Estimating the sound intensity reaching the cochlea as a result of dental drilling

Andrew Teng

Background

- Potential risk from dental drilling
- NIHL and/or tinnitus
- **Bone conducted** sound energy
- **Air conducted** sound intensity of a dental drill
  - 65-80 dBA
  - 86-115 dB SPL

Objective

*"The aim of the study was to develop and test a method that provides a reliable **estimate** of the amount of sound energy reaching the cochlea **via bone conduction** in dental drilling."*

Methods

- Translational study
  - Phase 1 – Method development
  - Phase 2 – Proof-of-concept

Phase 1 – Method development

Ipsilateral ear

25 participants

20 dB HL (test ear)
250-4000 Hz

2 masking sounds:
white noise &
recorded dental drill sound

50 dB HL
mastoid

5 pure tone (inserts)
dB HL
increments

Protocol summary

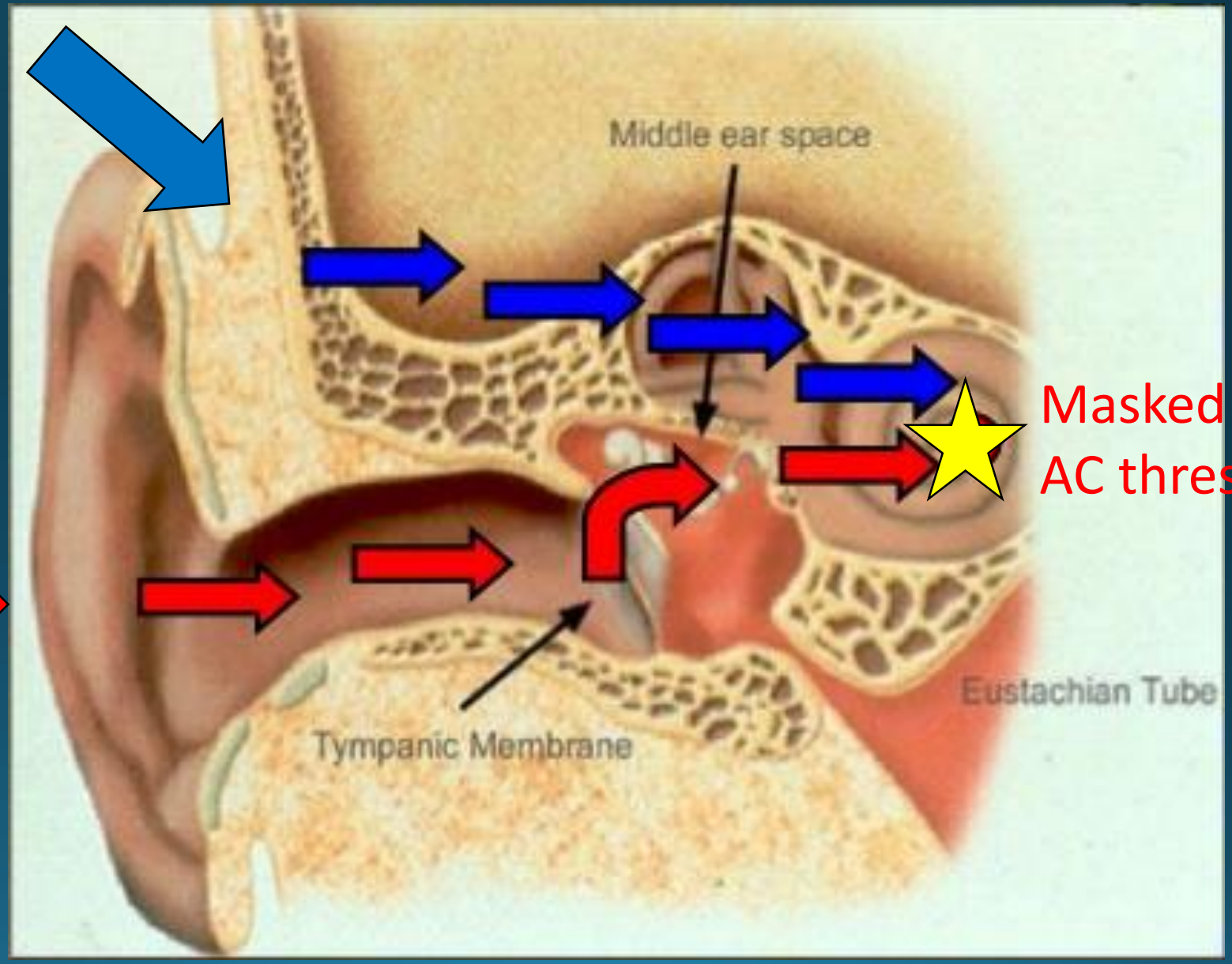
1. Find pure tone air conduction thresholds in both ears across the frequencies 250–4000 Hz.
2. Identify better hearing ear (test ear) based on the lowest hearing threshold averaged over the 4 frequencies 500, 1000, 2000 and 4000 Hz.
3. Find un-occluded and occluded bone conduction thresholds in the test ear at frequencies 250–1000 Hz.
4. Calculate the occlusion effect.
5. Present masking sounds via the bone vibrator to the mastoid (test ear). Simultaneously, find masked (pure tone) air conduction thresholds in the ipsilateral ear.
6. Add the occlusion effect[1] to obtain the masked thresholds at frequencies 250-1000 Hz.
7. The masked thresholds will provide an estimate of the intensity level of the masking sounds reaching the cochlea.

