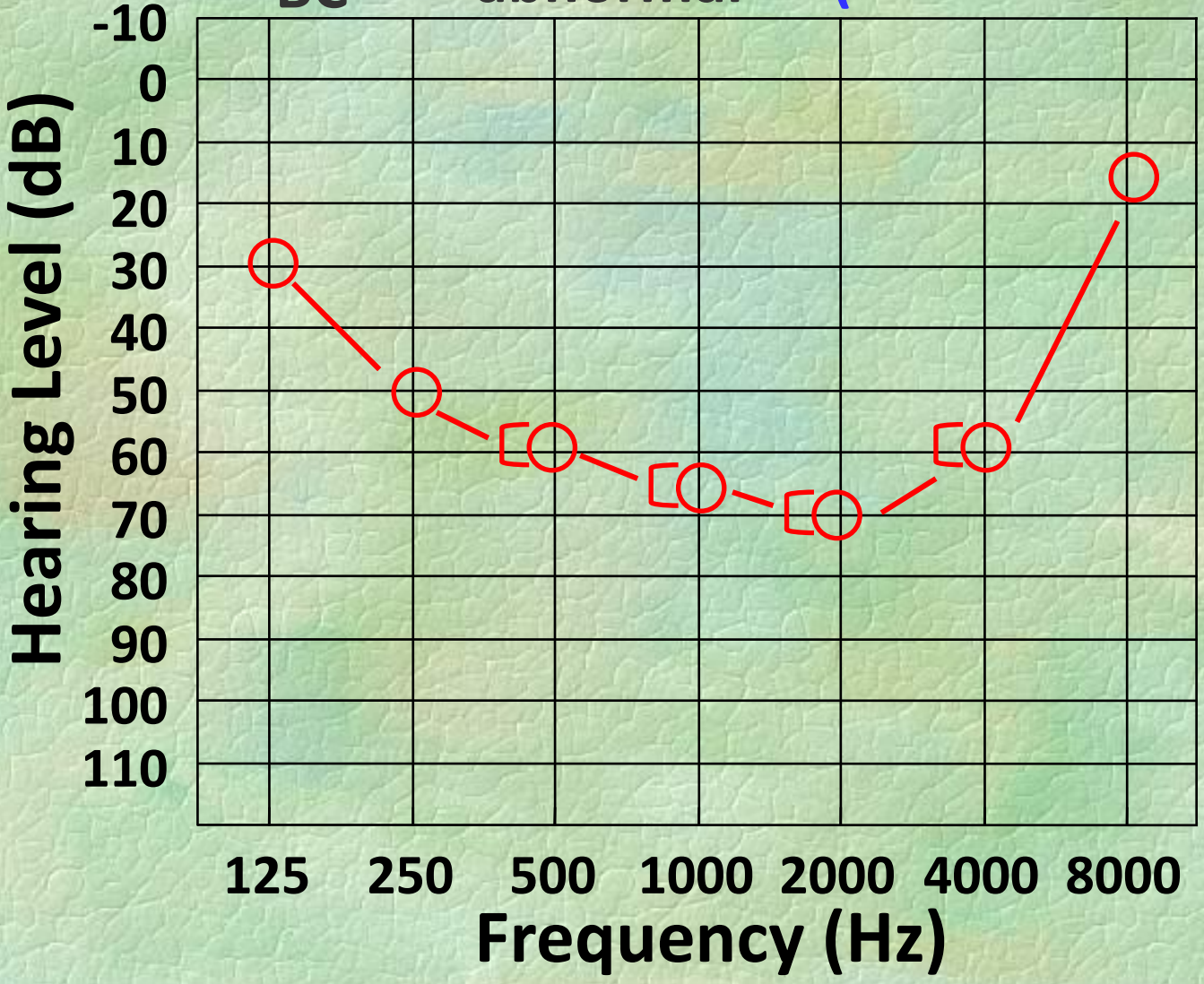
純音聽力圖判讀

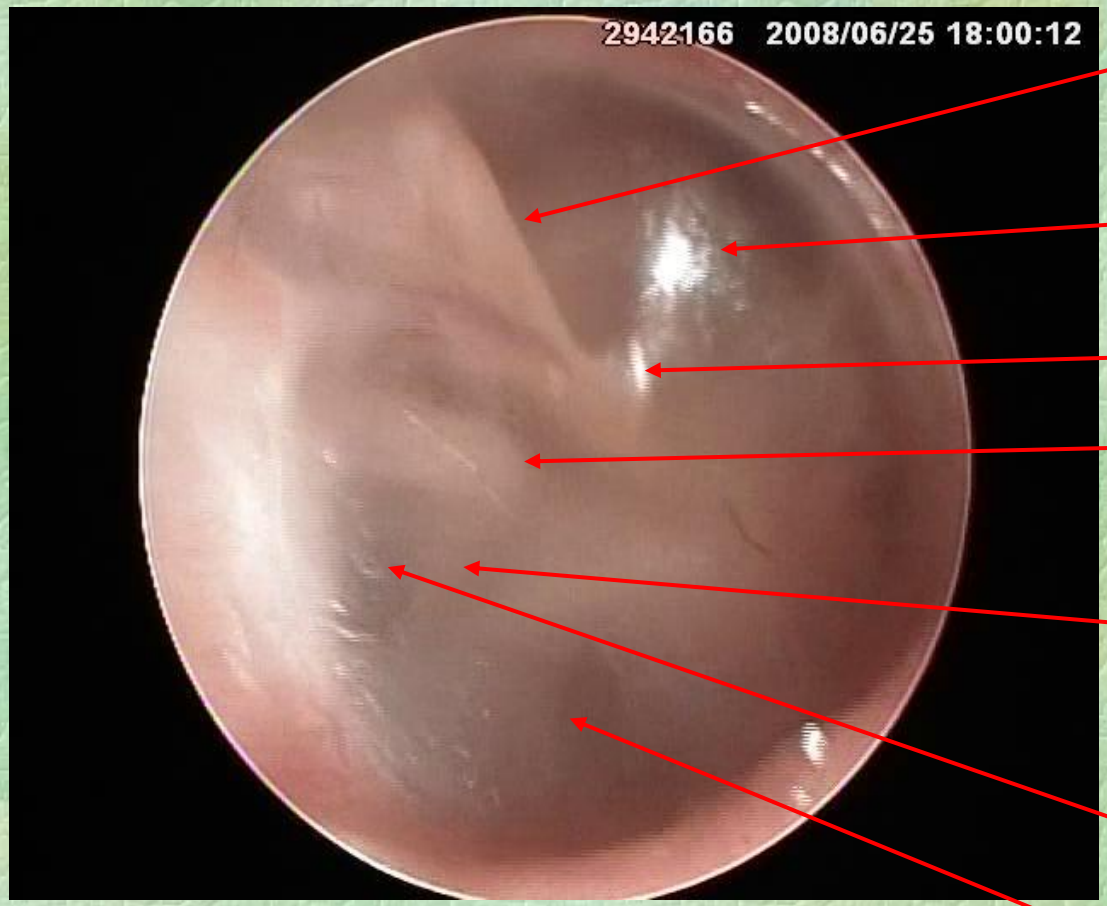
ABG (-)

BC abnormal

感覺神經性聽損

(Sensorineural HL)




2942166 2008/06/25 18:00:12
handle, malleus
light reflex
umbo
I-S joint
posterior crus
oval window
round window

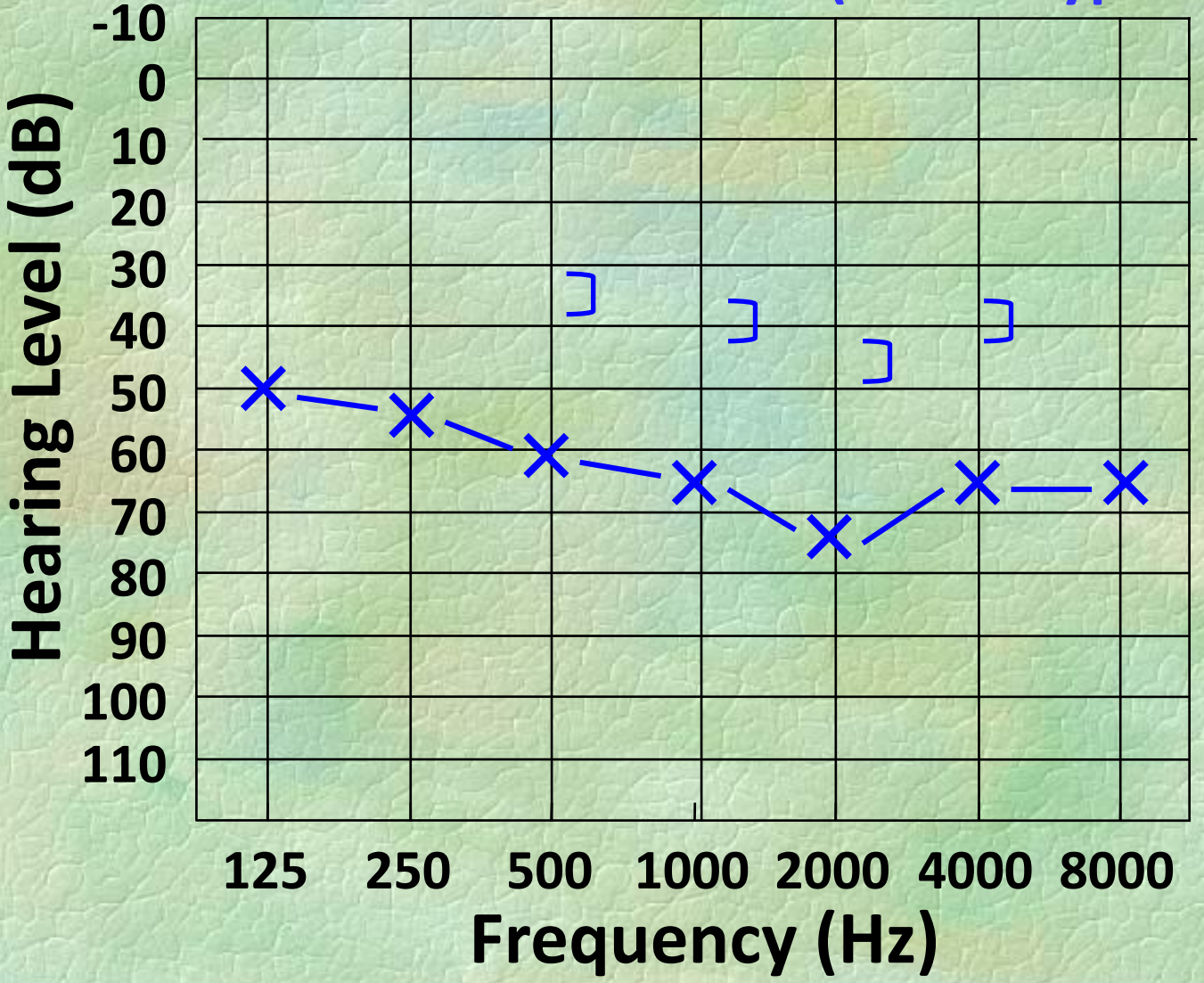
純音聽力圖判讀

ABG (+)

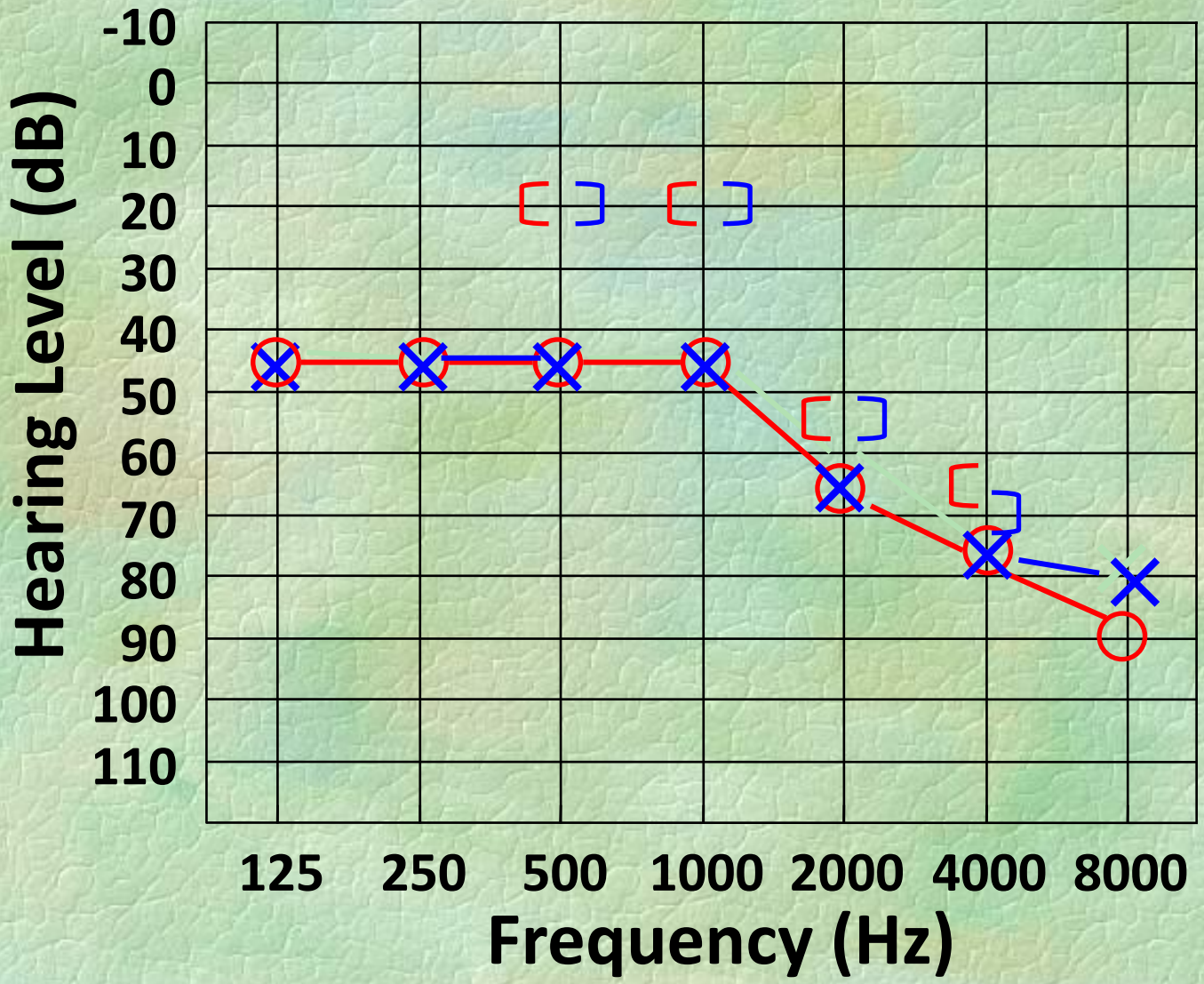
BC abnormal

混合性聽損

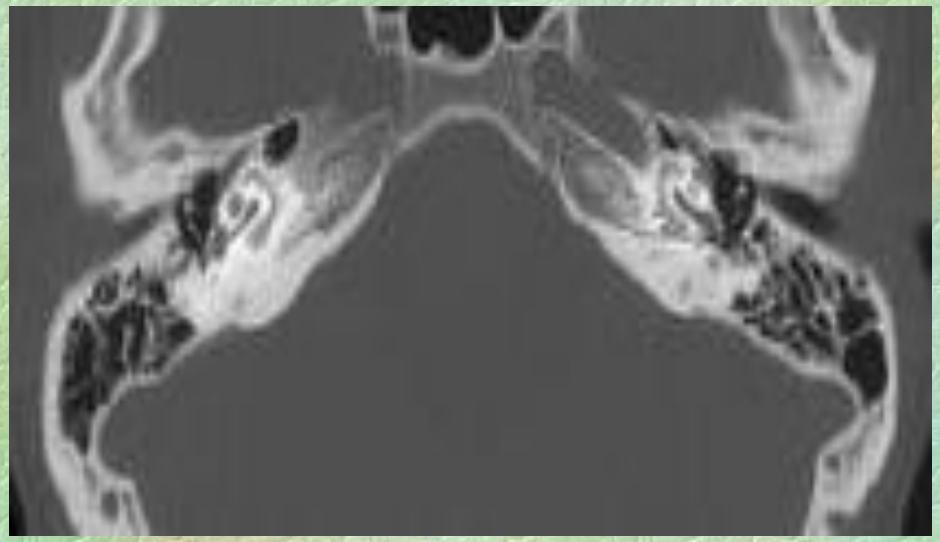
(Mixed type HL)

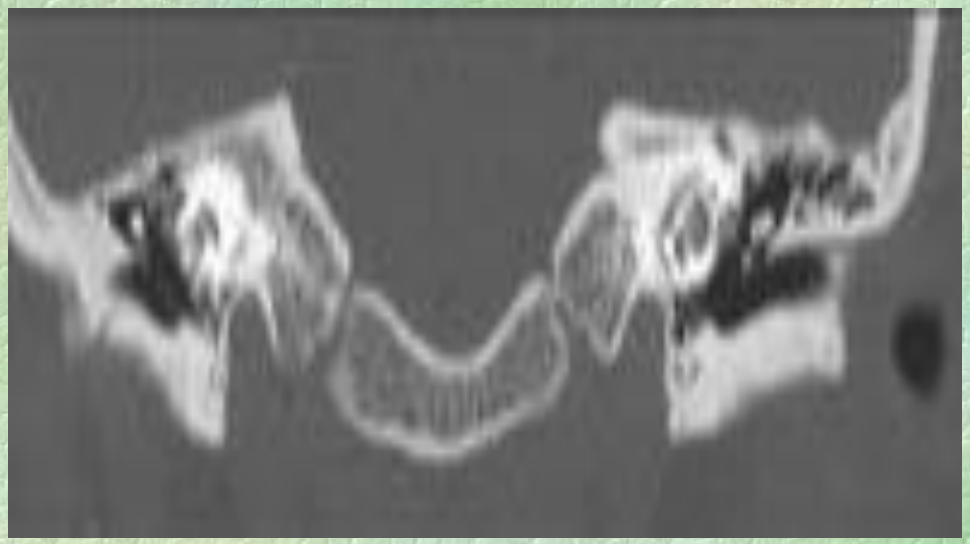


耳蝸性耳硬化症
Cochlear Otosclerosis



耳蝸性耳硬化症
Cochlear Otosclerosis





病變部位的診斷

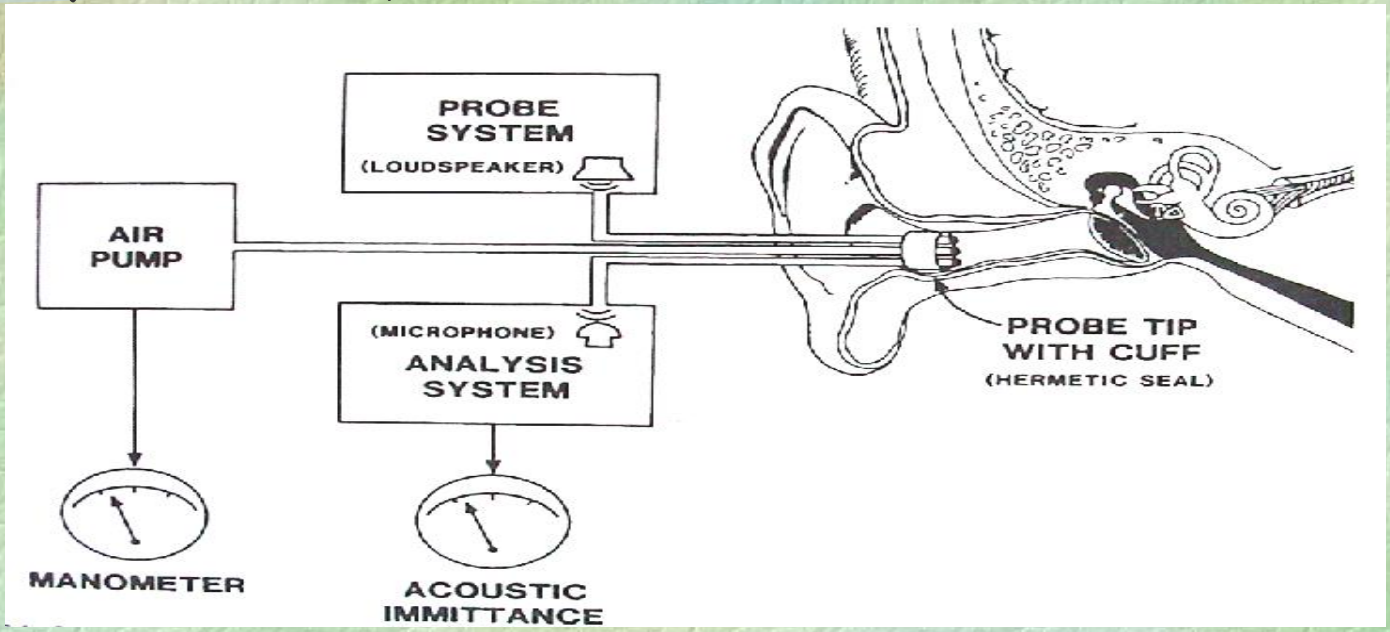
聽阻聽力檢查

聽反射閾值(ART)

