Dead Regions in the cochlea: What are they and why do they matter?

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Content

1. Anatomical/physiological basis
2. Tests for detecting DEAD REGIONS
3. Clinical implications
Normal organ of Corti

(Courtesy of Professor Andrew Forge)
Mild OHC pathology
Example of IHC pathology
(Dead Region)
Traveling wave

Basilar membrane displacement

Distance from stapes, mm
• Signals that fall within a ‘dead region’ may be detected by ‘off-frequency’ listening
How useful is PTA?

• A pure tone audiogram tells us if a tone needs to be elevated to be detected

• It does not tell us if detection is on-frequency or off-frequency

• Dead Regions cannot be reliably detected using PTA
Moore et al. [2000]
Detecting Dead Regions

- Psychophysical tuning curve [PTC]
- Threshold Equalizing Noise [TEN] test
Psychophysical tuning curve

- PTC shows the level of noise [at different frequencies] required to mask a tone [at a fixed frequency]
- tool for measuring frequency resolution
- Good [but not perfect] research tool
[Courtesy of Moore, 2001]
High-frequency dead region

[Courtesy of Moore, 2001]
TEN Test

• good for clinical practice

• Developed by Brian Moore and colleagues, Cambridge, UK

• http://hearing.psychol.cam.ac.uk/dead/dead.html
Principles of TEN Test

[Graph showing broadband noise levels across different frequencies (Hz) and decibels (dB HL).]
DR > 1 kHz

Broadband noise
Do the results from PTC and TEN always agree?

*Mostly, but not always*
Study One: Application of TEN test in hearing-impaired teenagers with severe-to-profound hearing loss
Subjects

• 33 teenagers with longstanding severe to profound SNHL

• mean age 14 years [13 female, 20 male]
Mean hearing thresholds
Results from 63 ears

- DR: [TEN at ca. 90 dB/ERB]
- Criteria not met for DR
- Inconclusive
Summary of Study One

• Dead Regions appear to be relatively common among teenagers with longstanding hearing impairment

• For most ears, results inconclusive at some frequencies because of the severity of loss
Study Two: Repeatability of the TEN test for hearing-impaired teenagers with severe-to-profound hearing loss
Subjects

- 34 ears of 24 teenagers
- subgroup of Study One retested after 12 months
Results from 34 ears

Number of ears

Criteria met for DR (n=31)  Criteria not met first test (n=3)

- No change
- Change category
- Inconclusive
Summary of Study Two

- Findings are repeatable
- Results should be interpreted with caution when criteria are just met
Potential limitations of TEN test with severe to profound losses

- unable to obtain sufficient output for noise or/and tone
- TEN is uncomfortably loud
TEN test with children

- Babies require objective technique
- 6-30 month age group require VRA technique
Insert earphone VRA
Clinical Implications

• Previous studies in adults have sometimes shown limited benefit of amplification at high frequencies

• Could this be because the subject has a Dead Region at high frequencies?
Benefit of amplification when Dead Region

• Vickers DA et al  *J Acoust Soc Am* 2001; 110: 1164-75

• Baer T et al  *J Acoustic Soc Am* 2002; 112: 1133-44
Methods
(Vickers et al, 2001)

- 10 subjects with high frequency SNHL
- PTCs and TEN test confirmed dead region in 7 subjects
- Speech was amplified then presented in quiet before and after removing high frequencies
No dead region

Dead region above 700 Hz

Dead region above 750 Hz

Lowpass filter cutoff frequency, Hz

Percent correct
Summary of these studies

- Adults **without** high frequency DRs benefit from high frequency amplification

- Adults **with DRs** do not benefit from amplification that extends 50 to 100% above edge of DR
New & ongoing studies in hearing impaired teenagers

- Study Three: Comparing TEN and PTC
- Study Four: Measuring benefit
- Study Five: EAS
Five ‘take home’ messages

1. ‘Dead Regions’ are regions of non-functioning IHCs
2. Signals that fall within a ‘dead region’ may be detected by ‘off-frequency’ listening
3. DRs can be detected using TEN test or PTC
4. Amplifying DR is not beneficial in adults and, in some cases, may even impair intelligibility
5. Next step is to assess benefit in children with DR
Traveling wave