[1]Average occlusion effects from Dean and Martin (2000) were added to obtain the masked thresholds: 16 db at 250 Hz, 10 dB at 500 Hz, 8 dB at 750 Hz and 6 dB at 1000 Hz.

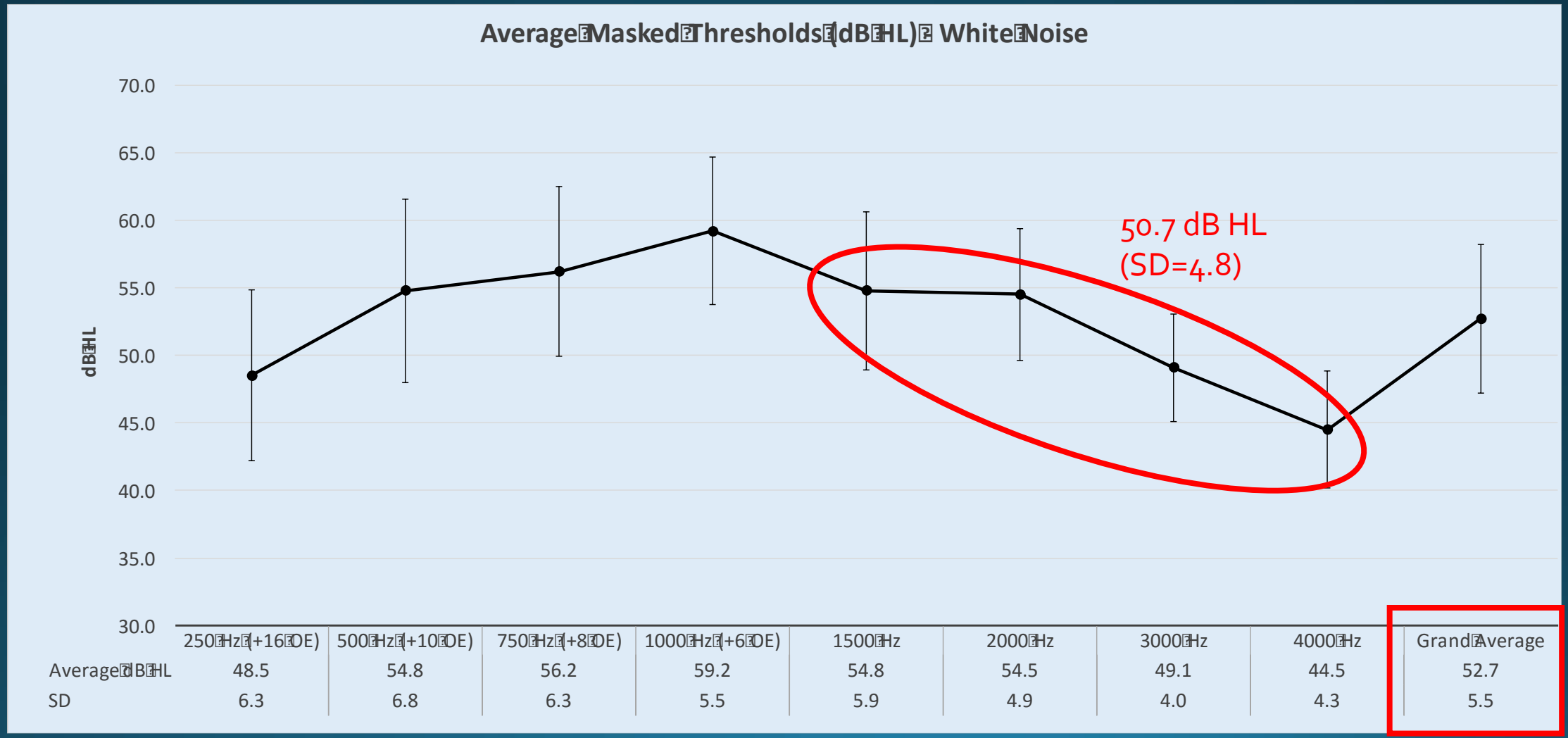
Masking sound via BC
@ 50 dB HL

Pure tone via inserts

(5 dB HL increments)