0.5 kHz、1 kHz、2 kHz、4 kHz

(1) 同側聽反射(Ipsilateral AR)

(2) 對側聽反射(Contralateral AR)



病變部位的診斷

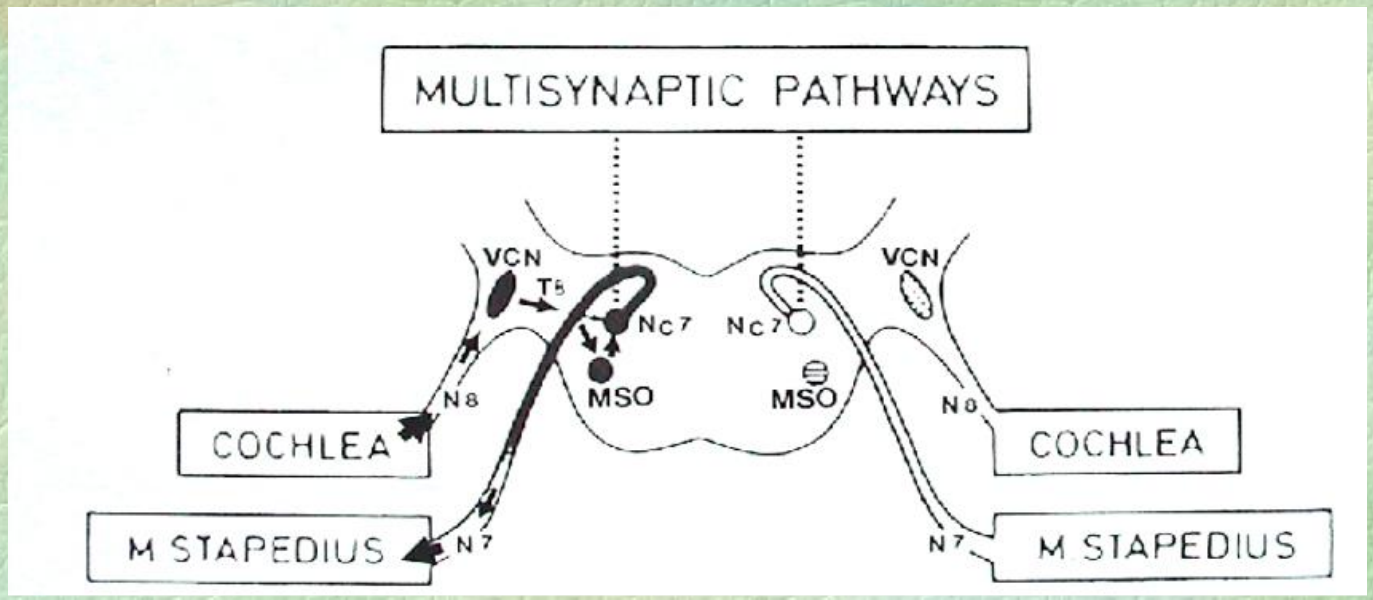
聽阻聽力檢查

聽反射閾值(ART)

(1) 同側聽反射閾值

85 dB (PTA+70~90 dB)

同側聽反射路徑



病變部位的診斷

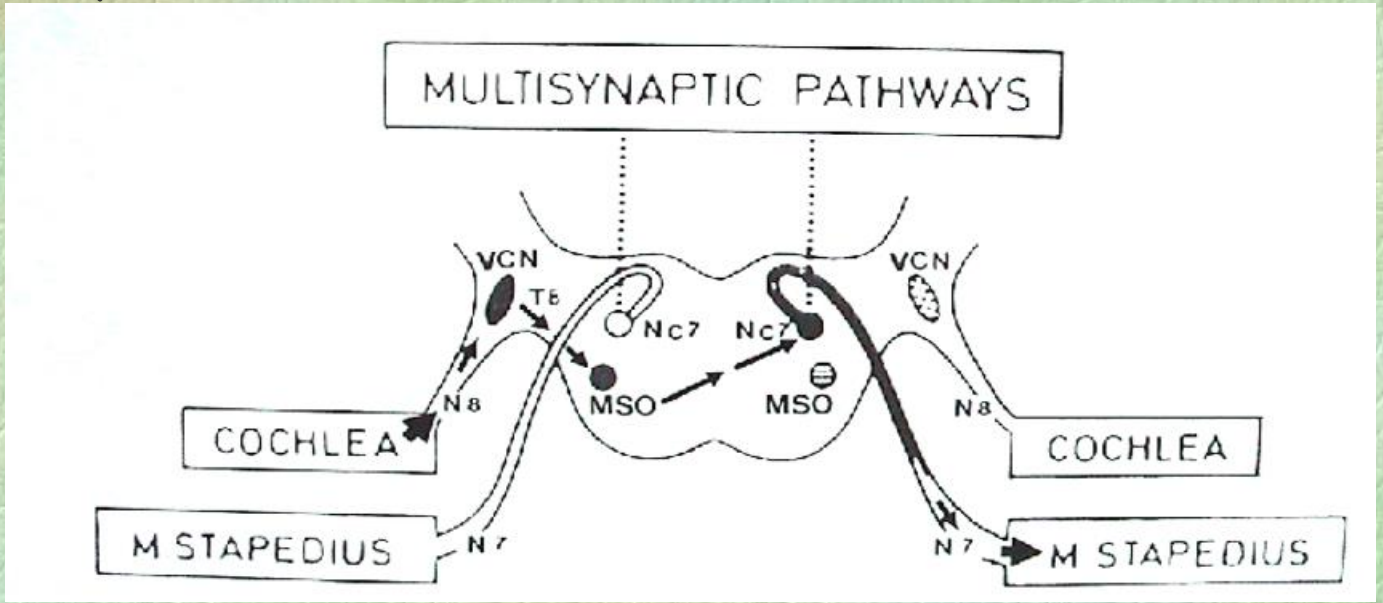
聽阻聽力檢查

聽反射閾值(ART)

(2) 對側聽反射閾值

同側閾值+2~16 dB

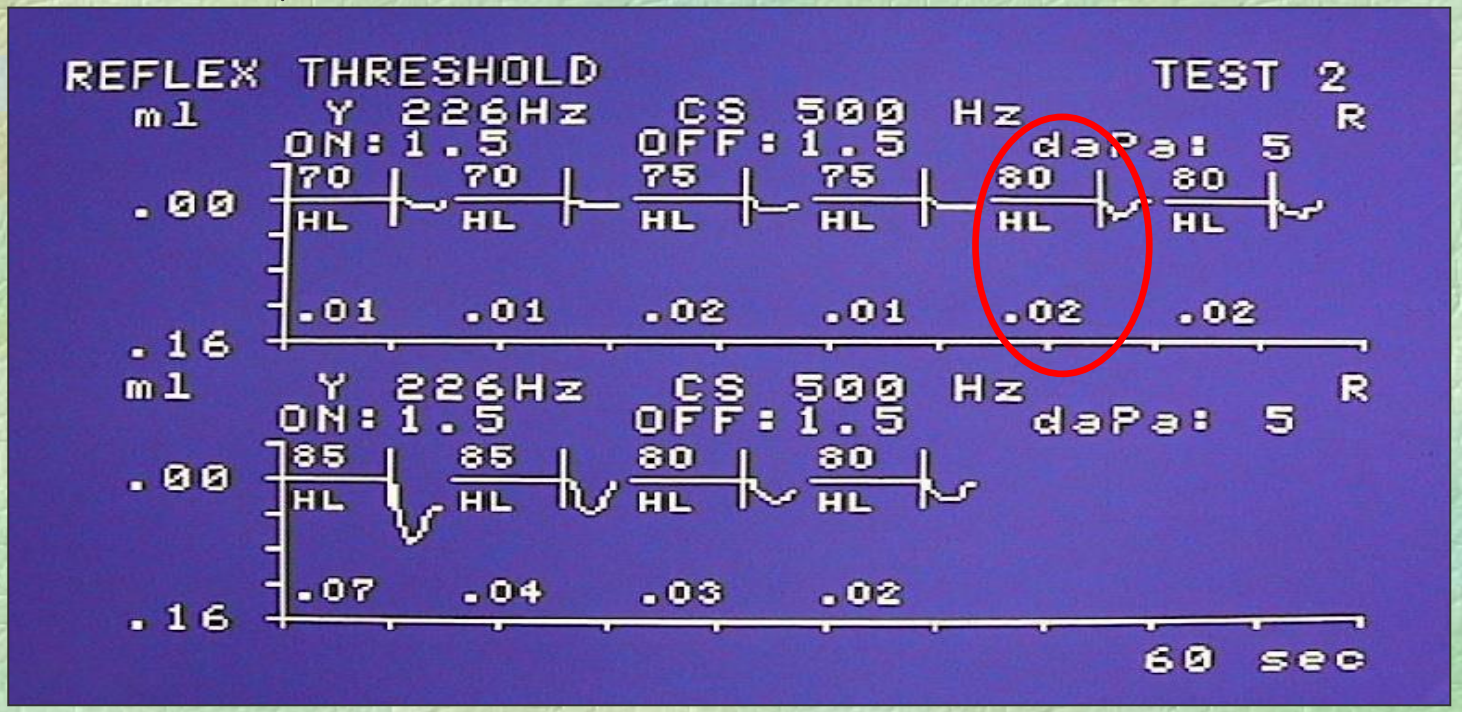
對側聽反射路徑



聽阻聽力檢查

聽反射閾值(ART)

聽反射測驗可造成 > 0.02ml compliance 改變的最小刺激音量



病變部位的診斷
聽阻聽力檢查

聽反射閾值 (AR threshold, ART)

傳音性聽力損失(Conductive HL):

反應耳ABG 5dB,則50% AR(-)

反應耳ABG 10dB,則80% AR(-)

刺激耳ABG 27dB,則50% AR(-)

耳蝸性聽力損失(Sensory HL):

刺激耳85dB(Thr),則50% AR(-)

刺激耳60dB(Thr),則10% AR(-)

耳蝸後病變(Neural HL):

刺激耳 0 dB(Thr),則30%AR(-)

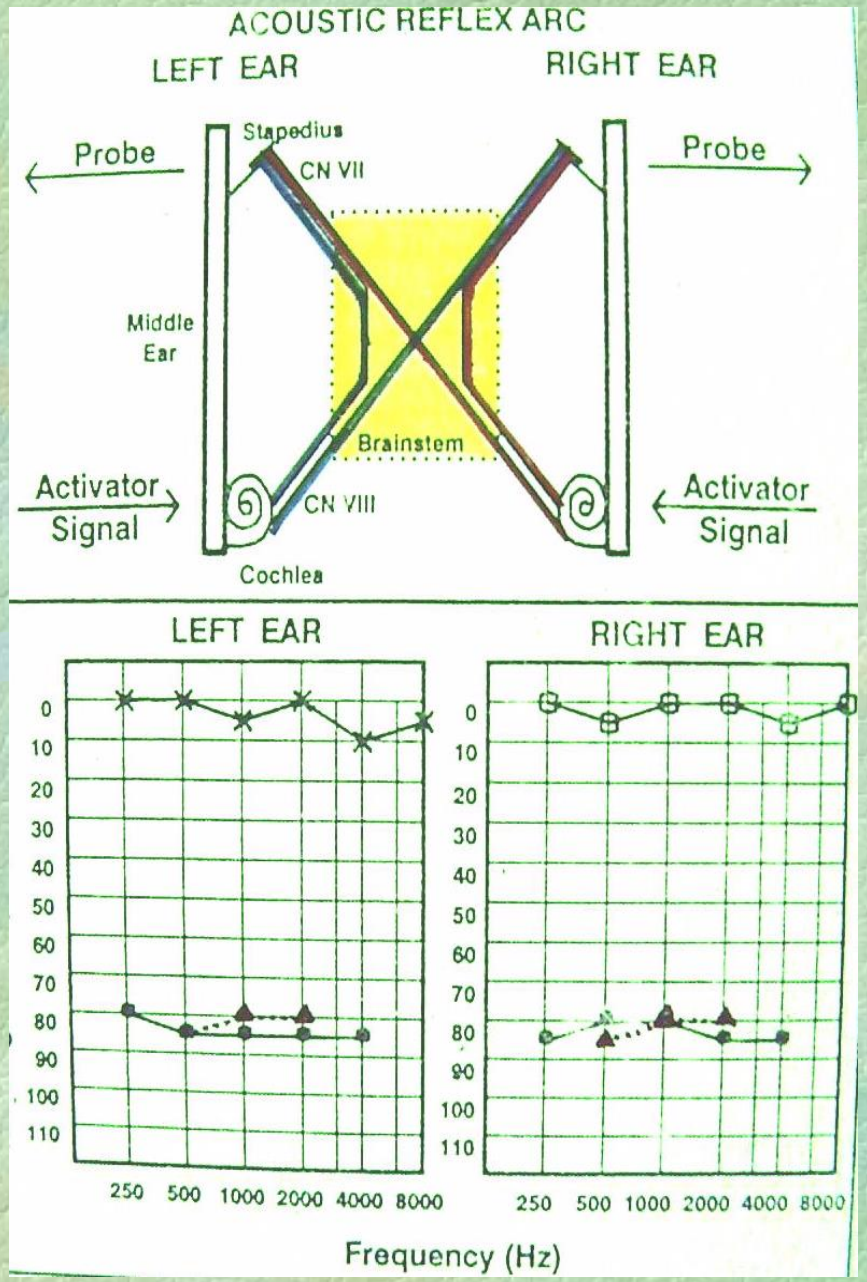
刺激耳30dB(Thr),則70%AR(-)

聽阻聽力檢查
聽反射閾值(ART)

1. Normal

	Contra	Ipsi
R't	N	N
L't	N	N

▲:同側聽反射閾值
●:對側聽反射閾值

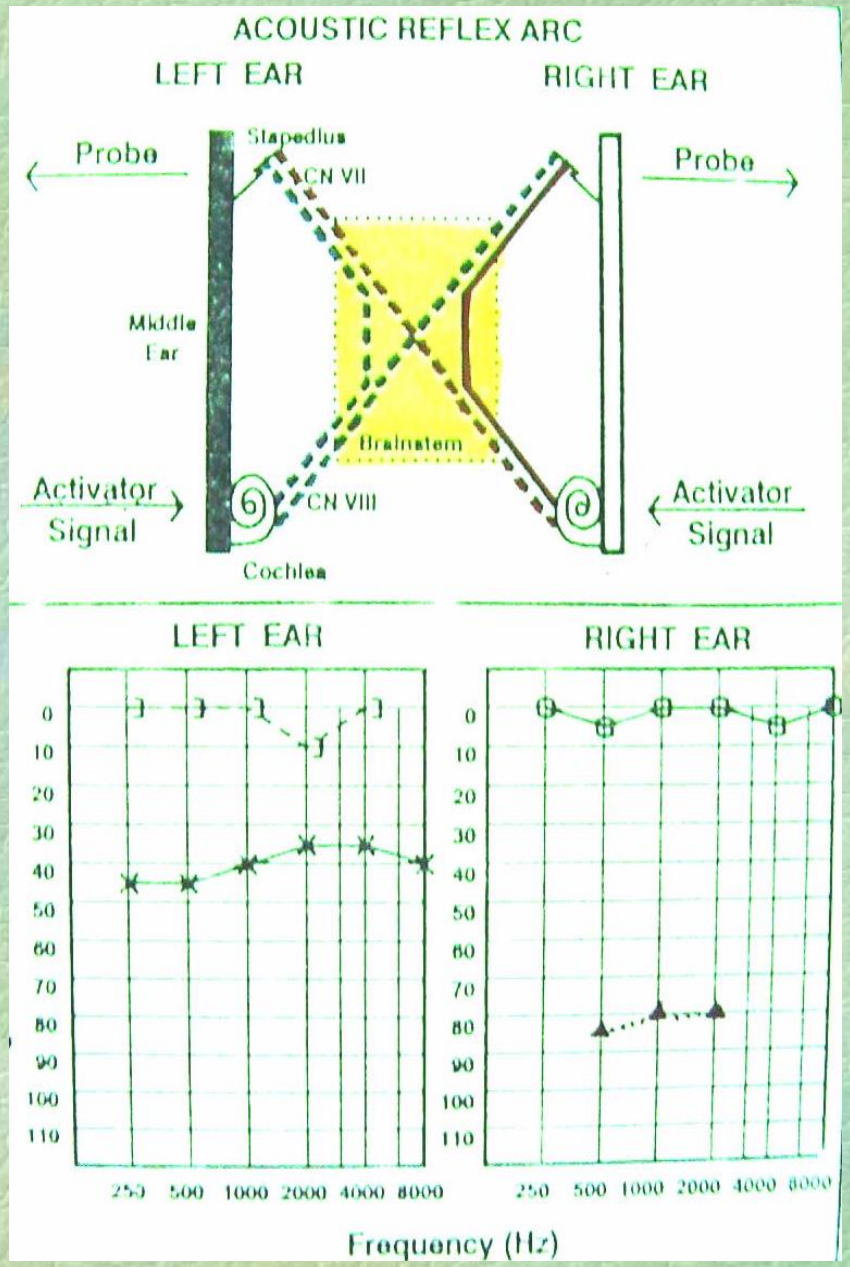


聽阻聽力檢查
聽反射閾值(ART)

2. Conductive HL

	Contra	Ipsi
R't	abn	N
L't	abn	abn

▲:同側聽反射閾值
●:對側聽反射閾值

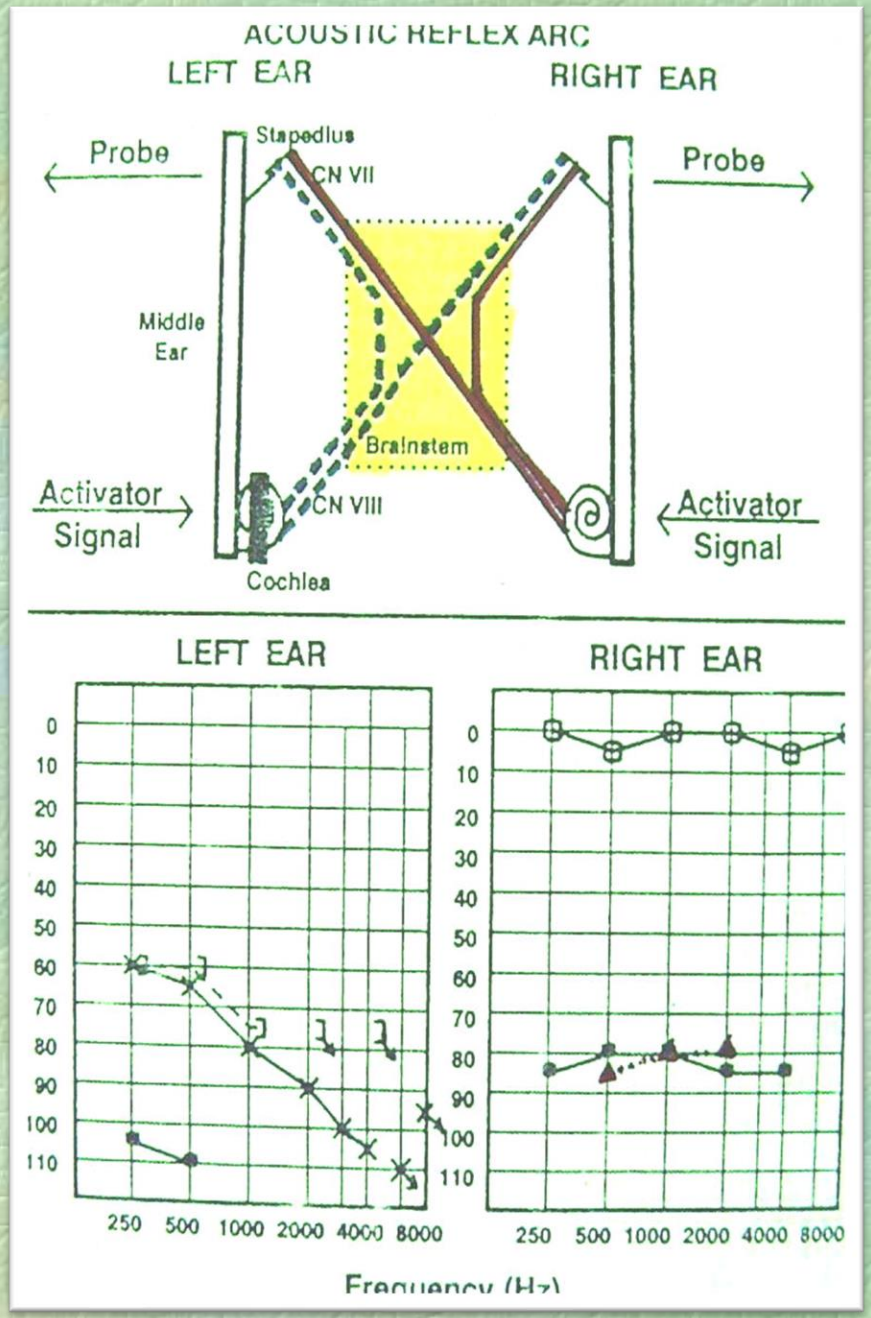


聽阻聽力檢查
聽反射閾值(ART)

