NASOPHARYNGEAL PRESSURE DURING MIDDLE EAR EQUALIZATION: A DEVICE TO SUPPORT INVESTIGATION OF AURAL BAROTRAUMA

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Introduction

- DAN Medical Department:
  - The most common call on the medical information line is about ear problems especially aural barotrauma (AB)
  - The most common injuries in diving relates to the ears
- AB occurs during diving when the Eustachian tube (ET) fails to equilibrate the middle ear and environmental pressures.
- ET function is traditionally measured by tympanography, but previous work by Denoble at DAN/Duke indicated little correlation with AB (1).

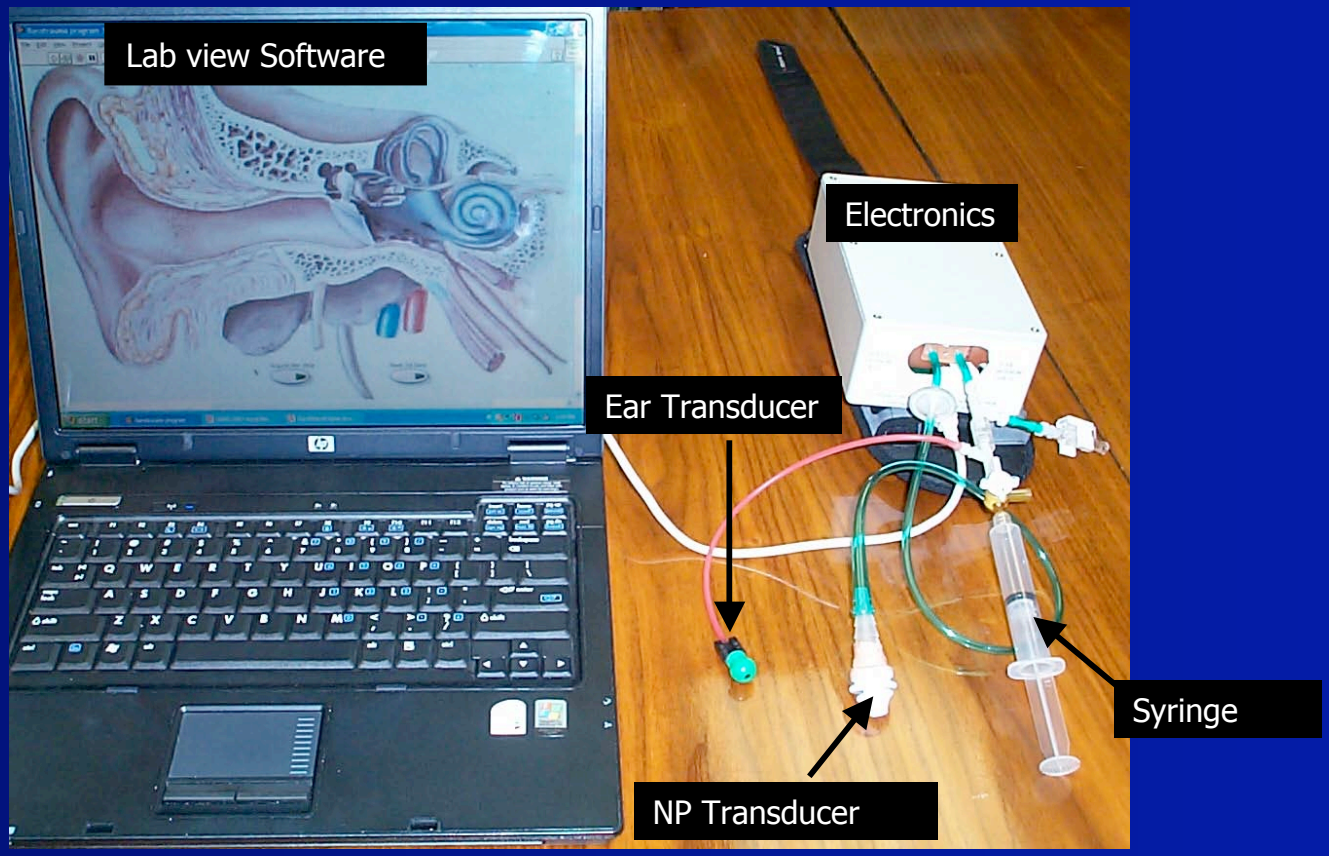
1. Denoble PJ et al. UHM 2006; 33:36

Hypothesis

- We hypothesize that the probability of aural barotrauma is associated with the nasopharyngeal pressure during middle ear equalization.
- … but we could find no instrument to make these measurements.

