PhD Open Days

Endolymph and Perilymph Sampling in Sheep: Cadaveric Pre-Mapping and *In Vivo* Surgery

PhD in Bioengineering and Biosciences

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1 Why a living sheep?

Endolymph, the K^+-rich fluid of the membranous labyrinth, drives hair-cell transduction; Na^+-rich perilymph surrounds it. This gradient collapses within hours of death,[1] so sampling needs a living animal.

Endolymph viscosity may also have shaped the semicircular canals as mammals became endothermic.[2] Testing this needs real *in vivo* data.

The sheep has a human-sized temporal bone, yet no technique to see its membranous labyrinth existed.

Endolymph
$K^+ \approx 120$ mEq/L
Inside the membranous labyrinth

Perilymph
$Na^+ \approx 143$ mEq/L
Inside the osseous labyrinth

AIM Develop a surgical corridor that exposes the membranous labyrinth of the living sheep, as the basis for reproducible endolymph and perilymph sampling.

2 Two-phase design

PHASE 1
Cadaveric pre-mapping
9 fresh heads · 18 ears
Micro-CT, ~13 µm voxel
Entry routes compared after canal wall down mastoidectomy[3]

PHASE 2
***In vivo*, terminal**
3 adult Merino ewes · 6 ears
Deep general anaesthesia, never recovered
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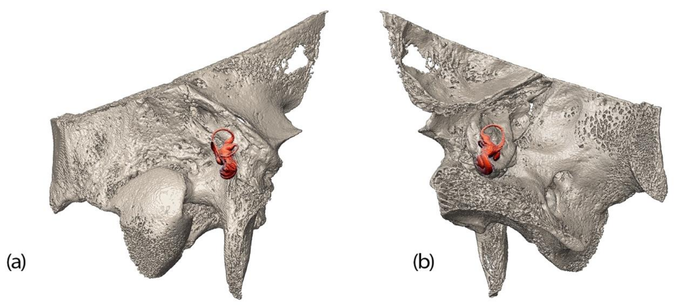
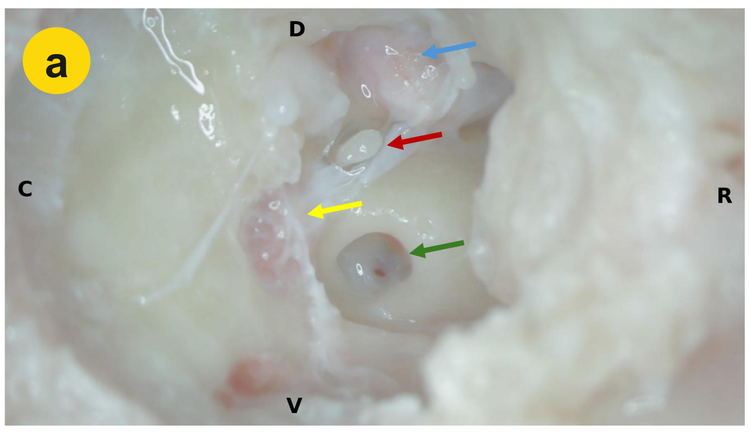
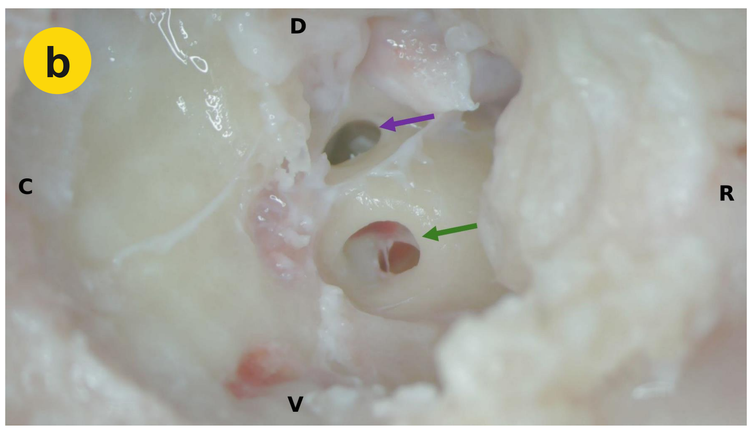


Fig. 1 Micro-CT model of a right ovine petrosal bone, osseous labyrinth in red: (a) lateral, (b) medial view. Used to map labyrinth depth and orientation before surgery.

