



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

Uguccioni DM1, Natoli MJ2, Comfort BJ2, Justus MA3, Freiburger JJ2, Vann RD1,2

1Divers Alert Network, 2Center for Hyperbaric Medicine and Environmental Physiology, 3Department of Otolaryngology – Head and Neck Surgery Duke University Medical Center, Durham, NC



INTRODUCTION

- ❖ The most common question to DAN Medics concerns aural barotrauma (AB), which occurs during diving when the Eustachian tube (ET) fails to equalize the middle ear and environmental pressures.
- ❖ ET function is traditionally measured by tympanography, but previous work indicated little correlation with AB (1).
- ❖ We hypothesize that the probability of AB is associated with the nasopharyngeal (NP) pressure during middle ear equilibration, which is characteristic for a given diver.
- ❖ We developed an instrument to measure NP pressure at sea level because we could not find one.
- ❖ We report the results of preliminary measurements of NP pressure during ET function in 20 subjects.

METHODS

- ❖ Figure 1 is a photograph of the instrument.
 - Pressure transducers were connected via tubing to an ear canal and nostril with the other nostril manually blocked.
 - Transducer signals were processed and recorded on a laptop computer using LabView® software.
 - A subject performed an equilibration maneuver during 5-sec. interval.
- ❖ Figure 2 shows NP and external ear pressures during equilibration.
 - NP pressure at middle ear equilibration was defined by the peak rate of change of the external ear canal pressure.
- ❖ To assess the reproducibility of the instrument, we measured NP pressure 3 times in both ears of each subject and reported the mean of the 3 measurements.
- ❖ To investigate the constancy of NP pressures in a given subject over time, we made NP measurements on 3 separate days for 4 of the 20 subjects.