Instrument

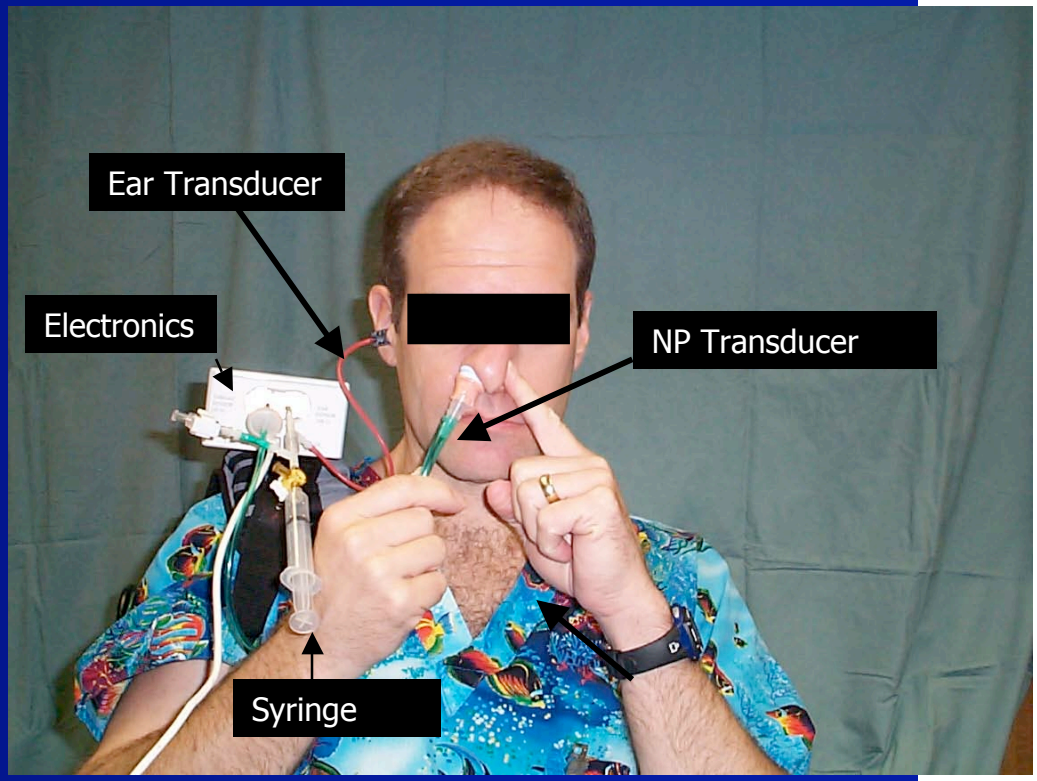
We developed an instrument to measure nasopharyngeal pressure during middle ear equilibration at sea level