3. Cochlear lesion

	Contra	Ipsi
R't	N	N
L't	abn	abn

▲:同側聽反射閾值
●:對側聽反射閾值

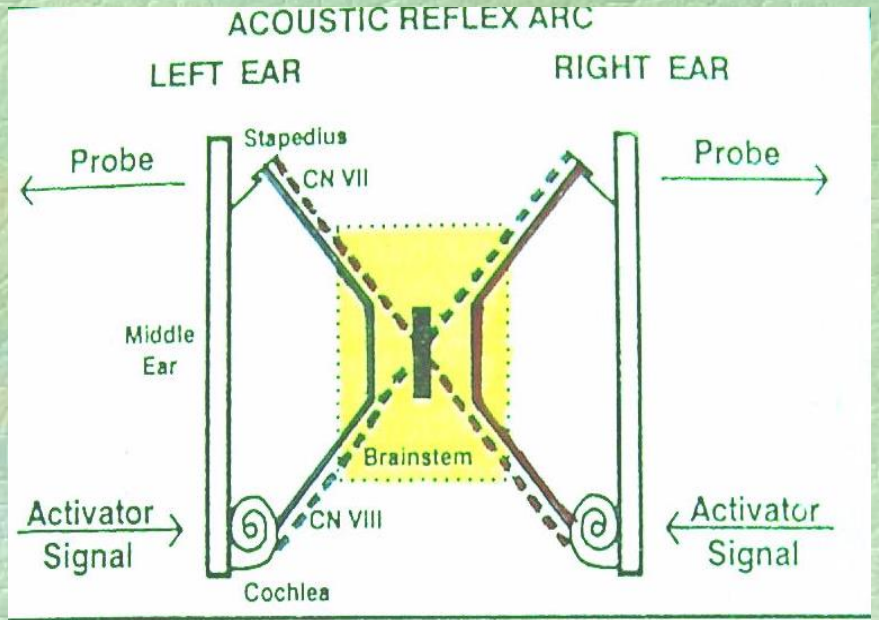


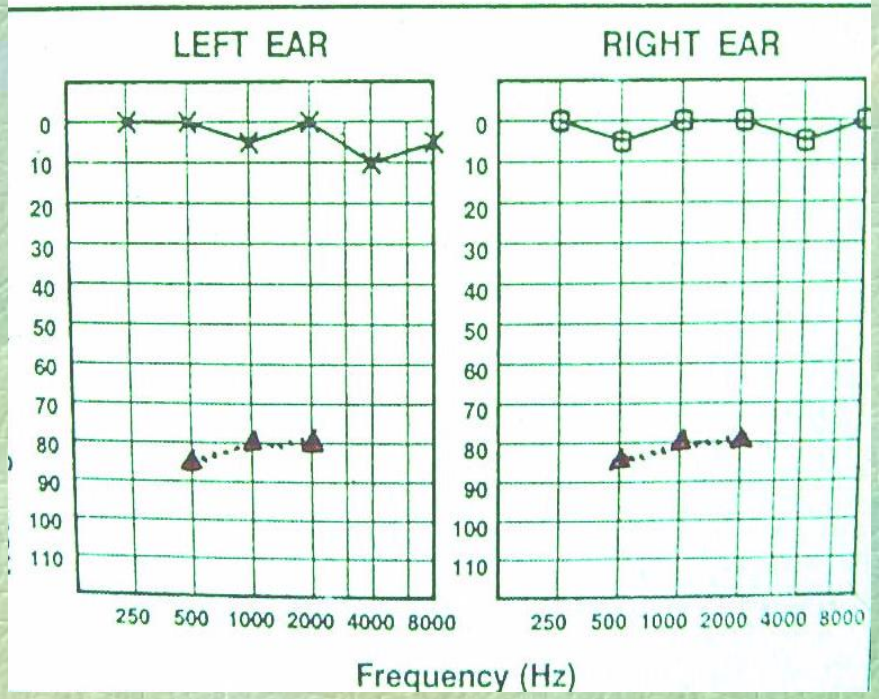
聽阻聽力檢查
聽反射閾值(ART)

4. Brainstem lesion

	Contra	Ipsi
R't	abn	N
L't	abn	N

▲:同側聽反射閾值
●:對側聽反射閾值

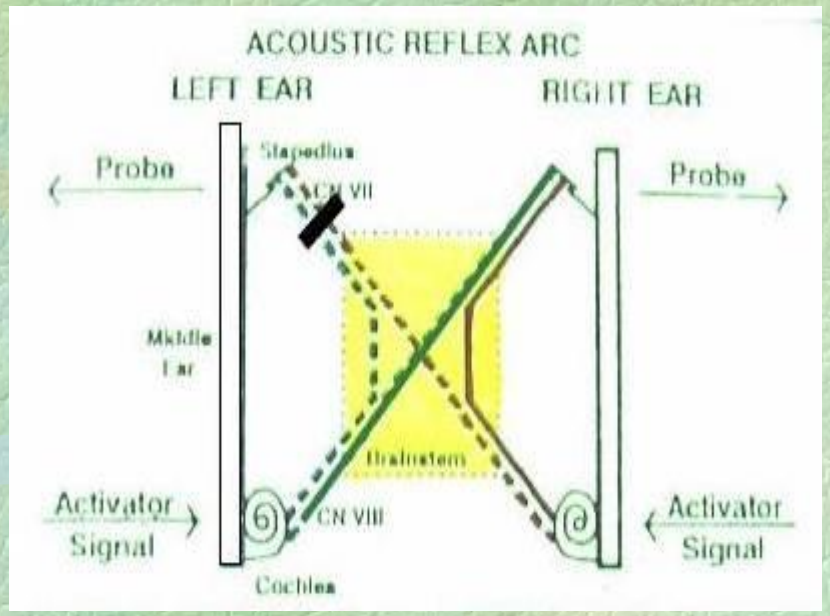




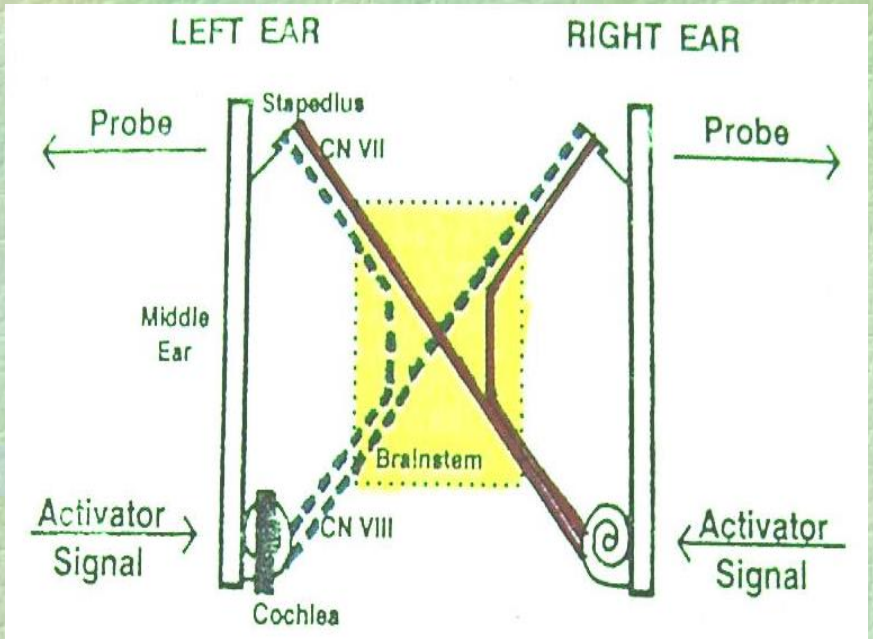
聽阻聽力檢查
聽反射閾值(ART)

5. Facial nerve lesion

	Contra	Ipsi
R't	abn	N
L't	N	abn

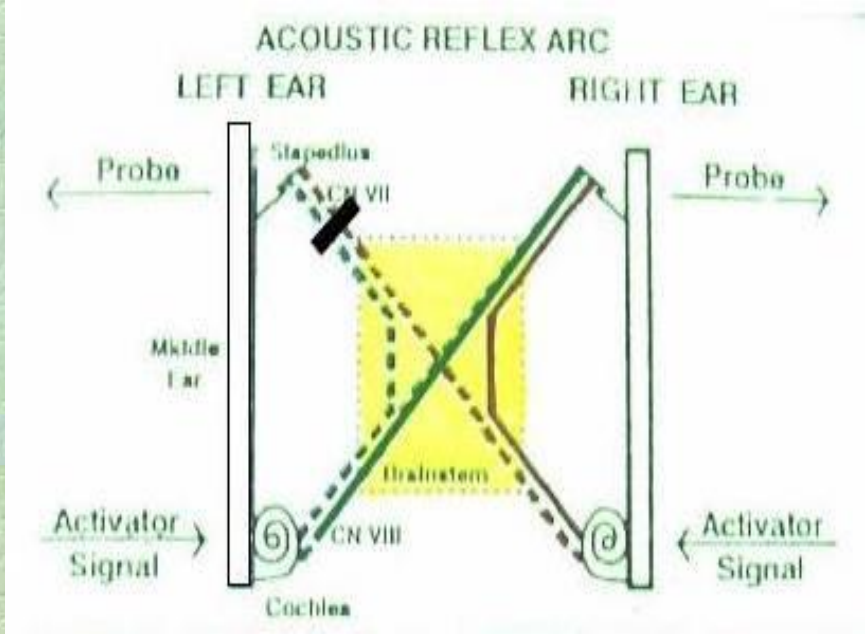


聽阻聽力檢查
聽反射閾值(ART)



	Contralateral				Ipsilateral			
	0.5K	1K	2K	4K	0.5K	1K	2K	4K
R't	85	85	90	90	80	80	85	85
L't	—	—	—	—	—	—	—	—

聽阻聽力檢查
聽反射閾值(ART)



	Contralateral				Ipsilateral			
	0.5K	1K	2K	4K	0.5K	1K	2K	4K
R't	——— CNT ———				85	85	90	90
L't	100	100	115	115	——— CNT ———			

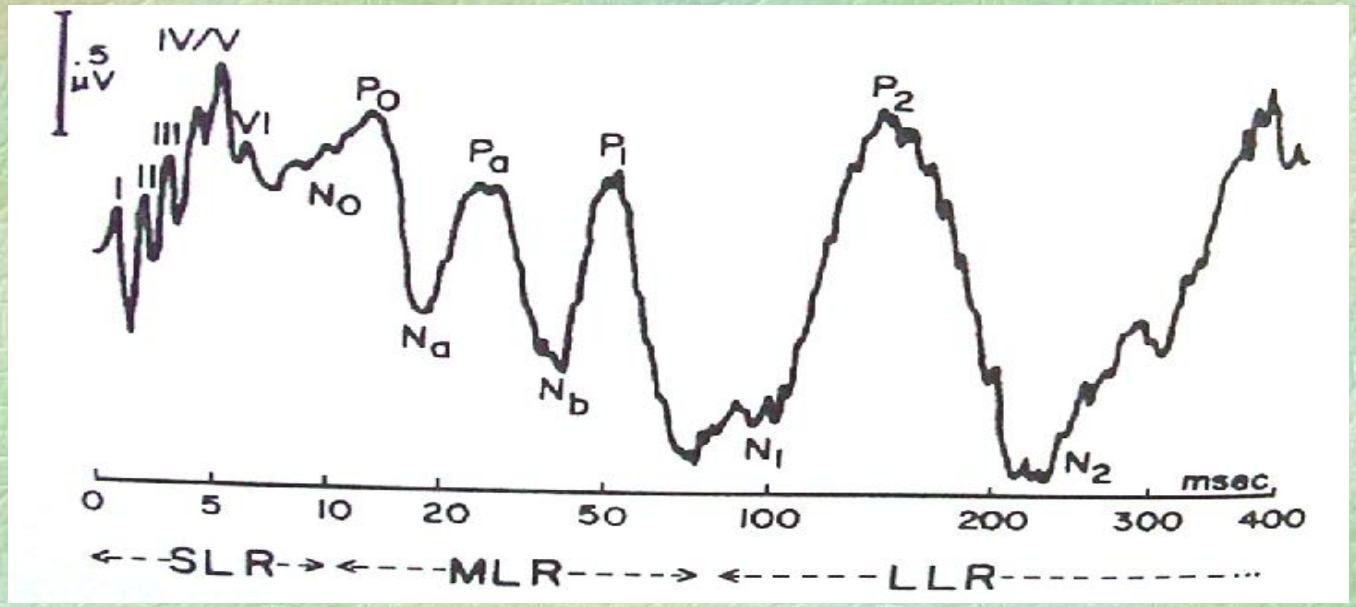
病變部位的診斷

腦幹聽性反應檢查(ABR)

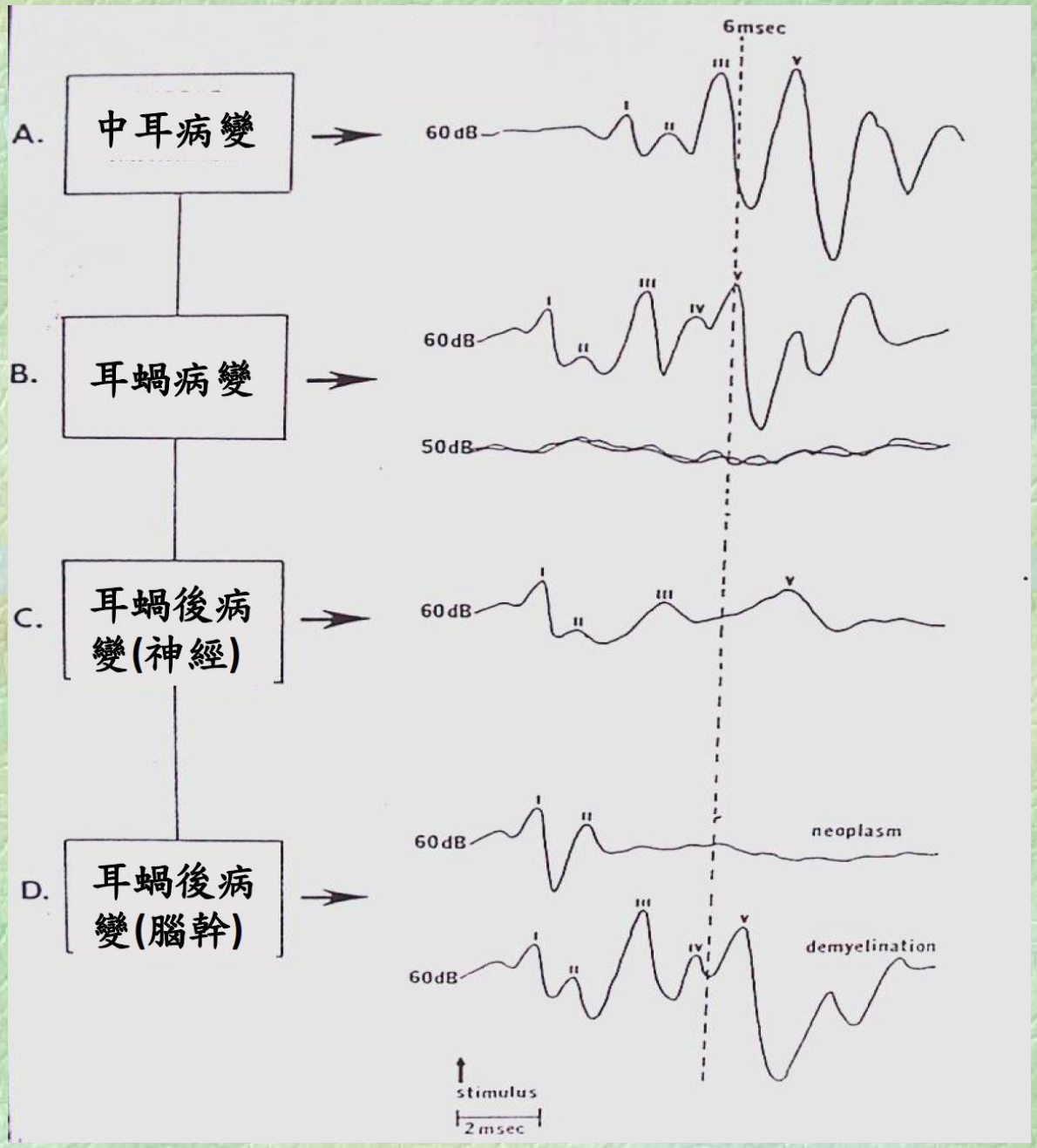
神經耳科學的檢查 (Neurodiagnosis)

- I、III、V波絕對潛時 (absolute latencies)
- 波間潛時(interpeak latencies, IPLs)

→ 耳蝸後病變



ABR


6msec
A.
中耳病變
60dB
I
II
III
V
B.
耳蝸病變
60dB
I
II
III
IV
V
50dB
C.
耳蝸後病變(神經)
60dB
I
II
III
V
D.
耳蝸後病變(腦幹)
60dB
I
II
neoplasm
60dB
I
II
III
IV
V
demyelination
stimulus
2msec

Standard Retrocochlear Test Battery

Auditory brainstem response (ABR):

1. no identifiable waveforms, if high tones < 60dB (20%~30%)
2. only wave I (+), all remaining waves (-) (10%~20%)
3. IDL(V) > 0.2 ms, IPL prolonged (40%~60%)
4. Normal (10%~15%)

Standard Retrocochlear Test Battery

Auditory brainstem response (ABR):

.The initial neurotological approach

.Limited use in neurotological diagnosis

.Previously-published audiological protocols

sensitivities : 82-97%

specificities: 15-61%

* sensitivities for small tumors 8~42%

病變部位的診斷

耳蝸電圖(Electrocochleogram)

包括: SP (Summating Potential)
AP (Action Potential)
CM (Cochlear Microphonic Potential)

1. 聽力閾值之評估
2. 手術中之聽力監測
3. 美尼爾氏病之診斷

SP / AP Amplitude Ratio ↑

病變部位的診斷

耳蝸電圖(Electrocochleogram)

侵襲性

經耳膜(transtympanic):

鼓室岬(promontory)