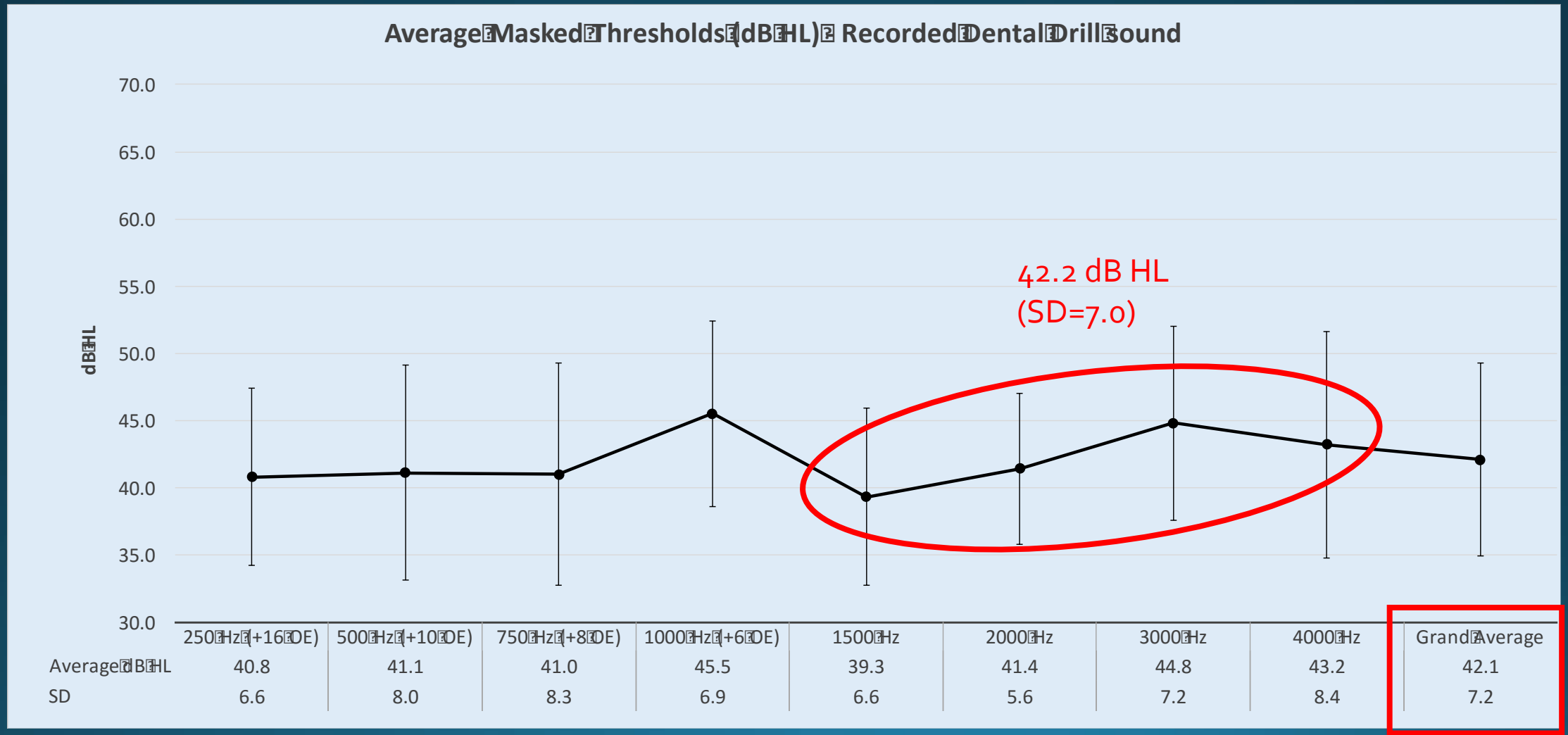


Results – Phase 1 (white noise @ 50 dB HL)



	250 Hz (+16 dB SPL)	500 Hz (+10 dB SPL)	750 Hz (+8 dB SPL)	1000 Hz (+6 dB SPL)	1500 Hz	2000 Hz	3000 Hz	4000 Hz	Grand Average
Average dB HL	48.5	54.8	56.2	59.2	54.8	54.5	49.1	44.5	52.7
SD	6.3	6.8	6.3	5.5	5.9	4.9	4.0	4.3	5.5

Results – Phase 1 (recorded dental drill sound @ 50 db HL)



	250 Hz (+16 DE)	500 Hz (+10 DE)	750 Hz (+8 DE)	1000 Hz (+6 DE)	1500 Hz	2000 Hz	3000 Hz	4000 Hz	Grand Average
Average dB HL	40.8	41.1	41.0	45.5	39.3	41.4	44.8	43.2	42.1
SD	6.6	8.0	8.3	6.9	6.6	5.6	7.2	8.4	7.2