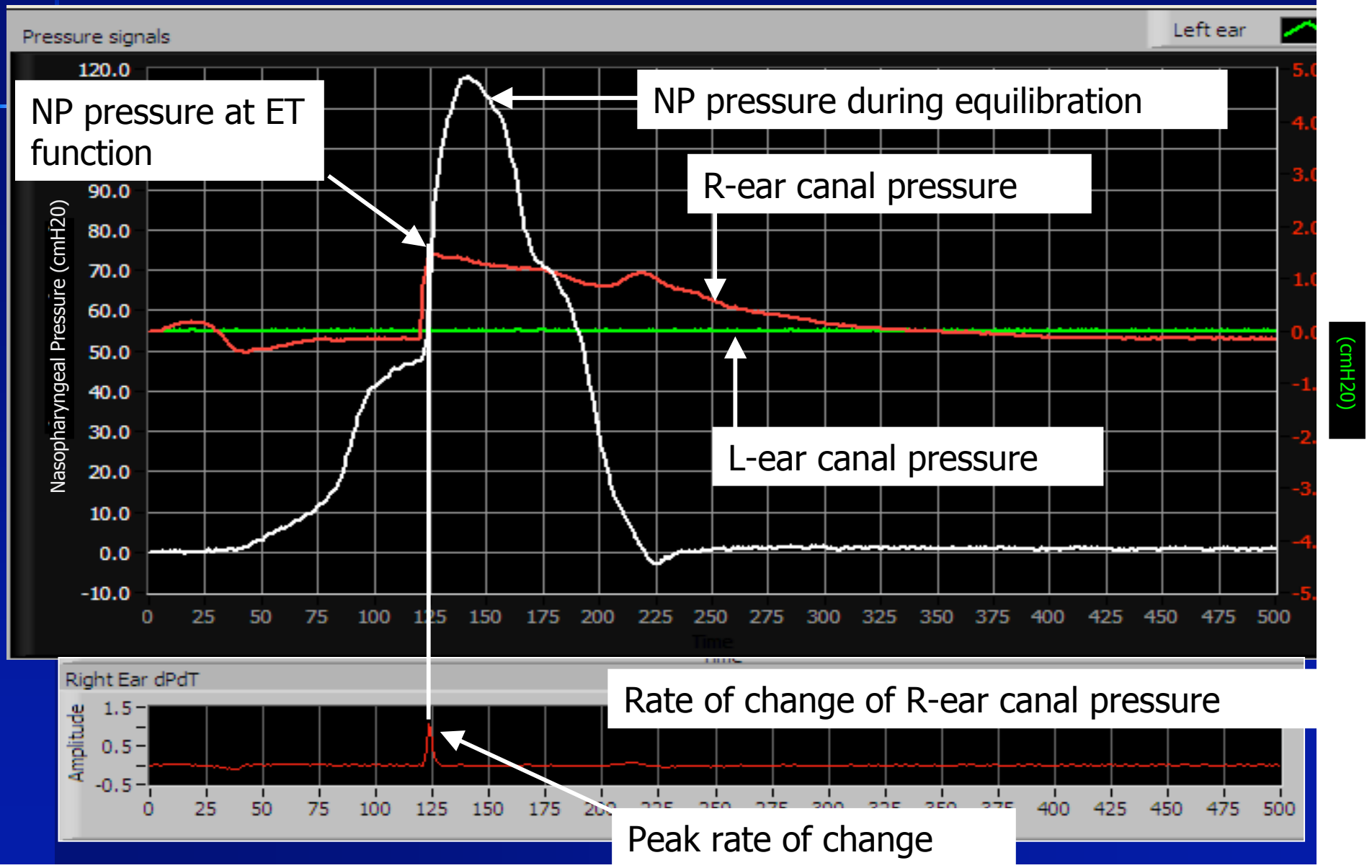
Methods

Pressure transducers were connected via tubing to an ear canal and nostril with the other nostril manually blocked.

While the subject performed an equilibration maneuver during a 5-sec interval, the instrument detected NP pressure at the time of middle ear equalization as defined by the peak rate of change of the ear canal pressure.