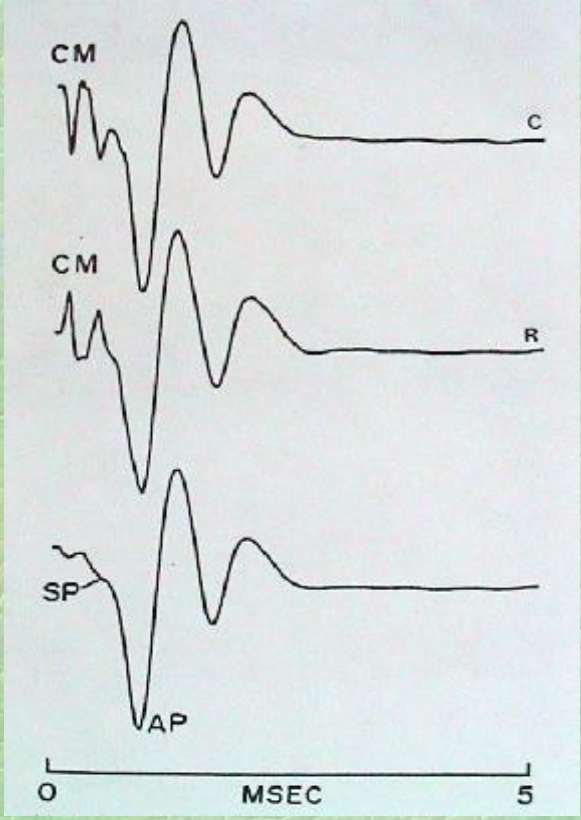
圓窗(round window)

非侵襲性

耳膜(tympanic)

耳膜外(extratympanic):

foam plug, leaf-type



病變部位的診斷

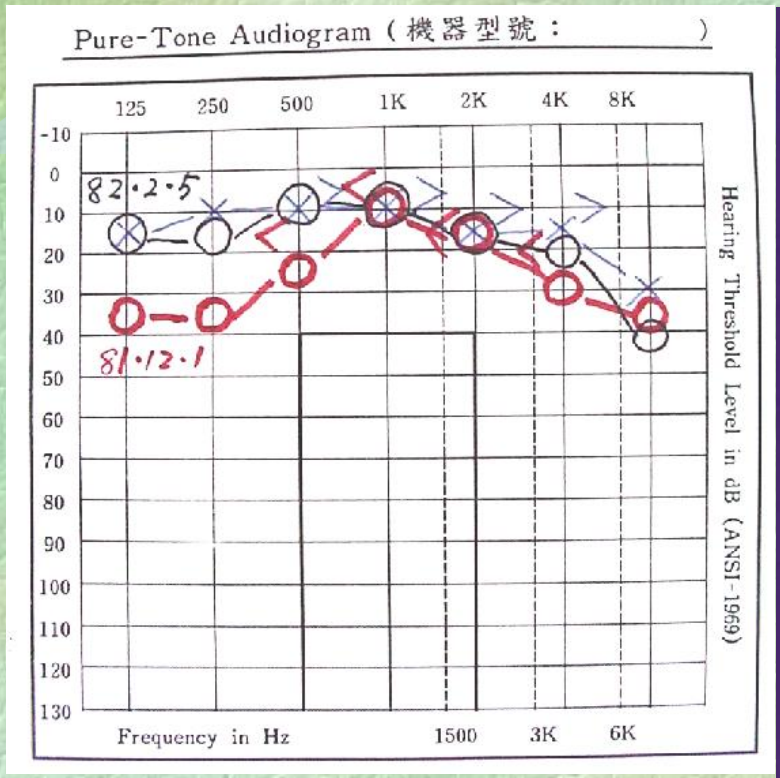
耳蝸電圖(Electrocochleogram)

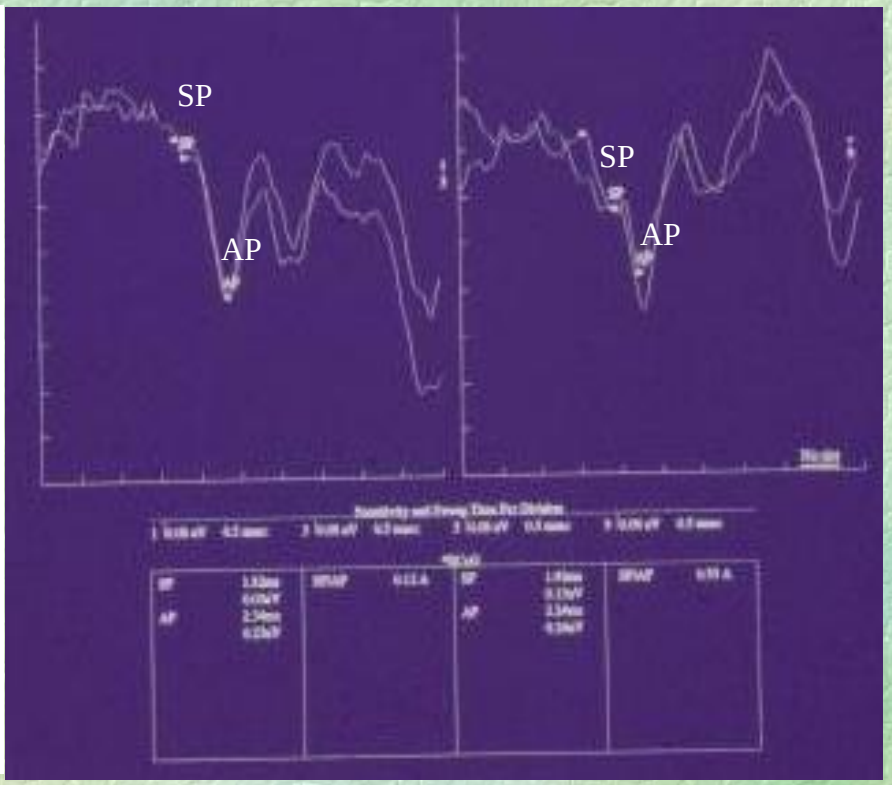
1. 綜合電位(Summating Potential, SP)
   耳蝸機轉的各種非線性綜合反應
2. 活動電位(Action Potential, AP)
   聽覺神經的活動電位
3. 耳蝸微音電位(Cochlear Microphonic Potential , CM)
   耳蝸基底迴的外毛細胞

耳蝸電圖(Electrocochleogram)

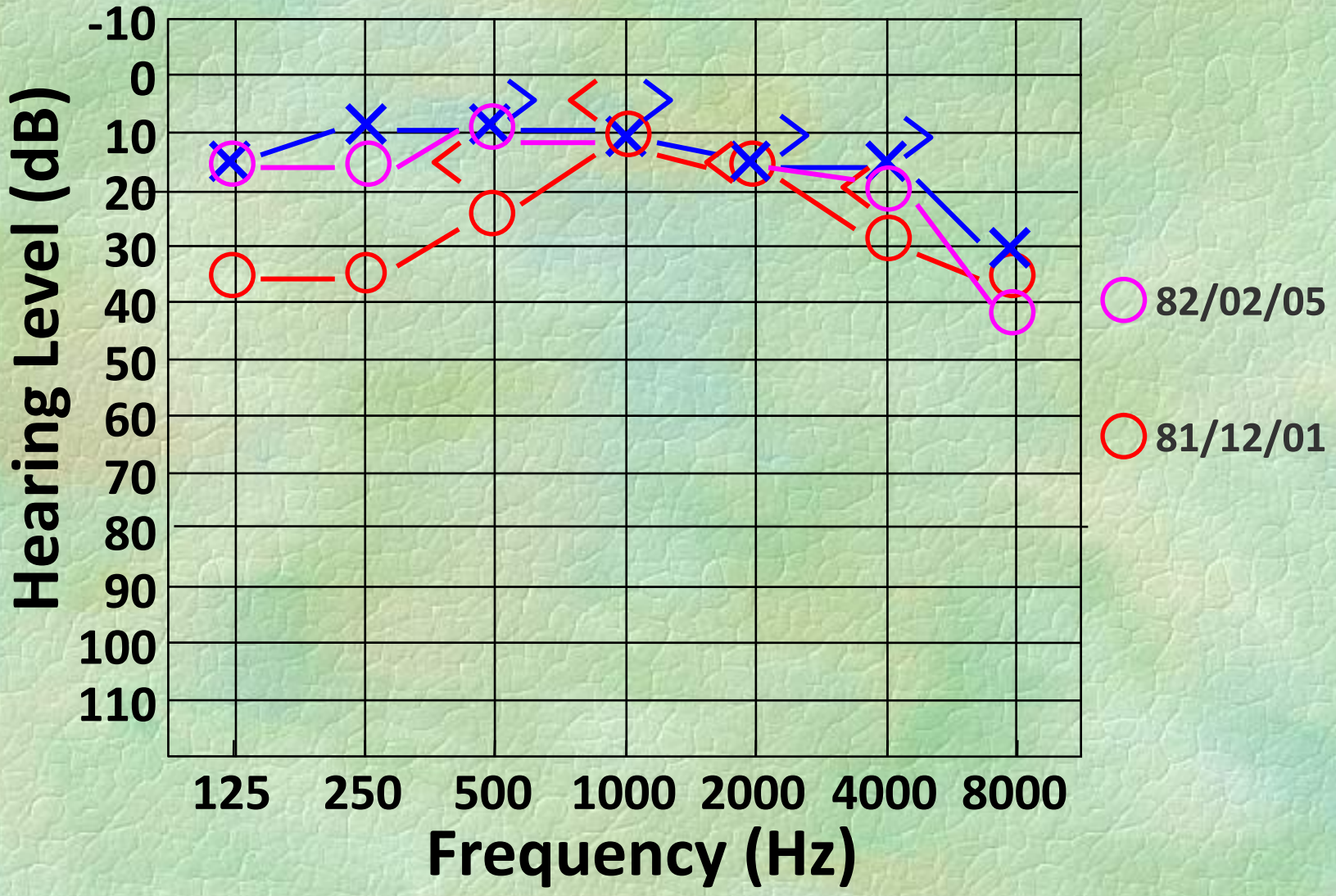
Diagnosis of Meniere's Dis.

SP / AP Amplitude Ratio ↑





Meniere's Disease



病變部位的診斷

特殊聽力檢查

1. 複響檢查
   (Recruitment Tests)
2. 聽覺適應檢查
   (Tests of Auditory Adaptation)
3. 語音失真檢查
   (Tests of Speech Distortion)

病變部位的診斷

1. 複響檢查(Recruitment Tests)

(1)聲微增敏感指數檢查(Sound Increment Sensitivity Index, **SISI**)

刺激音: pure-tone threshold + 20dB

音量增加: 1 dB, 0.2s/5s

耳蝸病變:

SISI ≥ 70% ⇒ recruitment (+)

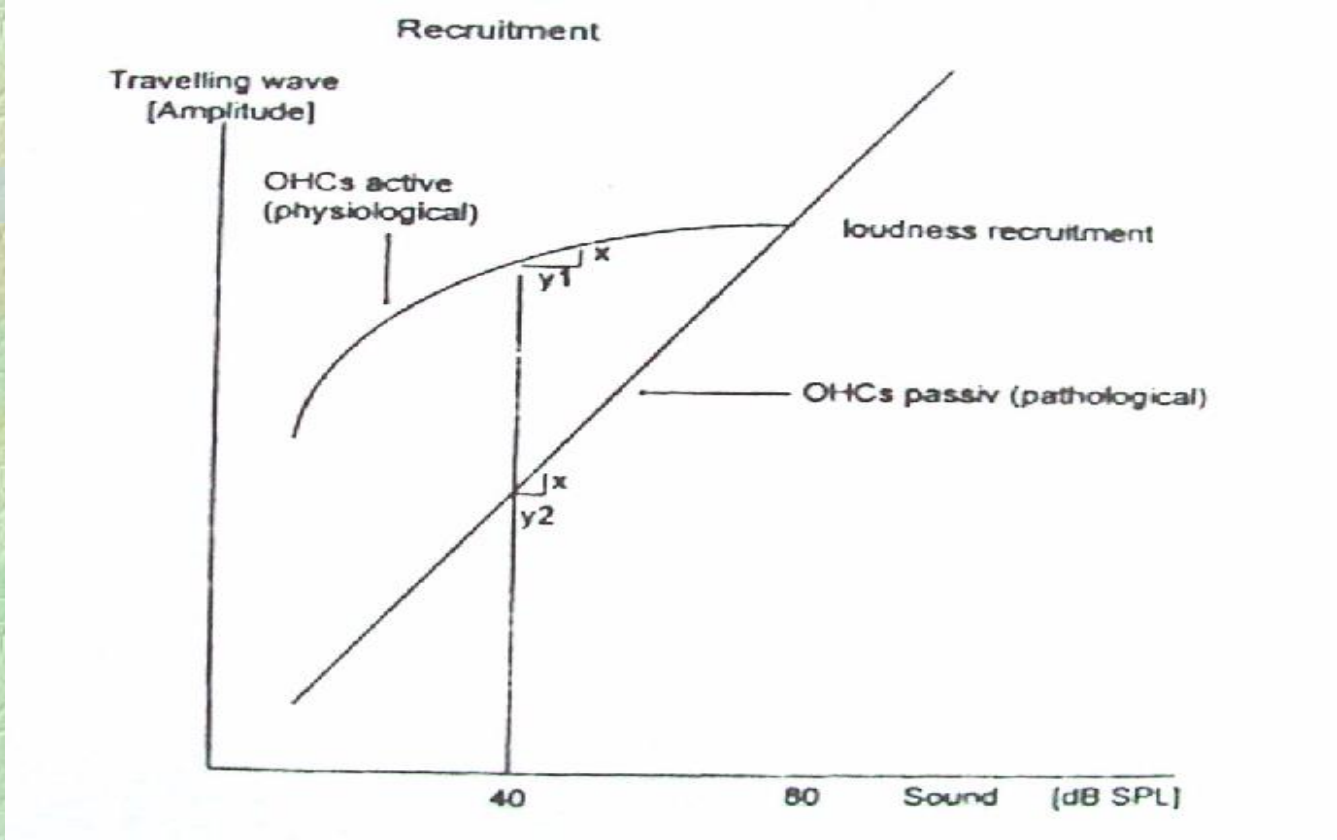
耳蝸後病變:

SISI ≤ 30%

病變部位的診斷

1. 複響檢查(Recruitment Tests)

(1)聲微增敏感指數檢查(SISI)



病變部位的診斷

1. 複響檢查(Recruitment Tests)

(2)聽反射閾值檢查(AR threshold, ART)

Sensation level (SL): ART – PT

耳蝸病變:

SL < 60dB $\Rightarrow$ recruitment (+)

病變部位的診斷

2. 聽覺適應檢查(Adaptation Tests)

(1)閾上音衰退檢查(Suprathreshold Adaptation Test, STAT)

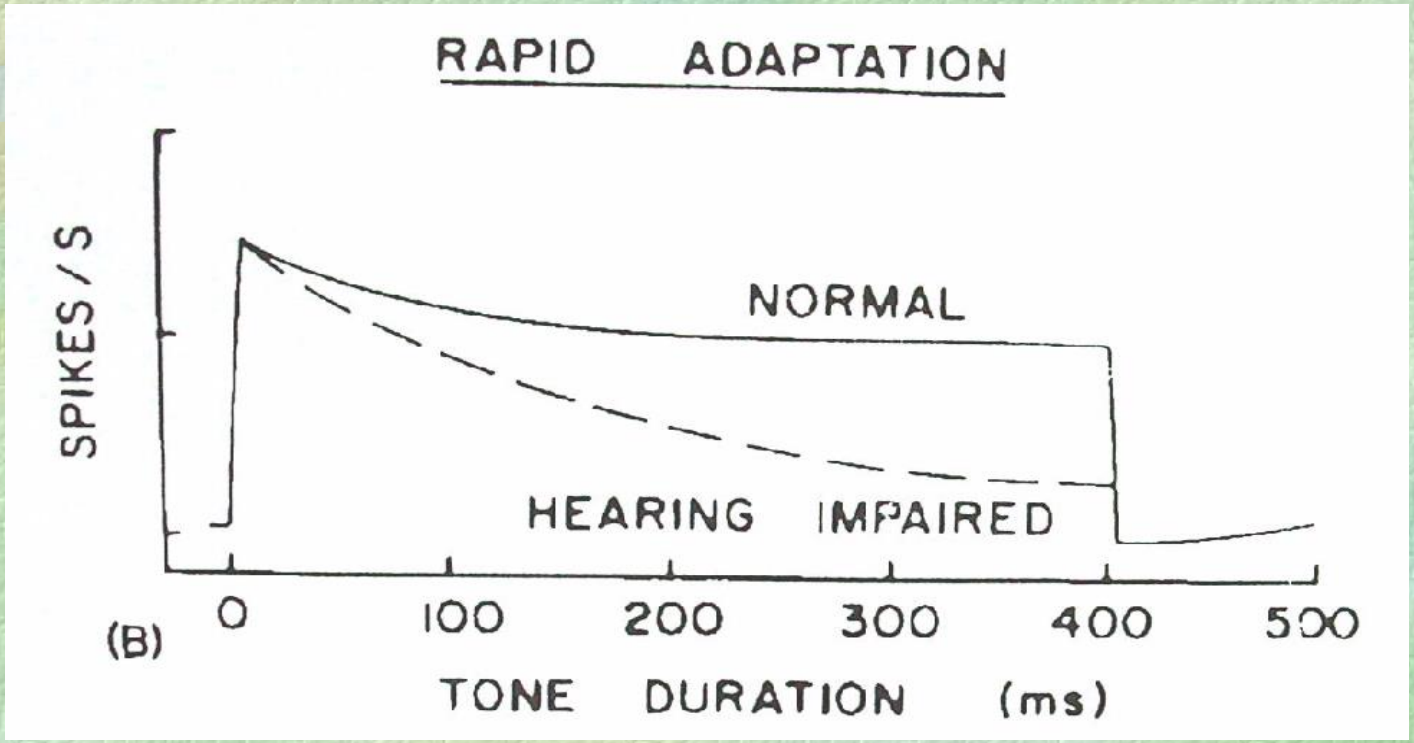
連續刺激音 100 dB at 0.5k Hz,
105 dB at 1.0k Hz

耳蝸後病變(+): < 60 sec

病變部位的診斷

2. 聽覺適應檢查(Adaptation Tests)

(1)閾上音衰退檢查(Suprathreshold Adaptation Test, STAT)



病變部位的診斷

2. 聽覺適應檢查(Adaptation Tests)

(2)聽反射衰退檢查 (Reflex Decay Test)

刺激音頻率: 0.5 kHz, 1.0 kHz

刺激音量: ART+10dB

Reflex decay (+):