Phase 2 – Proof-of-concept

4 participants

25 dB HL (test ear)
3000-8000 Hz

wisdom tooth surgery

lower jaw

test ear = surgical side of jaw

~~occlusion effect~~

Phase 2 – Proof-of-concept

Ipsilateral ear

4 participants

25 dB HL (test ear)
3000-8000 Hz

wisdom tooth surgery
lower jaw

test ear = surgical side of jaw

~~occlusion effect~~

60 dB HL starting level

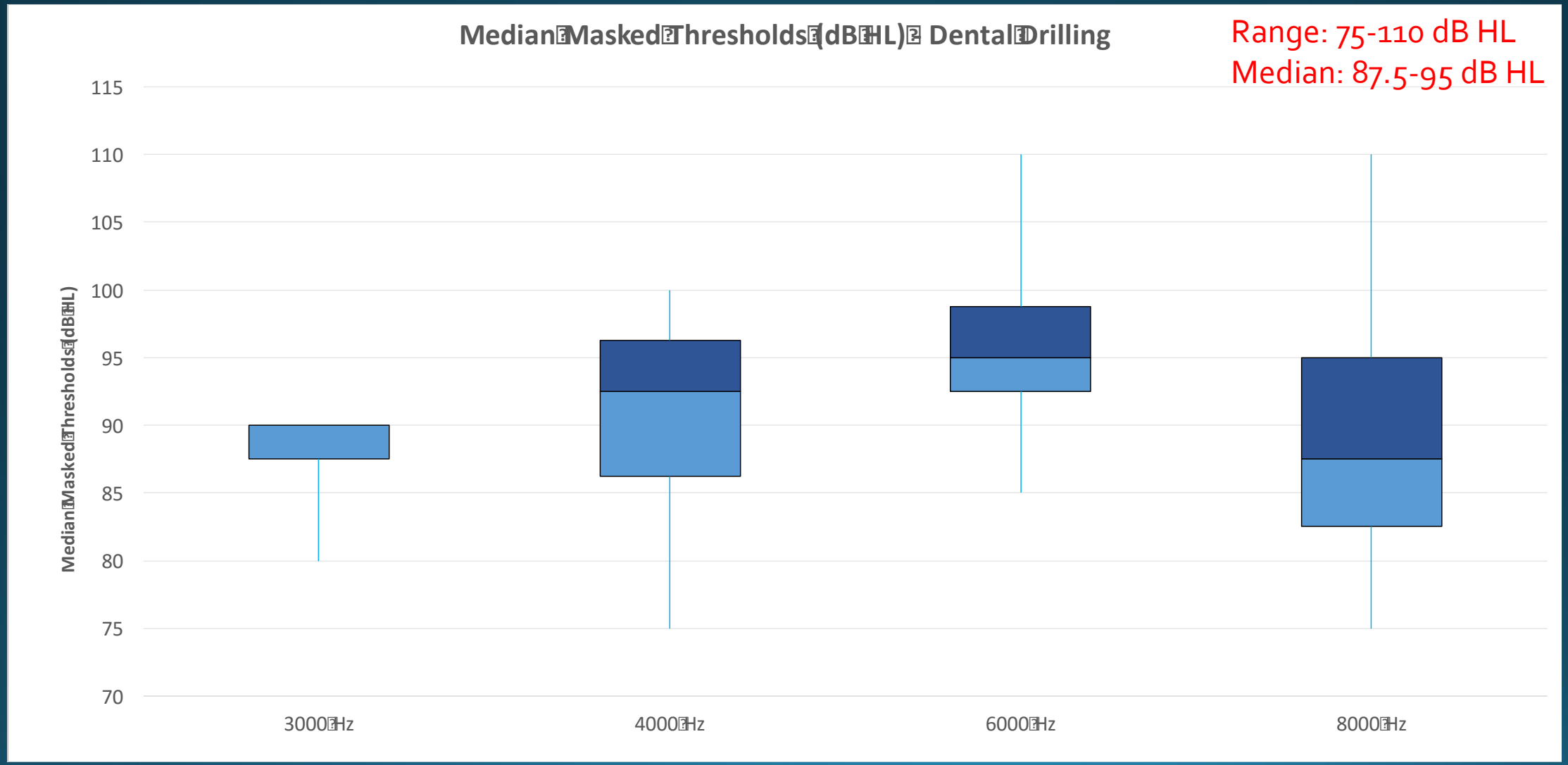
pure tone (inserts)

5 dB HL increments

NUH Dental Centre 3

KaVo INTRAmatic 10CN straight surgical handpiece

Results – Phase 2 (actual dental drill sound)



Conclusions

- Simple and reliable method
  - **Estimates** of masked thresholds
  - Bone conducted white noise
  - 250-4000 Hz
- Recorded dental drill sound
  - Lower masked thresholds
  - Less acoustic energy at <8000 Hz
  - Bone vibrator frequency response and accompanying limitations
- Actual dental drill sound
  - Above safe sound levels of 85 dBA
  - Risks of potential damage to the cochlea over prolonged duration of exposure