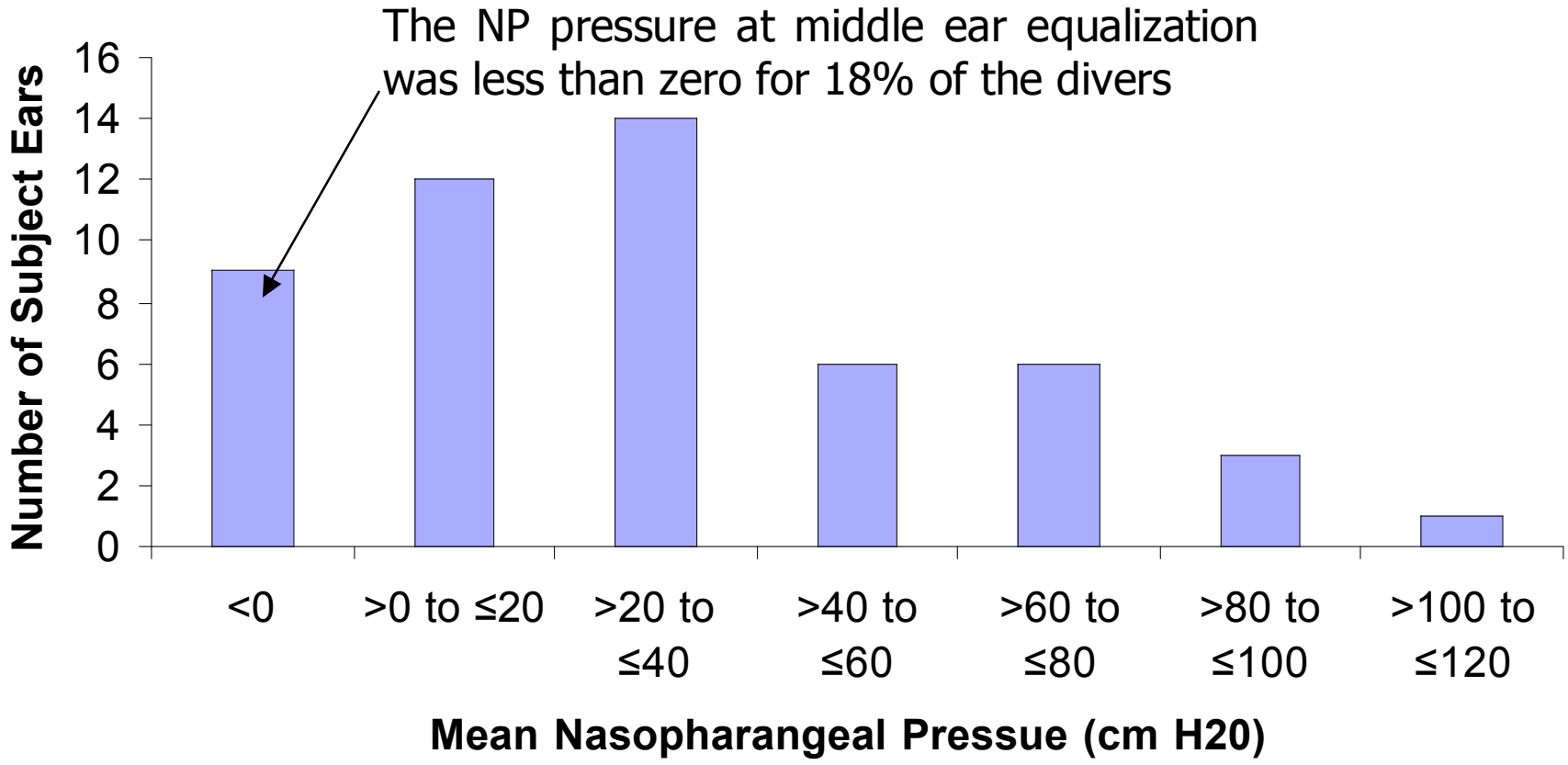
NP and external ear pressures during equilibration



Results

- 168 individual observations of NP pressure
  - 20 subjects (16 measured once, 4 measured 3 times over 3 days)
  - 3 per subject ear (L/R)
- 142 measurements (85%) were considered acceptable.
  - Measurements were rejected if peak rate of change of ear canal pressure was not obvious.
- NP pressures at equilibration ranged from -26.0 to 111.1 cm H_2O.
- No significant differences noted
  - between right and left ears
  - among the 3 sequential measures for each ear
  - among measurements made on separate days
- Intraclass Correlation (ICC) was 0.74 indicating that three-fourths of the variance was due to differences in NP pressure among subjects

Distribution of NP Pressures



Discussion

- Immediate objectives for the device and testing are to:
  - Update the pressure transducers to measure negative NP pressures more accurately.
  - Measure NP pressures that are characteristic of the principal techniques of middle ear equilibration.
  - Utilize an instrument (Ear Popper™) to assess Eustachian tube function independent of method of equilibration.

Conclusion

- Middle ear equilibration occurred over a wide range of NP pressures in 20 subjects
- The capability of measuring ET function offers a tool for investigating the nature of aural barotrauma.
  - The instrument will be used during open-water diving expeditions to investigate the association of AB with NP equilibration pressure