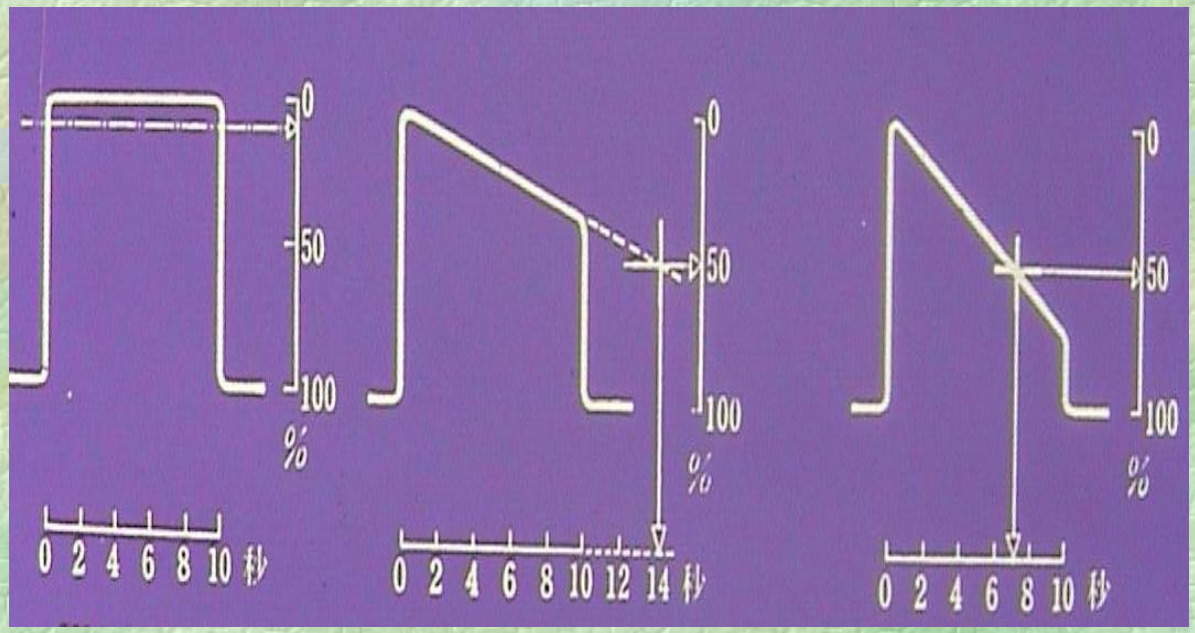
10秒內，amplitude ↓ > 50%

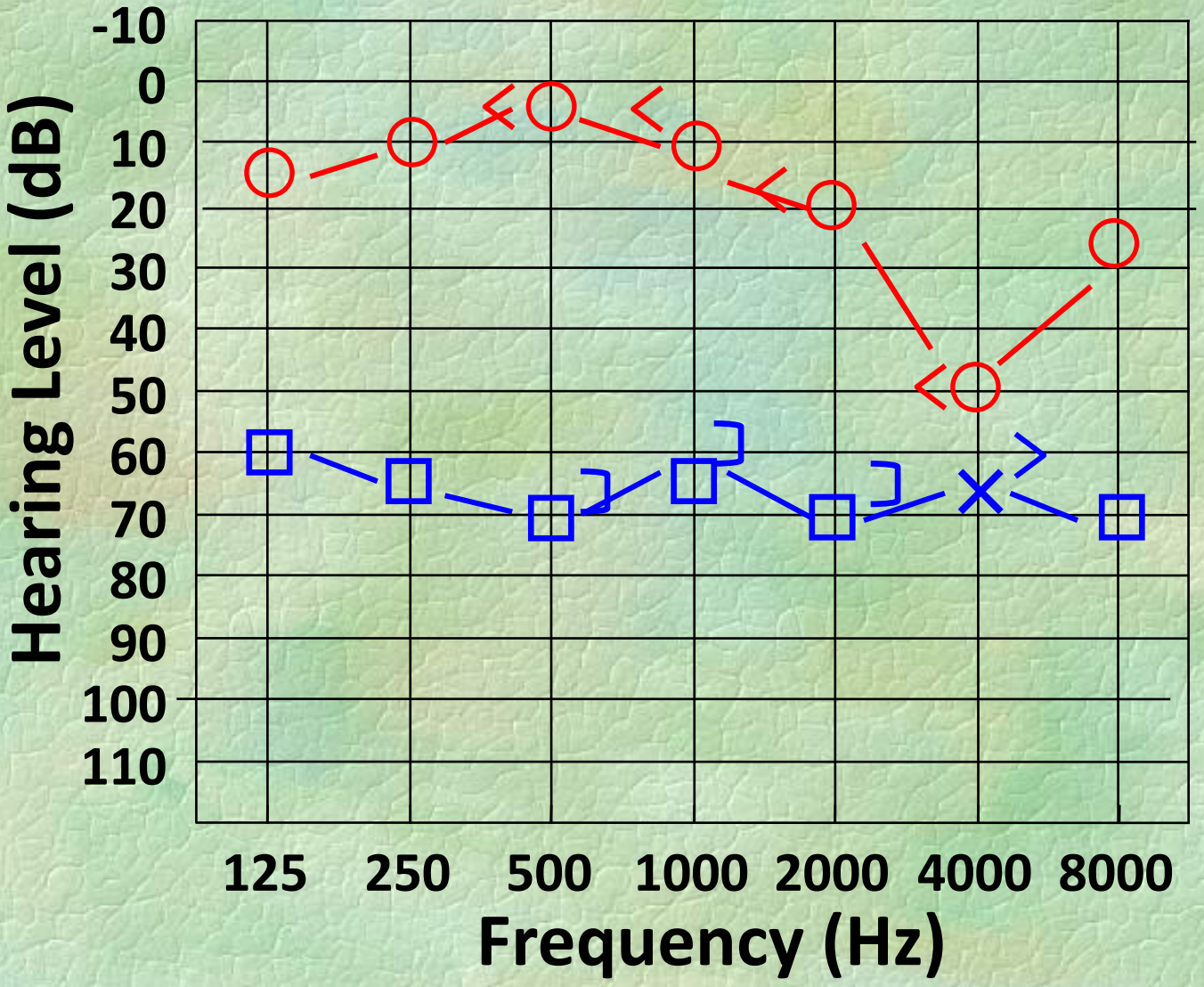
⇒耳蝸後病變(+)

病變部位的診斷

2. 聽覺適應檢查(Adaptation Tests)

(2)聽反射衰退檢查 (Reflex Decay Test)



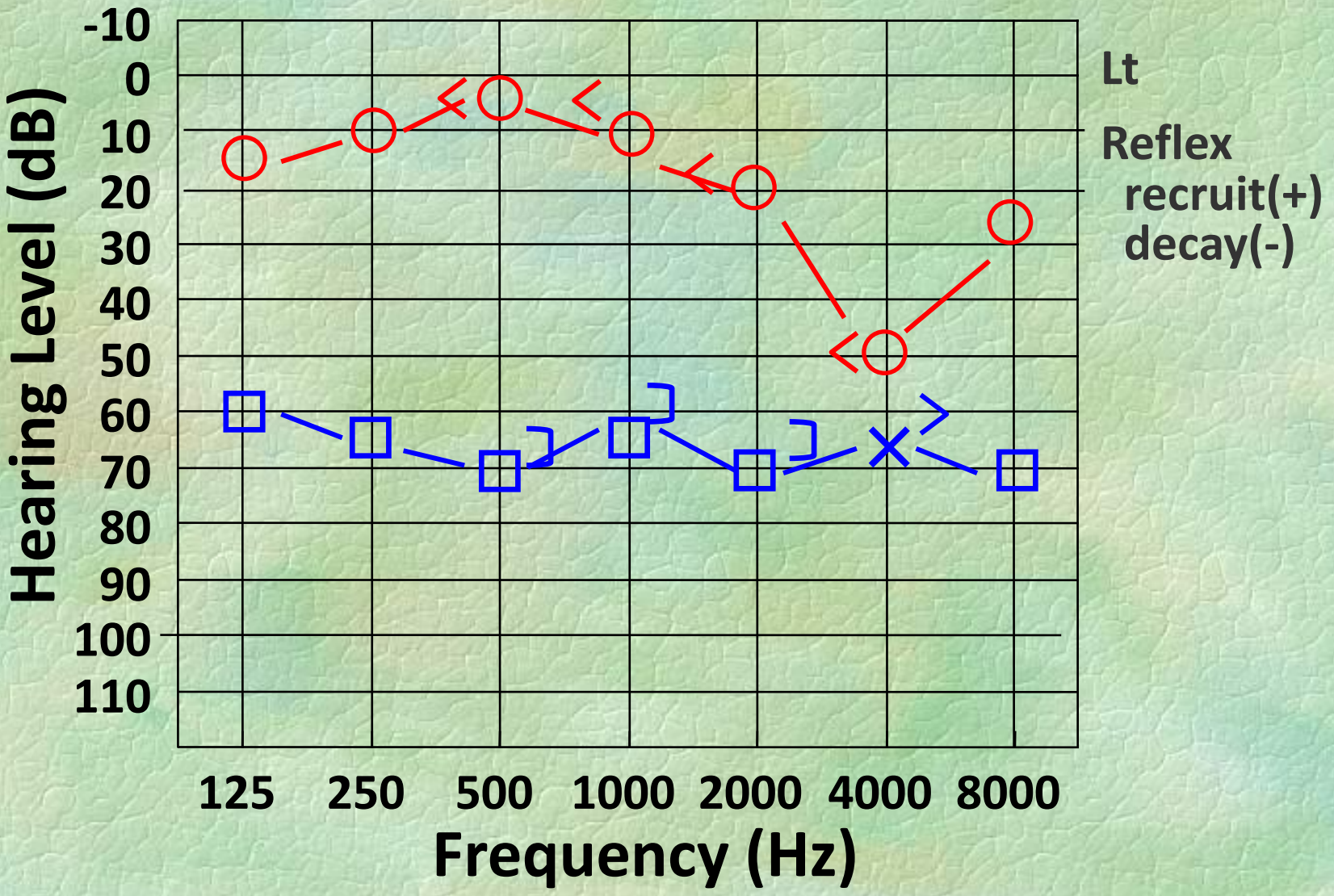

Hearing Level (dB)
-10
0
10
20
30
40
50
60
70
80
90
100
110
125
250
500
1000
2000
4000
8000
Frequency (Hz)

	Acoustic Reflex Threshold				Pure-tone Threshold				Sensation Level			
	0.5k	1k	2k	4k	0.5k	1k	2k	4k	0.5k	1k	2k	4k
Rt	100	100	105	125	5	10	20	50	95	90	85	75
Lt	100	100	120	125	70	65	70	65	30	35	50	60

Static Immitance	
Rt	0.16
Lt	0.18

Tympanogram	
Rt	A
Lt	A

Reflex Decay		
	0.5k	1k
Rt	–	–
Lt	–	–


-10
0
10
20
30
40
50
60
70
80
90
100
110
Hearing Level (dB)
125
250
500
1000
2000
4000
8000
Frequency (Hz)
Lt
Reflex
recruit(+)
decay(-)

病變部位的診斷

3. 語音失真檢查(Distortion Tests)

(1) 語音辨別檢查
(Speech Discrimination Scores)

(2) 語音均衡詞實引語度檢查
(Performance Index of Phonetically Balanced Words, PIPB)

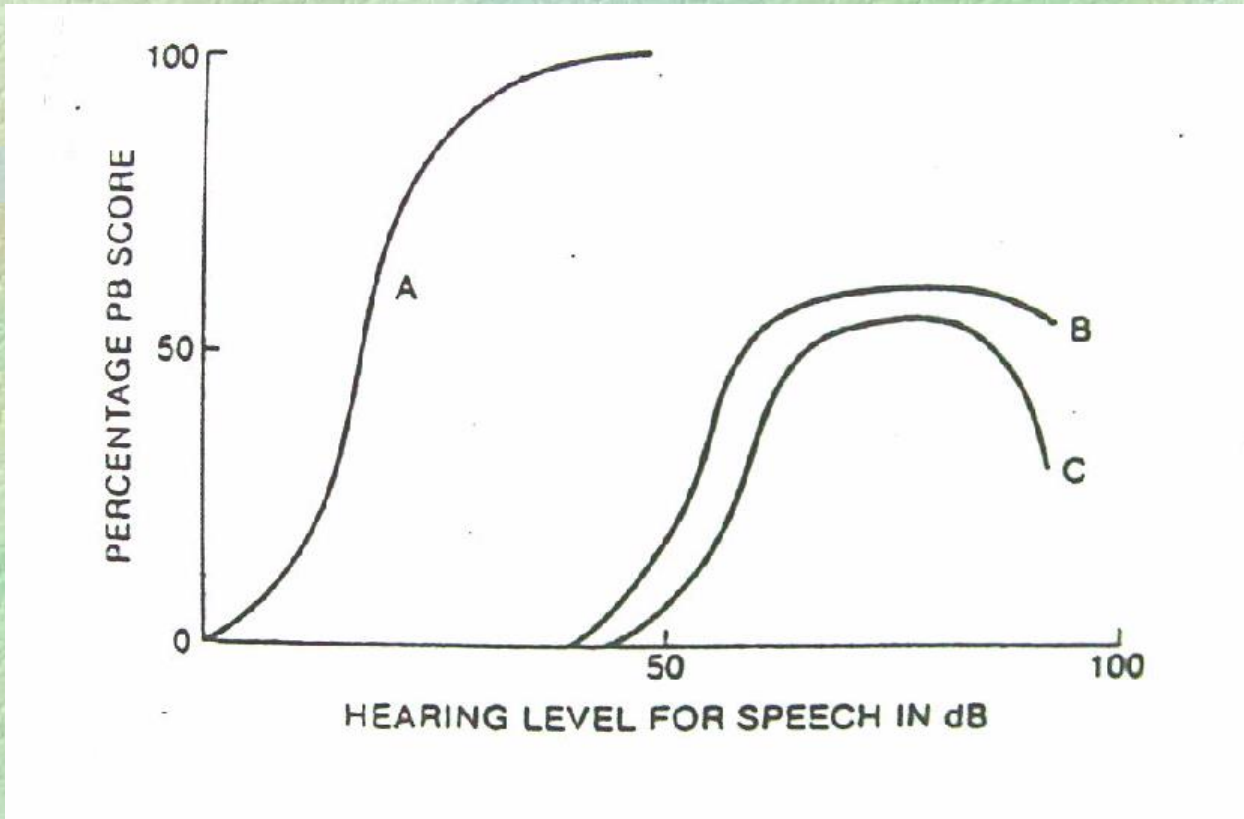
$(PB_{max} - PB_{min}) / PB_{max}$ %

耳蝸後病變(+): ≥ 25%~45%

病變部位的診斷

3. 語音失真檢查(Distortion Tests)

(2) 語音均衡詞實引語度檢查 (PIPB)



病變部位的診斷

3. 語音失真檢查(Distortion Tests)

(2) 語音均衡詞實引語度檢查 (PIPB)

