Validation of eardrum replacement scaffolds made from electrospinning

Dresden, 13.09.2019, Philipp Kempert
Introduction

- Myringoplasty (replacement of the tympanic membrane)

- Autologous material with unknown properties -> much experience of the surgeon is necessary

- Aim:
  - Identified material parameters
  - Identified oscillation of the reconstructed eardrum
  - Easier replacement

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Lars Chittka; Axel Brockmann - Perception Space—The Final Frontier, A PLoS Biology Vol. 3, No. 4, e137
doi:10.1371/journal.pbio.0030137
Electrospinning samples

- Poly ethylene oxide terephthalate (PEOT), polybutylene terephthalate (PBT)
- Young’s Modulus = 3.6 MPa

- Electrospinning base material and additive manufacturing

- Thickness base material ≈ 13 μm
- Thickness of additive manufacturing ≈ 100 μm
Methods

- Comparison of test stand and FE simulation model (Ansys)

- Applied sound pressure = 90 dB SPL ≈ 1 Pa

- Applied quasi-static pressure = (1 to 4) kPa

- Measurement with a Laser-Doppler Vibrometer (LDV)

- Sample size diameter = 8 mm
Test stand and simulation model
Measured oscillation of the tympanic membrane
Influence of the simulated preload

- Preload at the edge of the sample
Oscillation of middle ear in the FE model

![Graph showing oscillation of middle ear in the FE model](image)

- FE model of the middle ear
- FE model of the middle ear with changed tympanic membrane
- Movement of the stapes
- Movement of the umbo

**Graph Details**
- **Y-axis**: Magnitude in $\text{pm} / \text{Pa}$
- **X-axis**: Frequency in Hz

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Conclusion

- Many influences on the oscillation behaviour
- Good validation of model for applied quasi static pressure with analytic solutions
- Further optimization of the geometrical shape of the samples are necessary
Thank you very much for your attention.

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