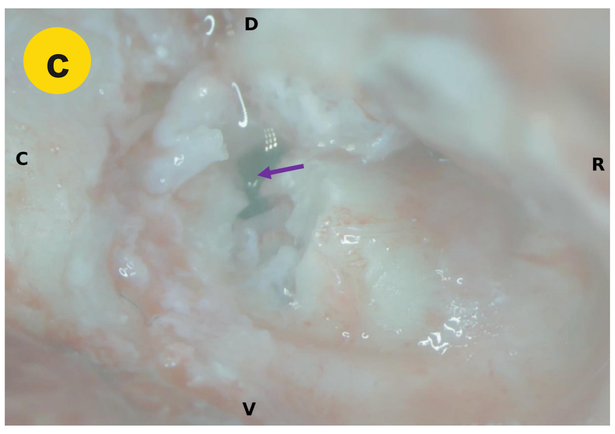
3 The surgical corridor, step by step (*in vivo*)



Perilymph first. Mastoidectomy; facial nerve sectioned (blue, yellow), malleus and incus removed, stapes kept (red). 1–2 µL aspirated through the round window (green).



Join the windows. Stapes removed; a malleus punch opens bone from the round window (green) across the promontory to the oval window (purple), exposing the vestibule.



Endolymph. Under fluorocarbon, ≤0.5 µL aspirated from the presumed utricle (purple; schematic of the eyepiece view).

4 What we found

18	6	6/6	2/6
cadaveric ears	ears *in vivo* (3 sheep)	perilymph obtained	endolymph obtained

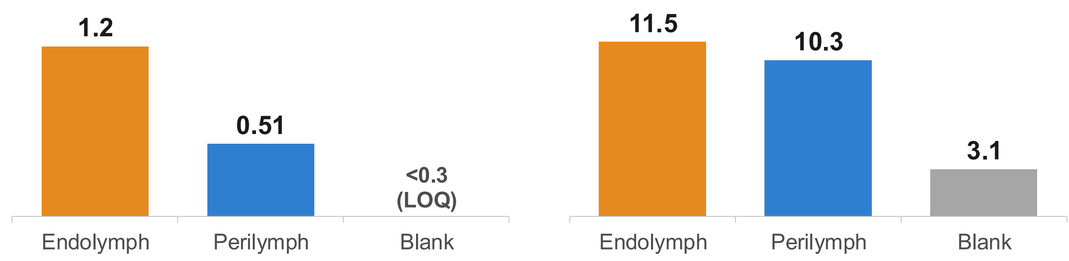
Entry routes to the labyrinth (cadaveric phase)

✗ Lateral semicircular canal	✗ Cochlear scala
✗ Either window alone	✓ **Round + oval window joined**

The membranous labyrinth was **never identified in cadavers**. *In vivo* it became visible only once the high-speed drill was replaced by a **malleus punch** (last two ears). Mean procedure time 180 min (2–6 h).

5 Preliminary ionic analysis

ICP-OES · one endolymph–perilymph pair · µg per tube



K^+ was **2.4× higher in endolymph** (≥4.7× in concentration), the expected pattern. But Na^+ was similar in both tubes and far above physiological endolymph, suggesting contamination.

Take-home

To our knowledge, the first surgical corridor that makes the membranous labyrinth visible in the living sheep.

Cadavers are not enough: the membranous labyrinth appeared only *in vivo*, and only with a punch, not a drill.

Next: dyed fluorocarbon, microelectrodes and viscosity in larger series, to test models of mammalian endothermy.

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