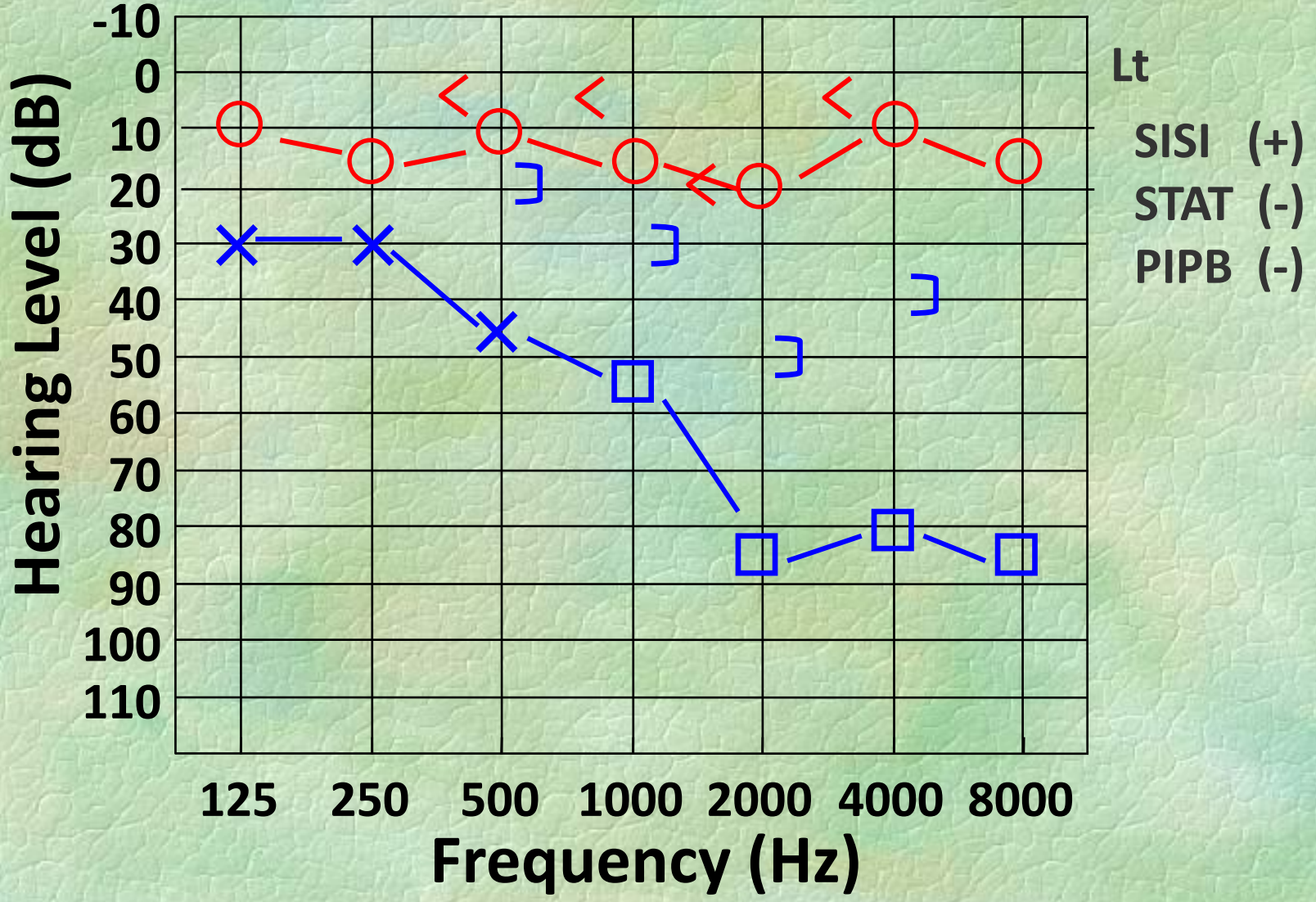
Speech Test

	SRT(dB)	MCL(dB)	UCL(dB)	SD(%)
Rt	20	75	100	28→8
Lt	10	50	90	96→96

R't PIPB (+): (28-8)/28 = 71%

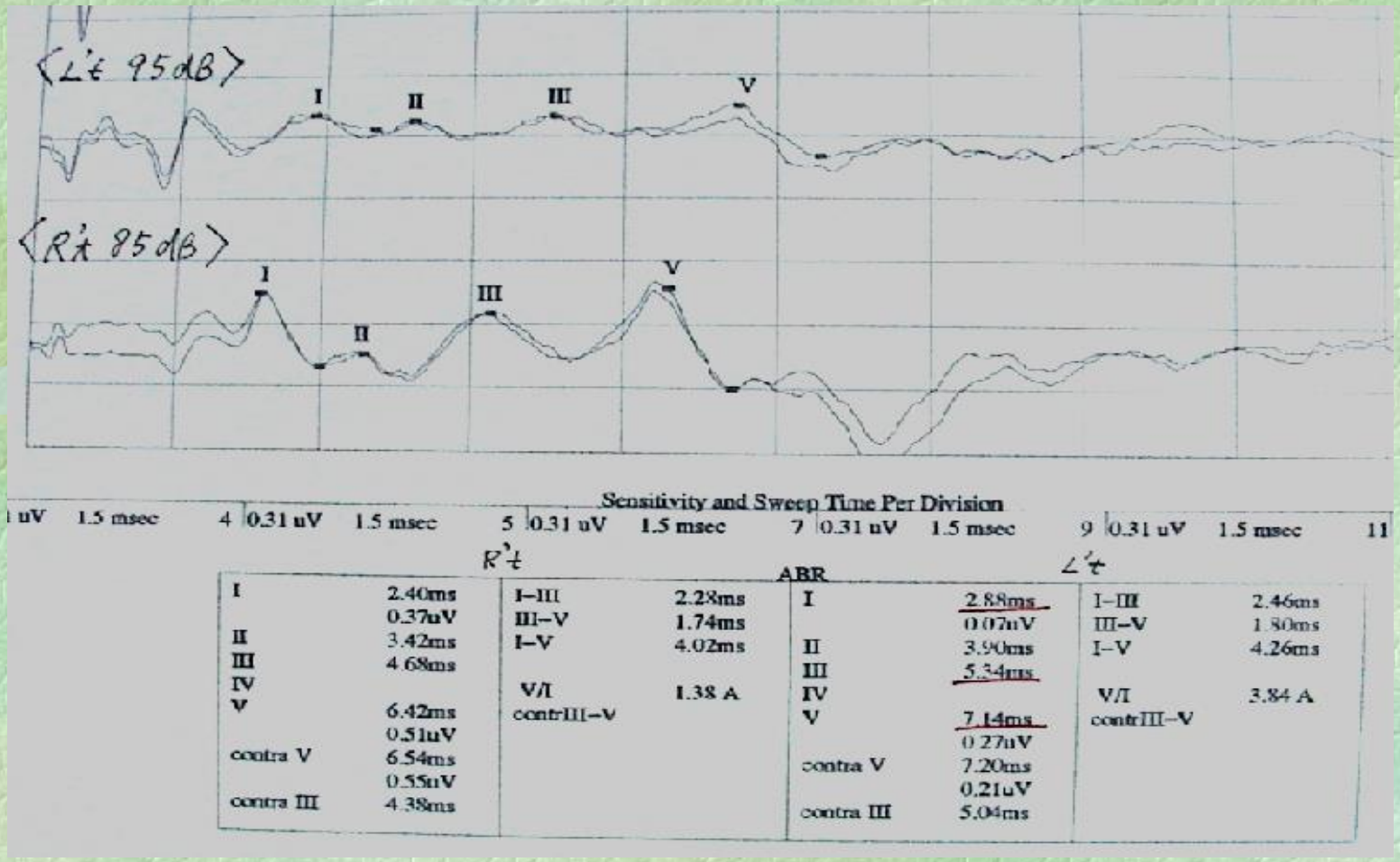
Case 1-Audiometry

2868454 Mixed HL



Case 1-ABR

2868454 Mixed HL

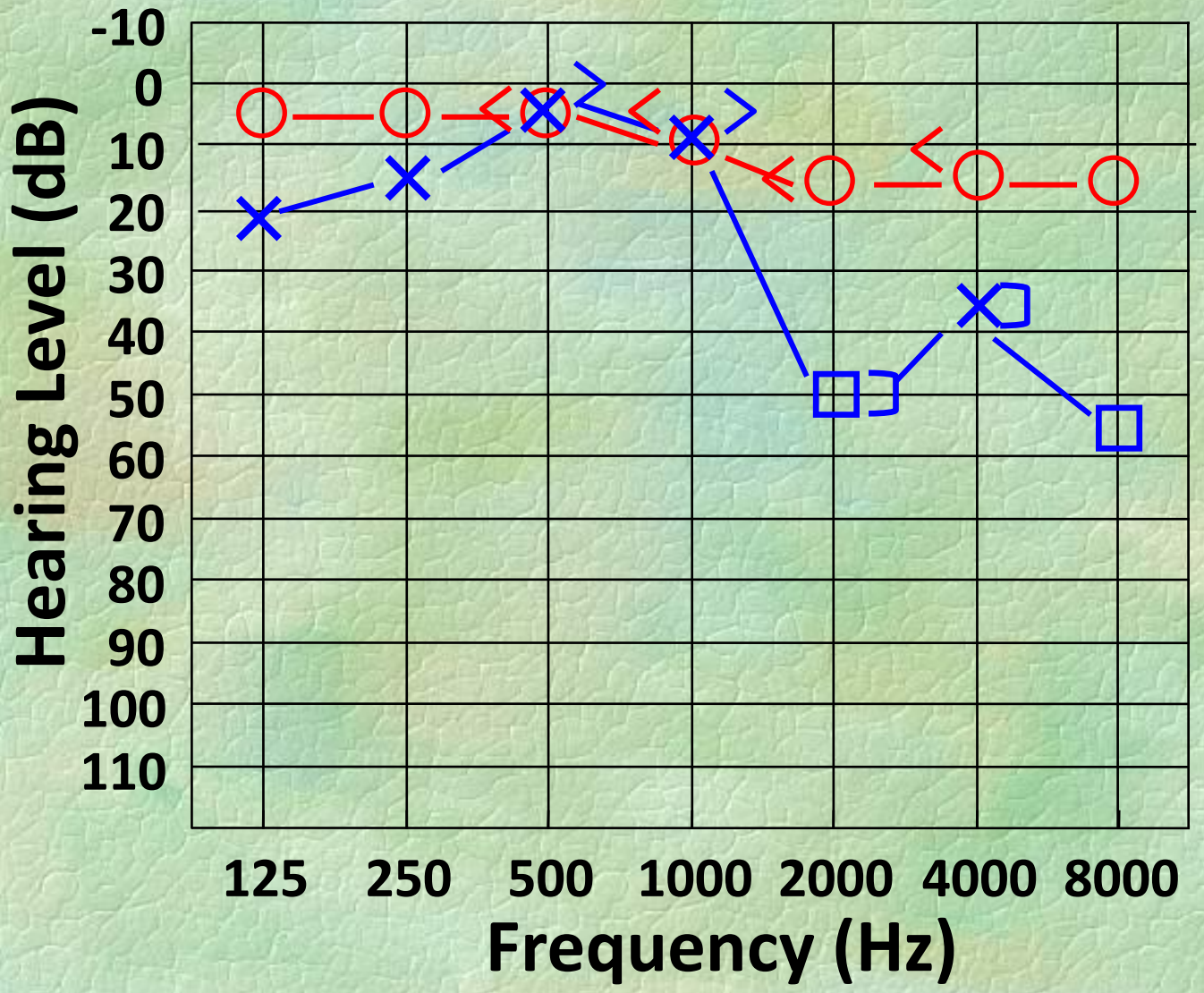


ABR

Rt				Lt			
I	2.40ms	I–III	2.28ms	I	2.88ms	I–III	2.46ms
	0.37uV	III–V	1.74ms		0.07uV	III–V	1.80ms
II	3.42ms	I–V	4.02ms	II	3.90ms	I–V	4.26ms
III	4.68ms			III	5.34ms		
IV		V/I	1.38 A	IV		V/I	3.84 A
V	6.42ms	contrIII–V		V	7.14ms	contrIII–V	
	0.51uV				0.27uV		
contra V	6.54ms			contra V	7.20ms		
	0.55uV				0.21uV		
contra III	4.38ms			contra III	5.04ms		

Case 2-Audiometry

2856841 Unilateral Sensorineural HL



Case 2-Audiometry

2856841 Unilateral Sensorineural HL

	Acoustic Reflex Threshold				Pure-tone Threshold				Sensation Level			
	0.5k	**1k**	**2k**	**4k**	**0.5k**	**1k**	**2k**	**4k**	**0.5k**	**1k**	**2k**	**4k**
Rt	85	85	85	85	5	10	15	15	**80**	**75**	**70**	**70**
Lt	100	105	–	–	5	10	60	35	**95**	**95**	–	–

Static Immitance	
Rt	0.6
Lt	0.4

Tympanogram	
Rt	A
Lt	A

Case 2-Audiometry

2856841 Unilateral Sensorineural HL

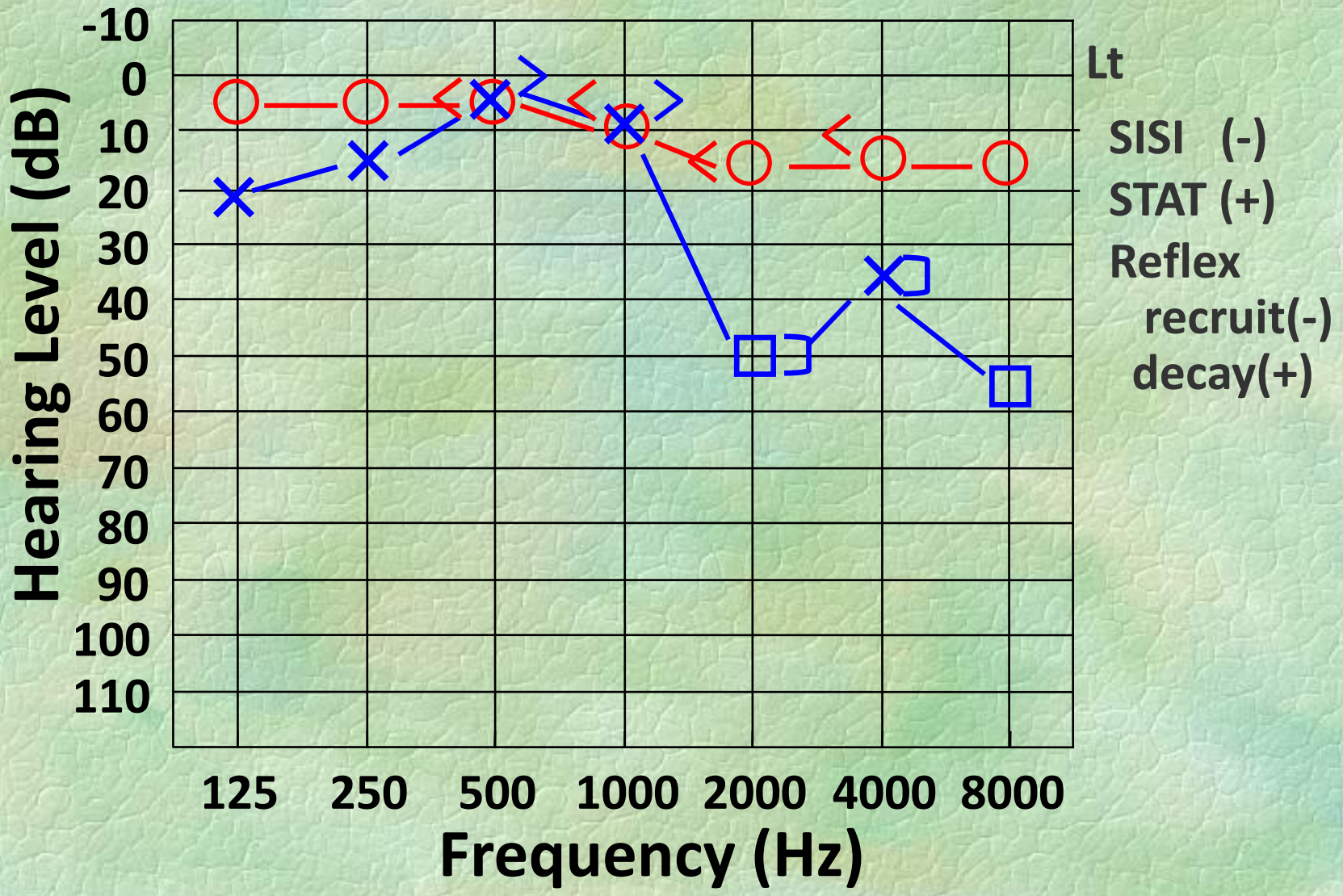
SISI				
	0.5 kHz	1 kHz	2 kHz	4 kHz
Rt				
Lt			100%	100%

STAT		
	0.5 kHz	1 kHz
Rt		
Lt (+)	10”	50”

Reflex Decay		
	0.5k	1k
Rt	–	–
Lt (+)	3”	4”

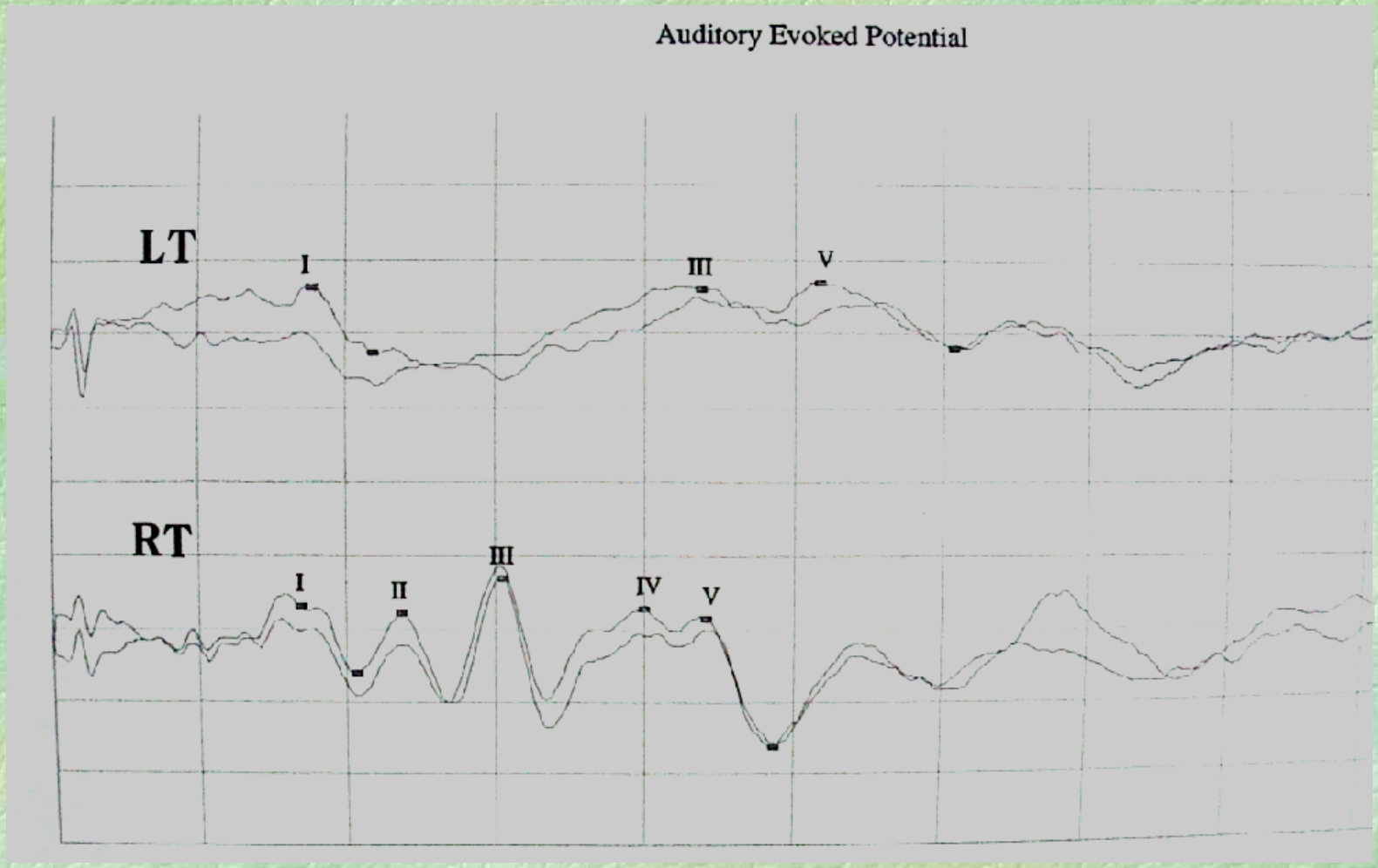
Case 2-Audiometry

2856841 Unilateral Sensorineural HL



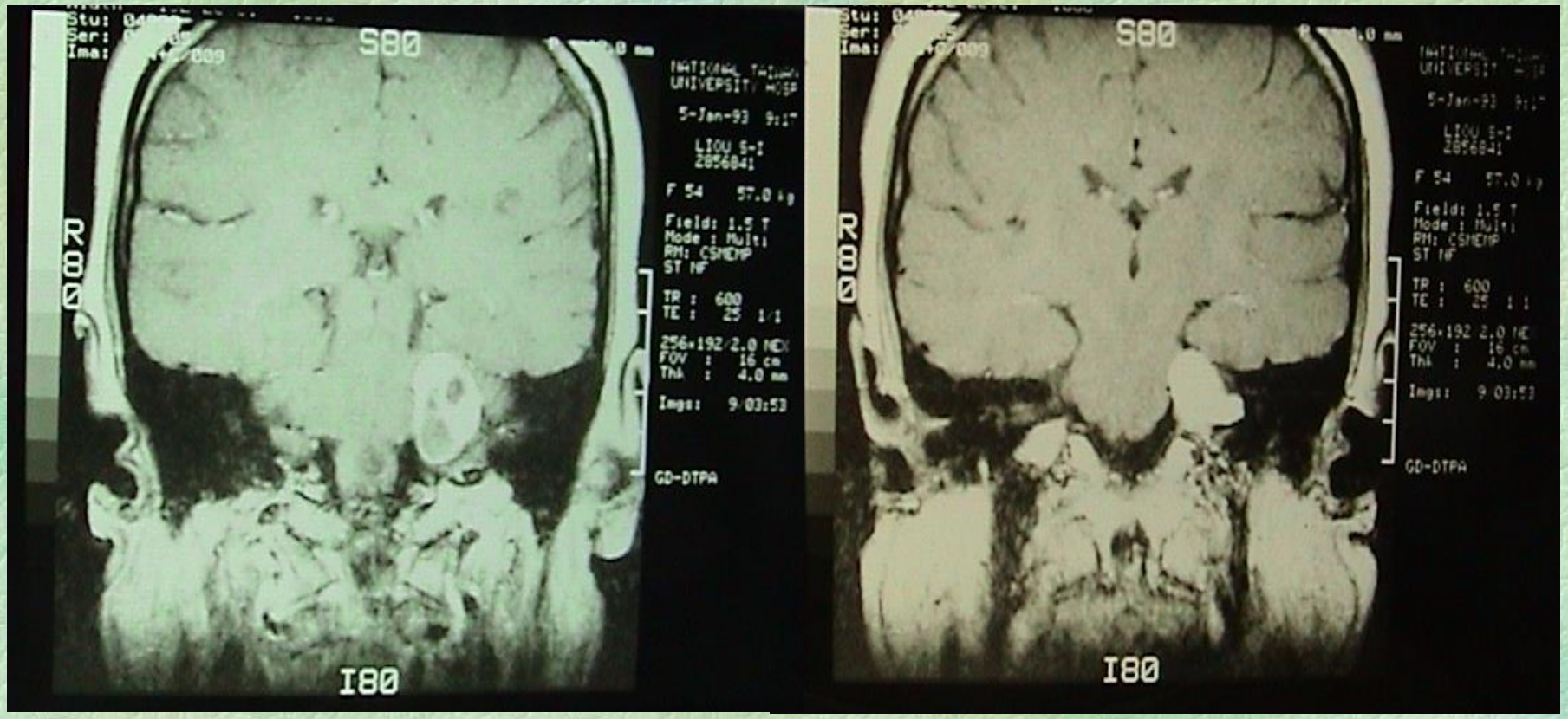
Case 2-ABR

2856841 Unilateral Sensorineural HL



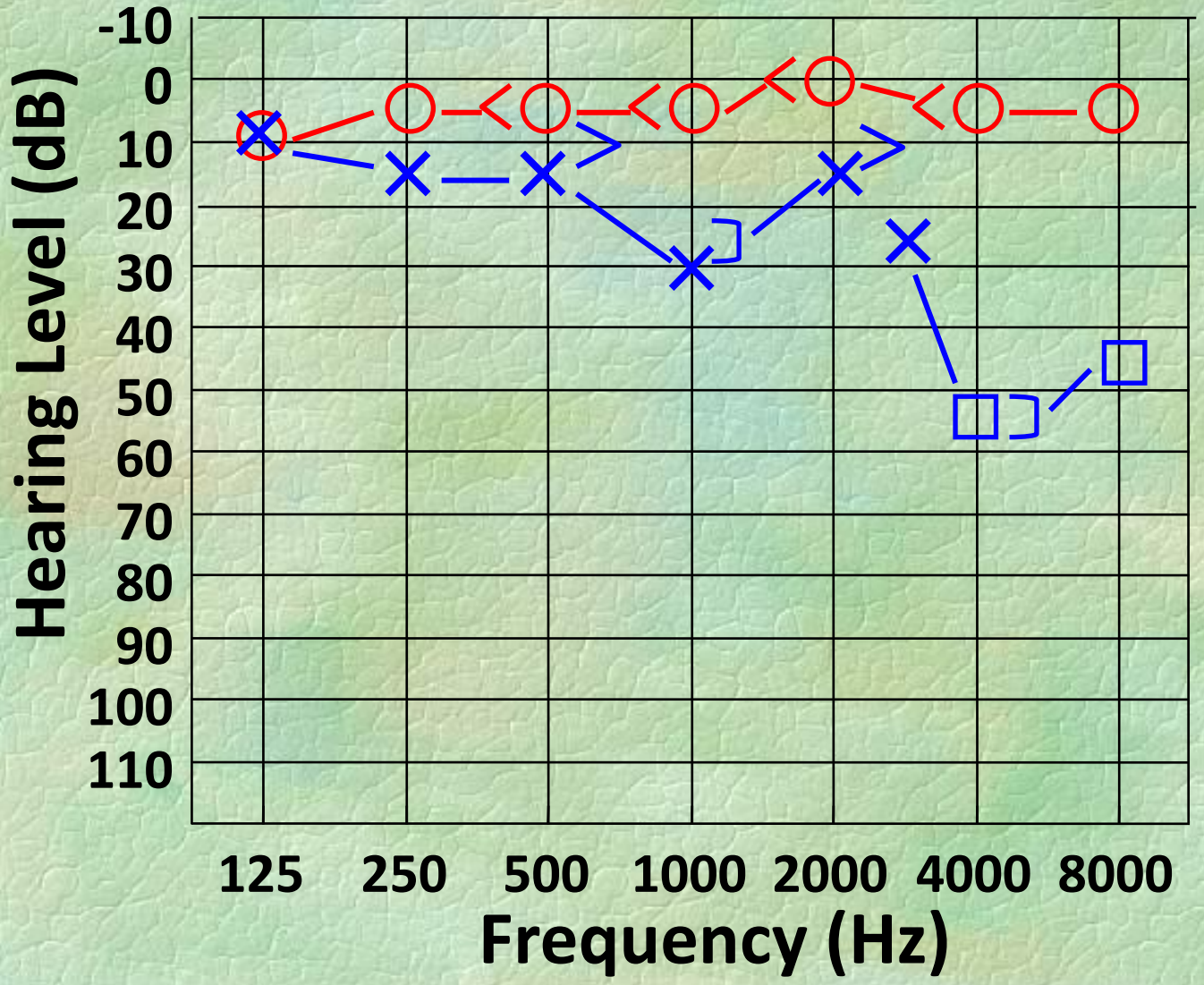
Case 2-Gd-MRI

2856841 Unilateral Sensorineural HL



Case 3-Audiometry

2674904 Unilateral Sensorineural HL



Case 3-Audiometry

2674904 Unilateral Sensorineural HL

Acoustic Reflex Threshold (dB)								
	Contralateral				Ipsilateral			
	0.5k	1k	2k	4k	0.5k	1k	2k	4k
Rt	85	95	95	85	90	90	90	90
Lt	95	95	100	100	95	105	100	–