Challenges & Limitations

Phase 1

- Input level sensitivity between the CD player and the audiometer
  - MP3 vs WAV format
  - Resulted in lower masked thresholds for the recorded dental drill sound
- Frequency response range of bone vibrator
  - 250-4000 Hz
  - Dental drill frequency spectrum in the high frequencies
- Limited output of the audiometer below -10 dB
  - Occlusion effect calculations
  - Dean and Martin (2000)

Challenges & Limitations

Phase 2

- Patients were anxious & fearful during the surgery
  - Might not have paid attention or detected the 'just-audible level' of the pure tone until it was at a supra-threshold level
  - Resulted in elevated estimates of the drill sound intensity
- Pure tone at 3000-8000 Hz perceptually harder to detect in the background of high frequency drill sound
- Exogenous factors
  - Variations in tooth & jaw bone compositions of each patient, duration of drilling, amount of force & pressure applied on the surgical site

Acknowlegements

- Prof. William Martin
- Dr. Jennifer Martin
- Dr. Intekhab Islam and Dr. John Loh (Dentists)
- Dental nurses from Dental Centre 3
- Study participants and dental patients
- Colleagues

References

Barek, S., Adam, O., & Motsch, J. F. (1999). Large band spectral analysis and harmful risks of dental turbines. *Clinical Oral Investigations*, *3*(1), 49-54.

Cooke, R., & Brennan, P. A. (1991). Sudden deafness after dental surgery. *BMJ: British Medical Journal*, *303*(6812), 1270-1270.

Dean, M. S., & Martin, F. N. (2000). Insert earphone depth and the occlusion effect. *American Journal of Audiology*, *9*(2), 131-134.

Di Francesco, R. C., Sperandio, F. A., Sanchez, T. G., & Bottino, M. A. (1997). 158: Noise-induced Hearing Loss in Dentists. *Otolaryngology--Head and Neck Surgery*, *117*(2), P210-P211.

Dutta, A., Mala, K., & Acharya, S. R. (2013). Sound levels in conservative dentistry and endodontics clinic. *Journal of Conservative Dentistry: JCD*, *16*(2), 121.

Elmehdi, H. M. (2010). Assessing acoustic noise levels in dental clinics and its link to dental anxiety and fear among UAE population. *Compressed Air*, *87*(3), 14.

Farrell, R. W., Pemberton, M. N., Parker, A. J., & Buffin, J. T. (1991). Sudden deafness after dental surgery. *BMJ: British Medical Journal*, *303*(6809), 1034.

References

Kadanakuppe, S., Bhat, P. K., Jyothi, C., & Ramegowda, C. (2011). Assessment of noise levels of the equipments used in the dental teaching institution, Bangalore. *Indian Journal of Dental Research*, *22*(3), 424-431.

Kansu, L., & Yilmaz, I. (2013). Sudden hearing loss after dental treatment. *Journal of Oral and Maxillofacial Surgery*, *71*(8), 1318-1321.

Qsaibati, M. L., & Ibrahim, O. (2014). Noise levels of dental equipment used in dental college of Damascus University. *Dental Research Journal*, *11*(6), 624.

Singh, S., Gambhir, R. S., Singh, G., Sharma, S., & Kaur, A. (2012). Noise levels in a dental teaching institute-A matter of concern!. *Journal of Clinical and Experimental Dentistry*, *4*(3), e141-5.

Wilson, R. H., Witkowski, C. E., & Wilson, A. A. (2009). Bilateral idiopathic sensorineural hearing loss following dental surgery. *Journal of the American Academy of Audiology*, *20*(3), 180-186.

Yamada, T., Kuwano, S., Ebisu, S., & Hayashi, M. (2016). Statistical analysis for subjective and objective evaluations of dental drill sounds. *PLoS One*, *11*(7), e0159926.

thank you!

Questions?