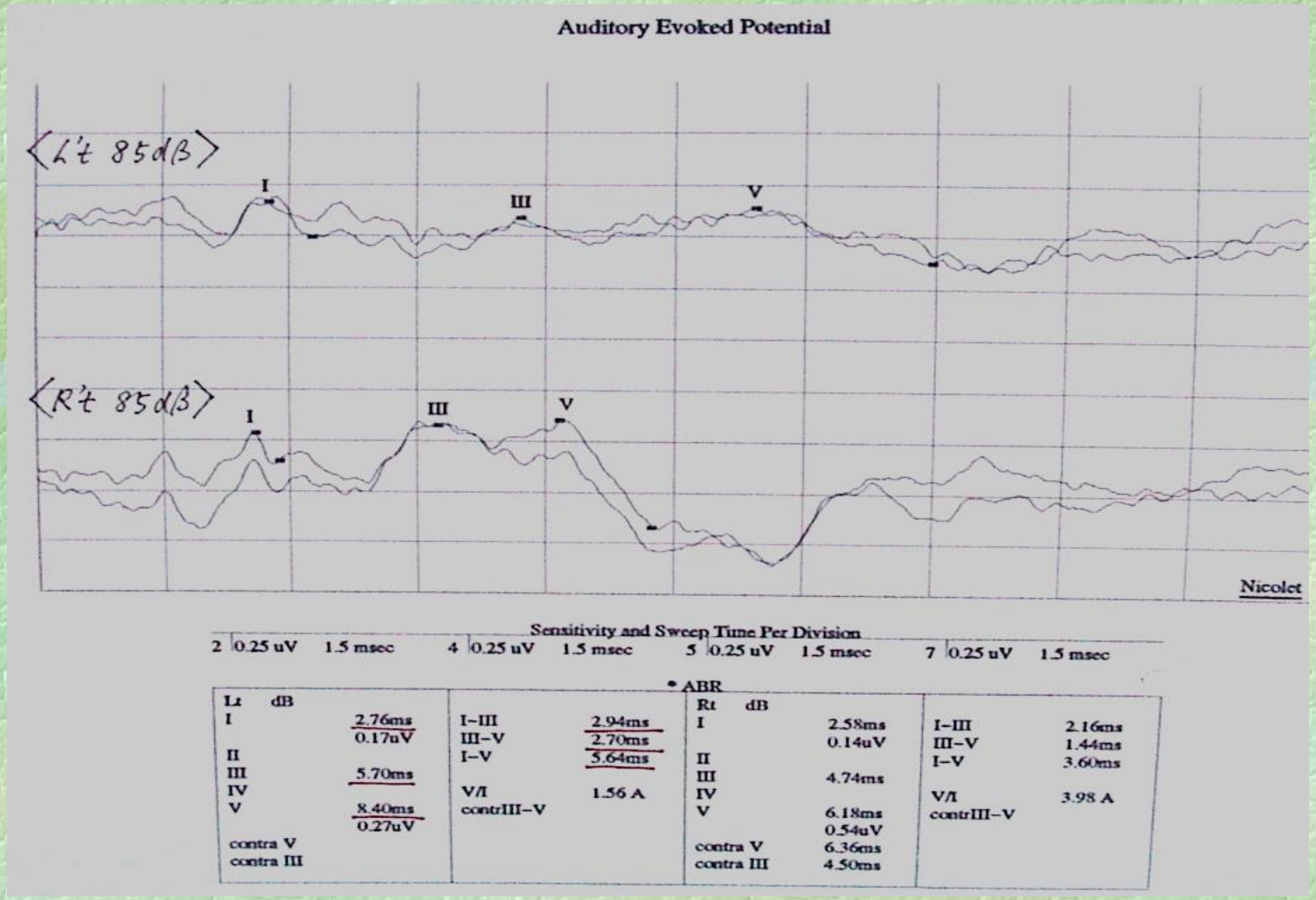
Static Immitance	
Rt	0.66
Lt	0.66

Tympanogram	
Rt	A
Lt	A

Reflex Decay		
	0.5k	1k
Rt	–	–
Lt	–	–

Case 3-ABR

2674904 Unilateral Sensorineural HL

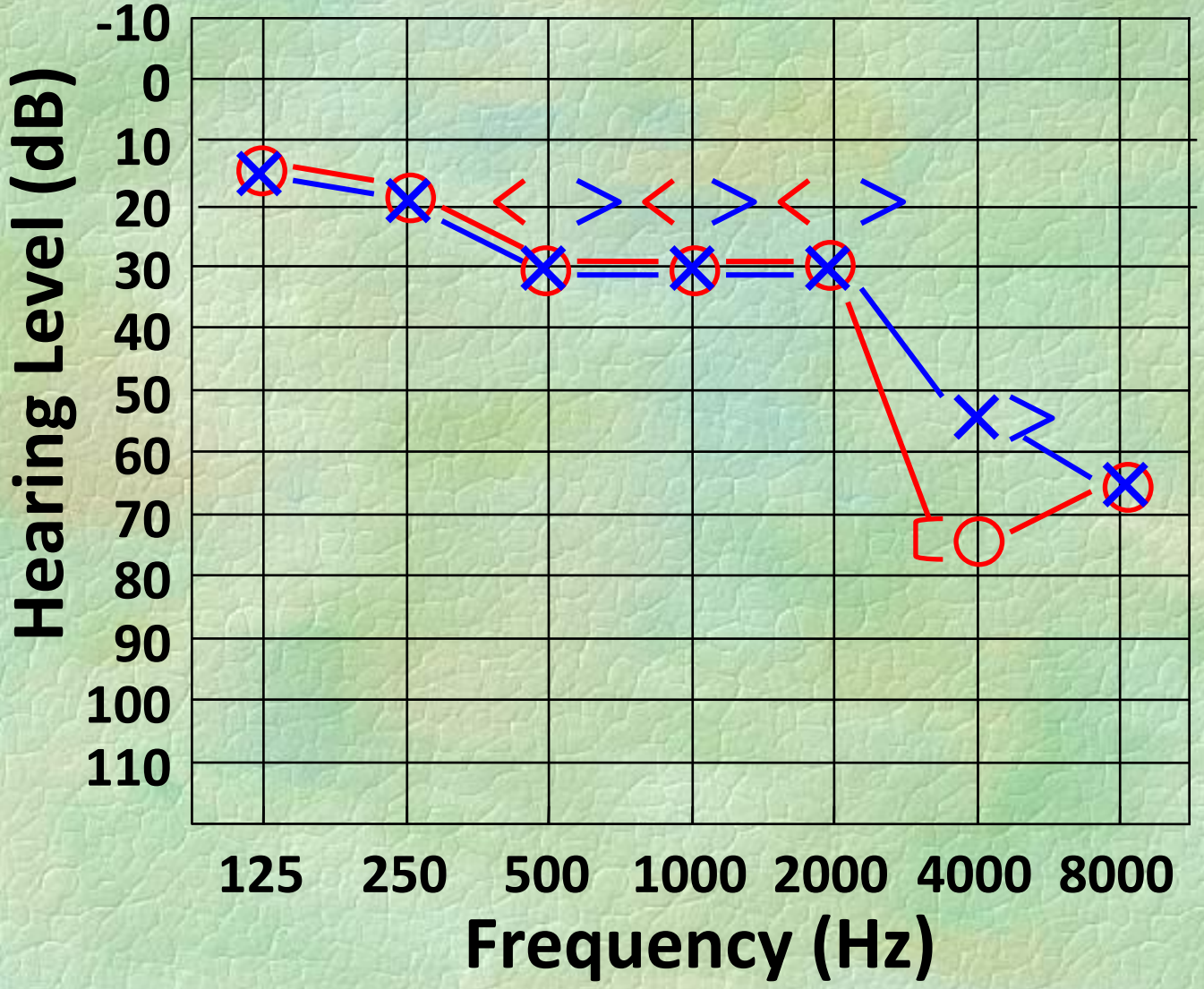


Case 3-Gd-MRI

2674904 Unilateral Sensorineural HL

Case 4-Audiometry

3428443 Asymmetric Sensorineural HL



Case 4-Audiometry

3428443 Asymmetric Sensorineural HL

Acoustic Reflex Threshold (dB)								
	Contralateral				Ipsilateral			
	0.5k	1k	2k	4k	0.5k	1k	2k	4k
Rt	90	85	90	90				
Lt	95	95	100	100				

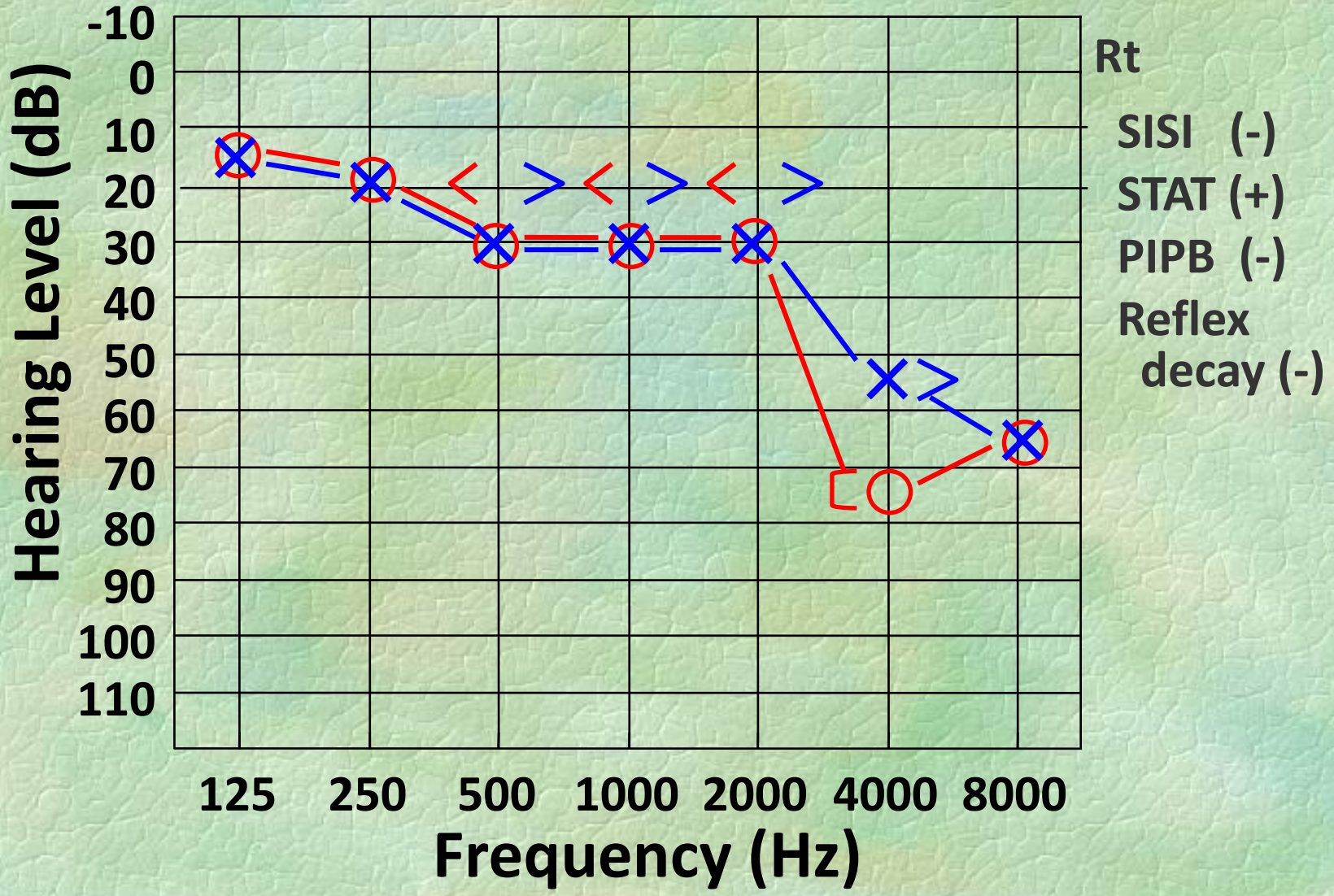
Static Immitance	
Rt	0.38
Lt	0.36

Tympanogram	
Rt	A
Lt	A

Reflex Decay		
	0.5k	1k
Rt	—	—
Lt	—	—

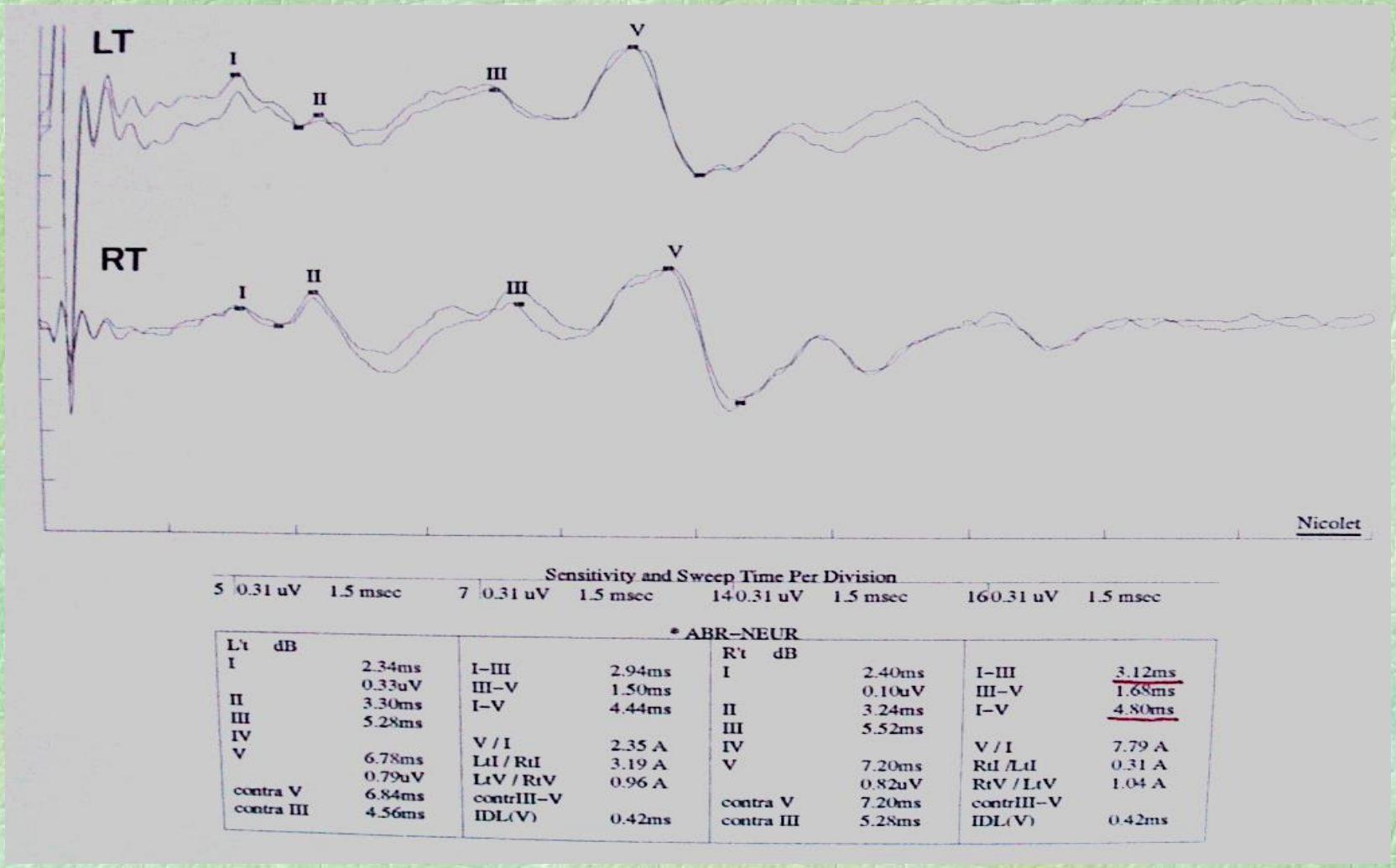
Case 4-Audiometry

3428443 Asymmetric Sensorineural HL



Case 4-ABR

3428443 Asymmetric Sensorineural HL



Sensitivity and Sweep Time Per Division

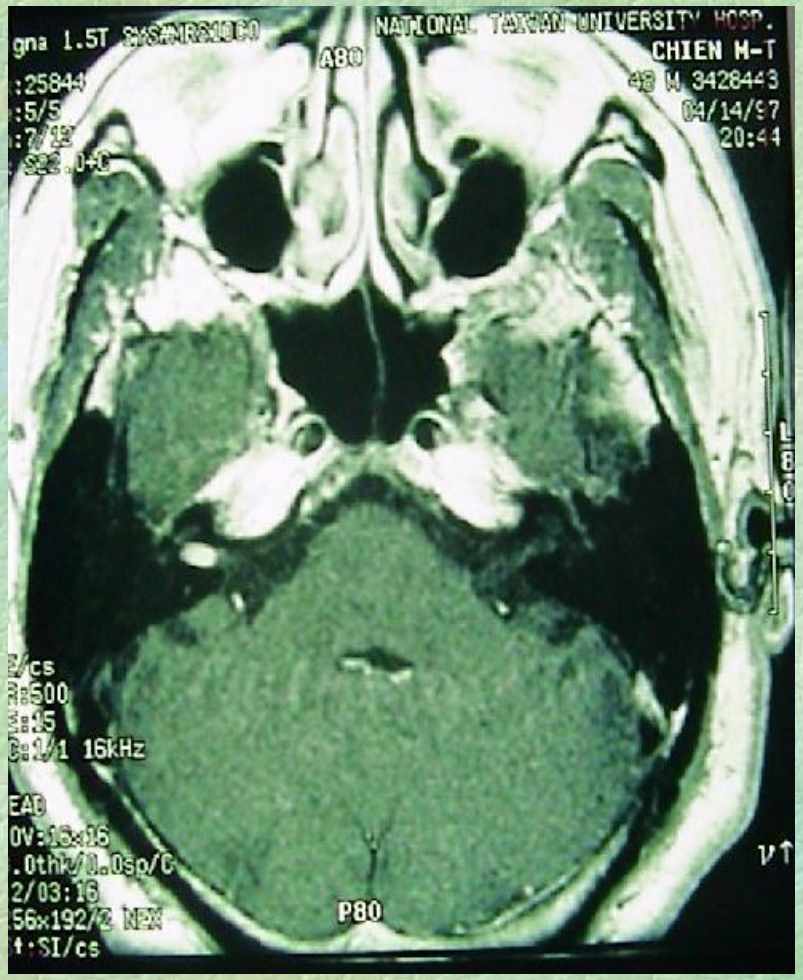
5 0.31 uV 1.5 msec 7 0.31 uV 1.5 msec 14 0.31 uV 1.5 msec 16 0.31 uV 1.5 msec

* ABR–NEUR

L't dB				R't dB			
I	2.34ms	I–III	2.94ms	I	2.40ms	I–III	3.12ms
	0.33uV	III–V	1.50ms		0.10uV	III–V	1.68ms
II	3.30ms	I–V	4.44ms	II	3.24ms	I–V	4.80ms
III	5.28ms			III	5.52ms		
IV		V / I	2.35 A	IV		V / I	7.79 A
V	6.78ms	LtI / RtI	3.19 A	V	7.20ms	RtI /LtI	0.31 A
	0.79uV	LtV / RtV	0.96 A		0.82uV	RtV / LtV	1.04 A
contra V	6.84ms	contrIII–V		contra V	7.20ms	contrIII–V	
contra III	4.56ms	IDL(V)	0.42ms	contra III	5.28ms	IDL(V)	0.42ms

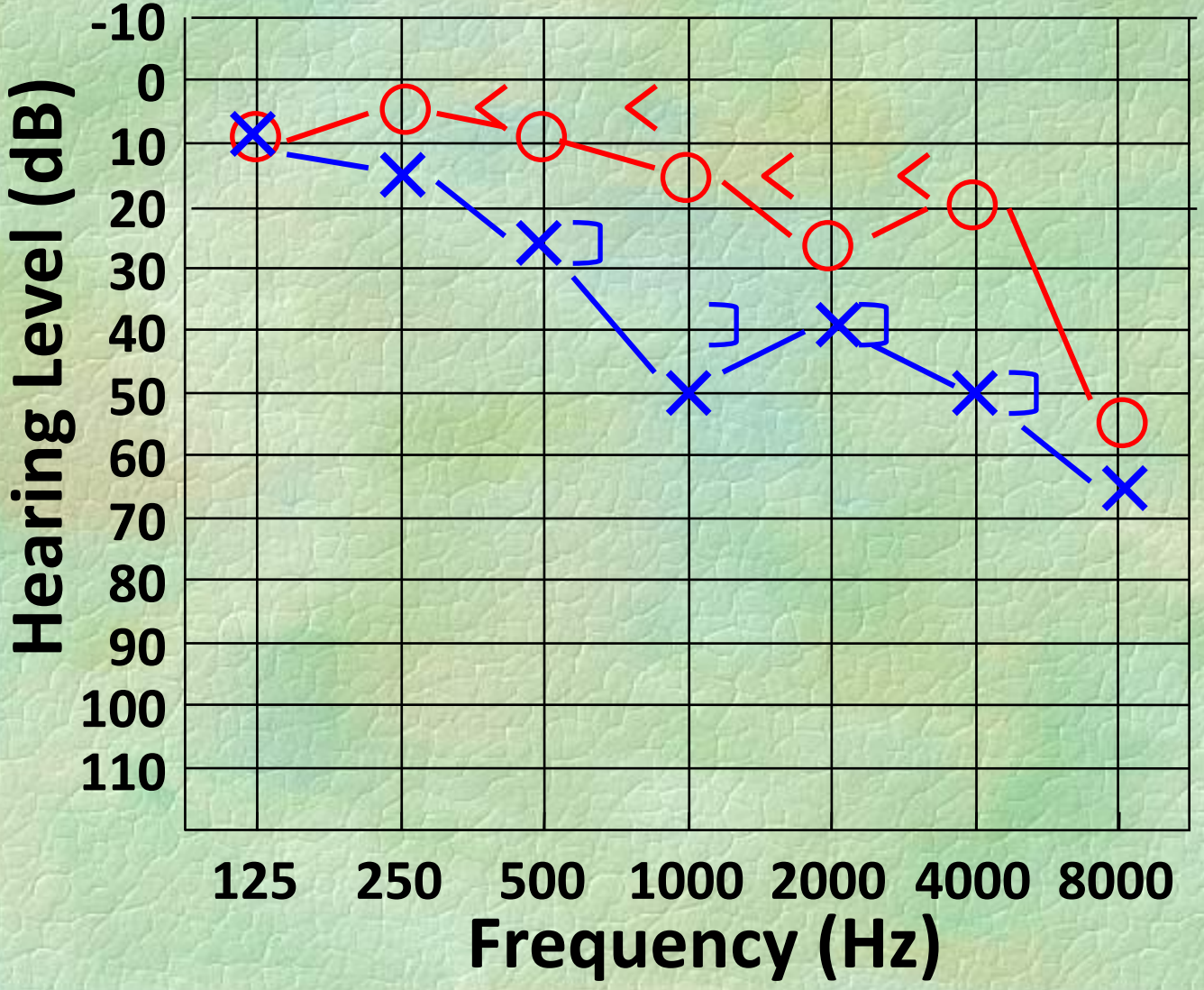
Case 4-Gd-MRI

3428443 Asymmetric Sensorineural HL



Case 5-Audiometry

3023277 Asymmetric Sensorineural HL



Case 5-Audiometry

3023277 Asymmetric Sensorineural HL

Acoustic Reflex Threshold (dB)								
	Contralateral				Ipsilateral			
	0.5k	1k	2k	4k	0.5k	1k	2k	4k
Rt	100	100	110	–	100	100	105	–
Lt	–	–	–	–	–	–	–	–

Static Immitance	
Rt	2.7
Lt	1.5

Tympanogram	
Rt	M
Lt	Ad

Reflex Decay		
	0.5k	1k
Rt	–	–
Lt	CNT	CNT

Case 5-Audiometry

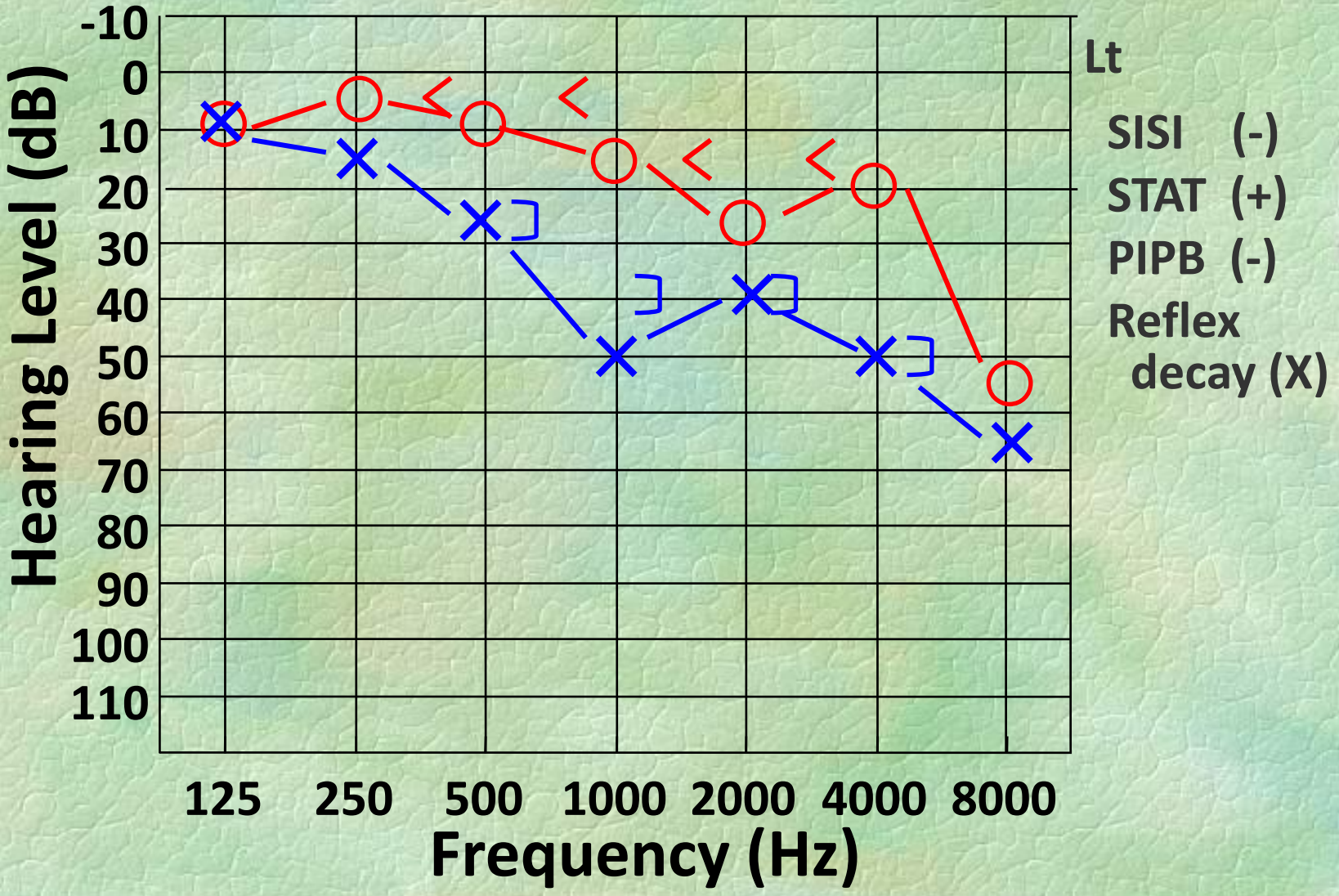
3023277 Asymmetric Sensorineural HL

SISI				
	0.5 kHz	1 kHz	2 kHz	4 kHz
Rt				
Lt (–)		10%	0%	10%

STAT				
	0.5 kHz	1 kHz	2 kHz	4 kHz
Rt				
Lt (+)	8”	7”	16”	

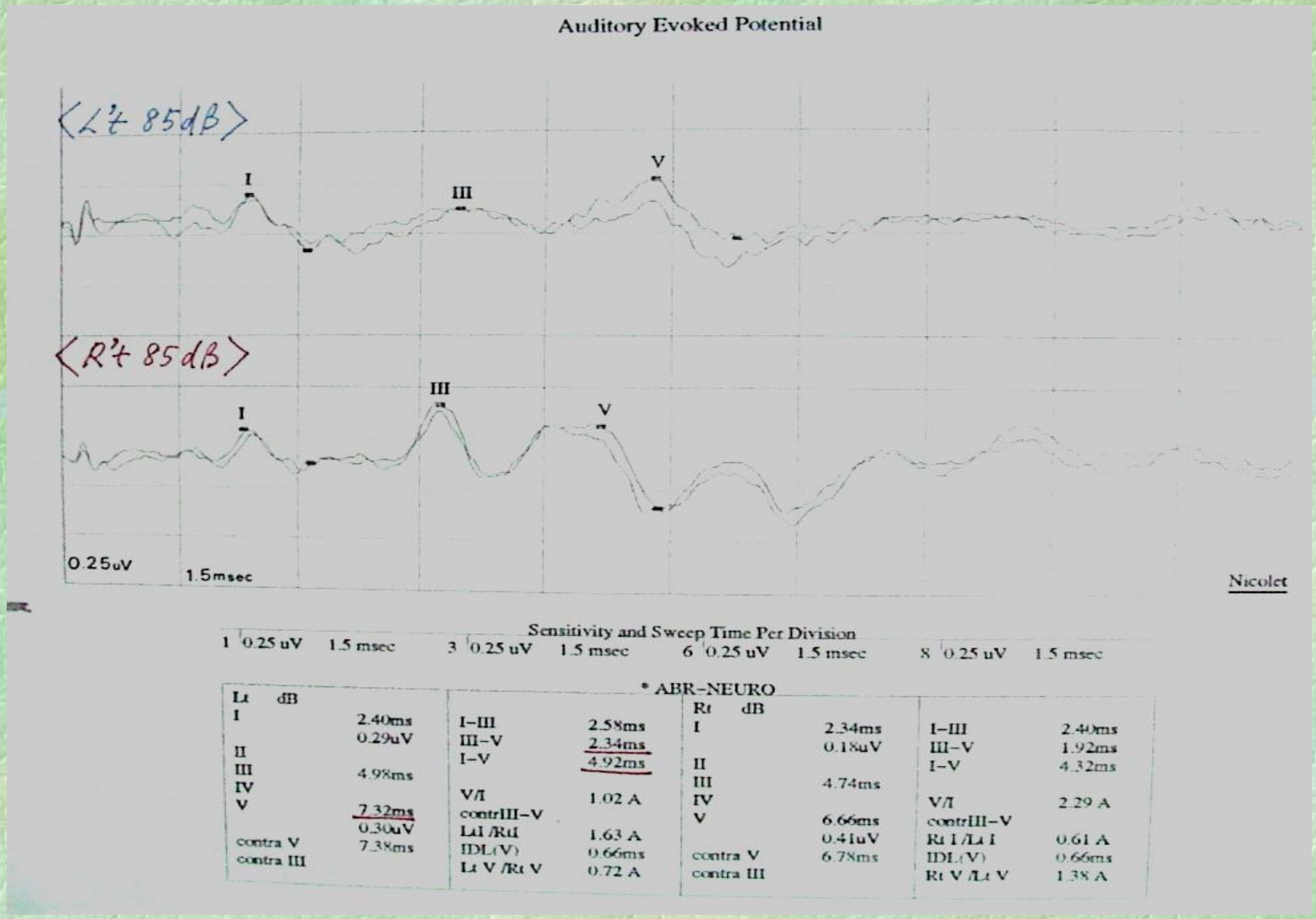
Case 5-Audiometry

3023277 Asymmetric Sensorineural HL



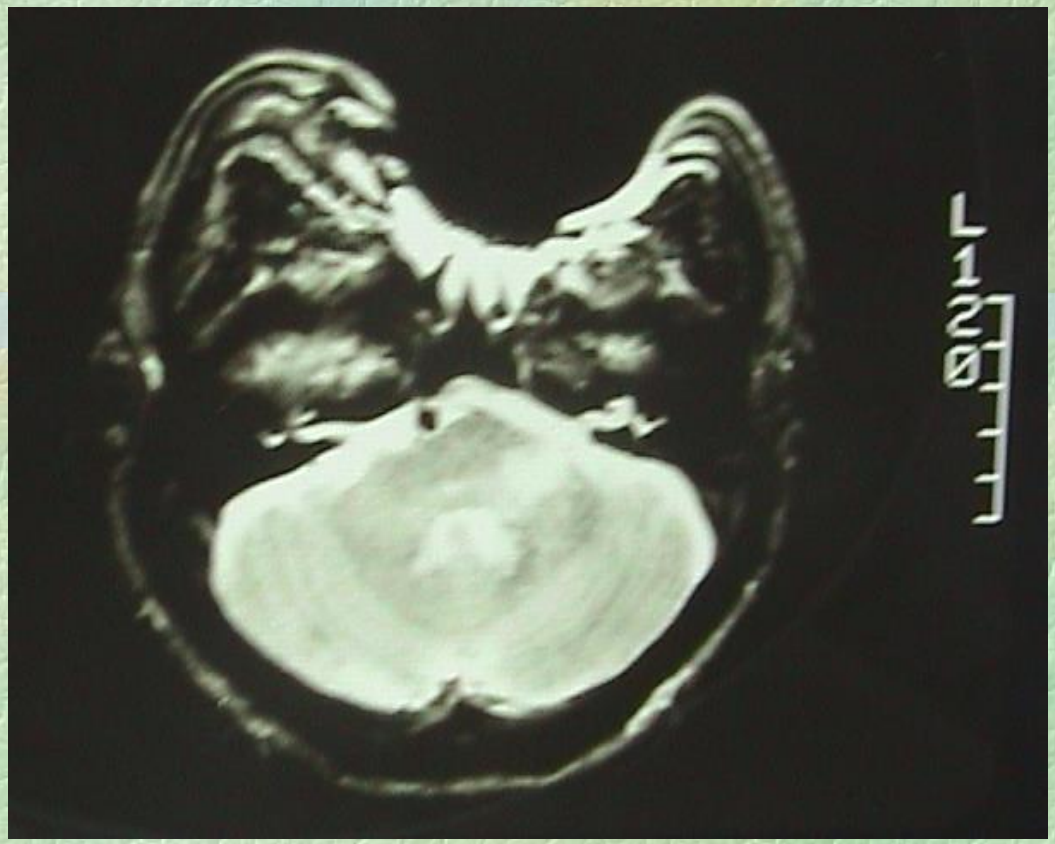
Case 5-ABR

3023277 Asymmetric Sensorineural HL

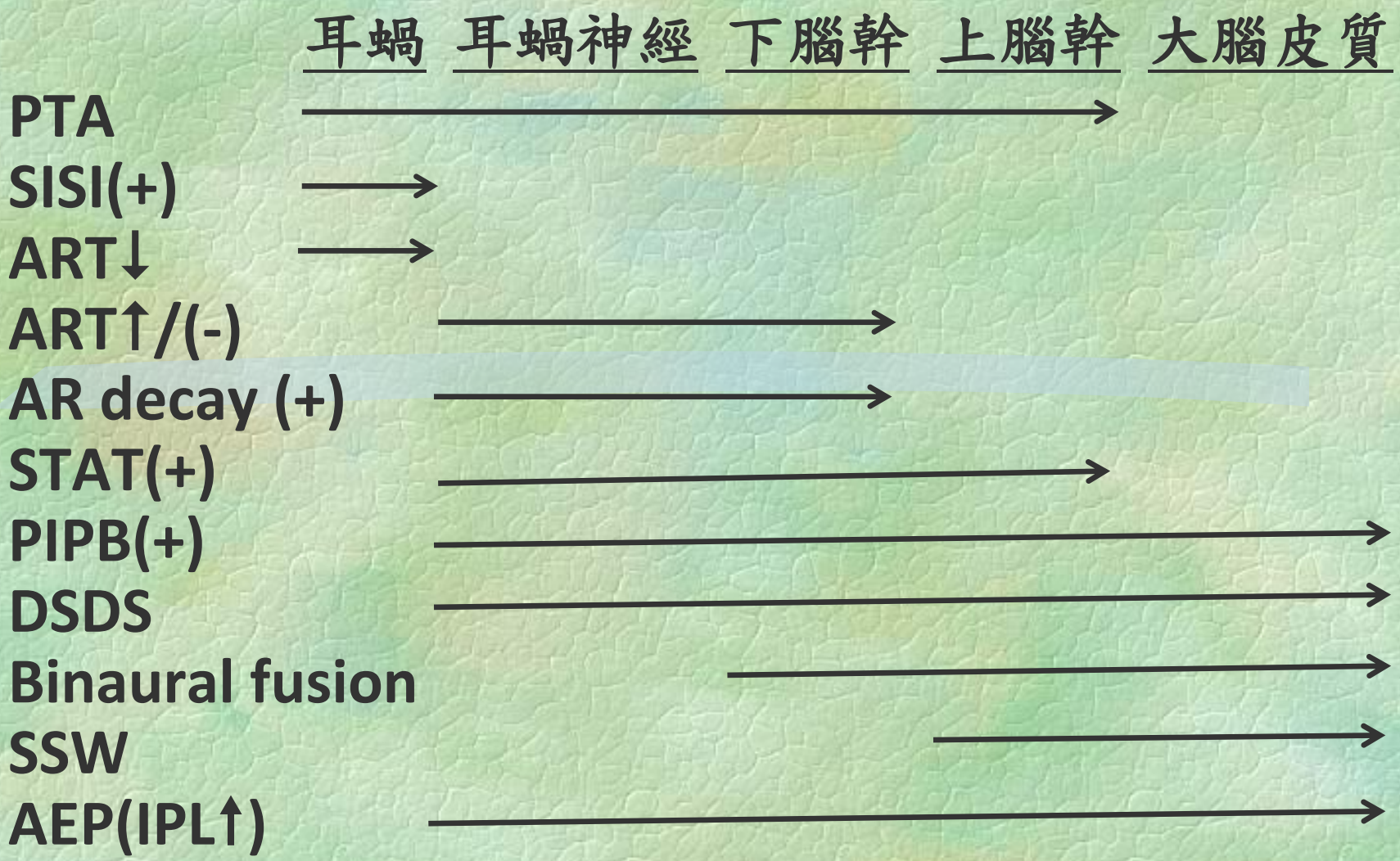


Case 5-Gd-MRI

3023277 Asymmetric Sensorineural HL



聽力檢查結果 vs. 病變部位



病變部位的診斷

		靈敏度		
		Hsu	Harder	Kotlarz
Speech	PIPB	23%		40%
Adaptation	ARD	25%	35%	
	STAT	39%	38%	
Recruitment	SISI	67%		
	ART	81%	89%	
ABR		86%	100%	

結 論

行為聽力檢查

特殊聽力檢查

1. SISI test
2. STAT test
3. PIPB

生理聽力檢查

聽阻聽力檢查(Impedance audiogram)

聽反射閾值、衰退 (Acoustic reflex threshold & decay)

腦幹聽性反應檢查(ABR)*

耳蝸電圖(Electrocochleogram, ECoG)*