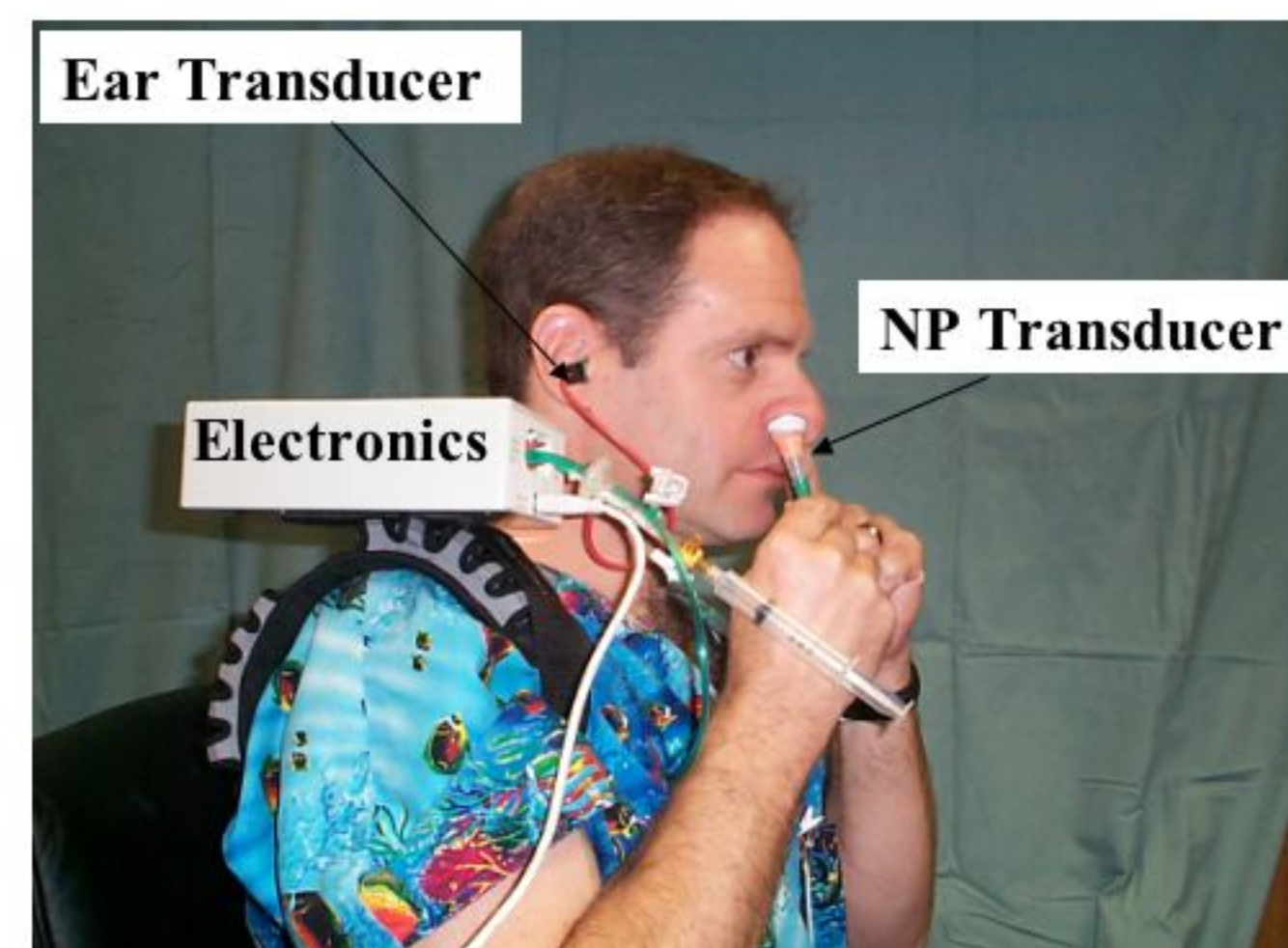


Figure 1. Instrument for measuring ET function

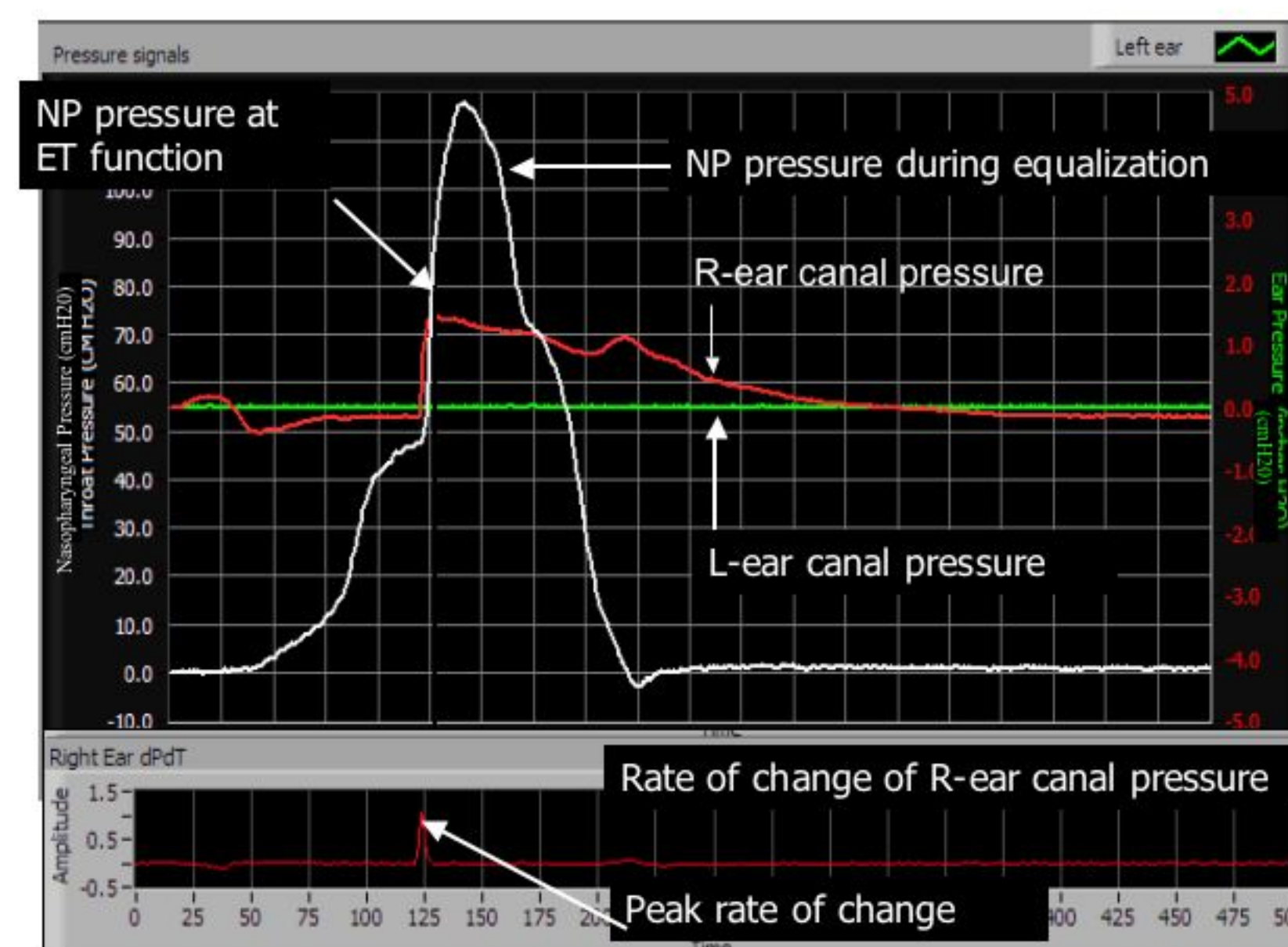


Figure 2. Pressure traces

RESULTS

- ❖ 168 measurements of NP pressure
 - 20 subjects (16 measured once, 4 measured 3 times over 3 days)
 - 3 measurements per subject ear (L/R)
 - 142 measurements (85%) were considered acceptable.
 - Measurements were rejected if the peak rate of change of ear canal pressure was not detected.
- ❖ NP pressures at equilibration ranged from -26.0 to 111.1 cm H₂O (Fig. 3).
 - 18% of subjects had negative NP pressures.
- ❖ There were no significant variations:
 - between right and left ears
 - among the 3 sequential measures for each ear
 - among measurements on 3 separate days
- ❖ The Intraclass Correlation (ICC) was 0.74 indicating that three-fourths of the variance was due to differences in NP pressure among subjects.

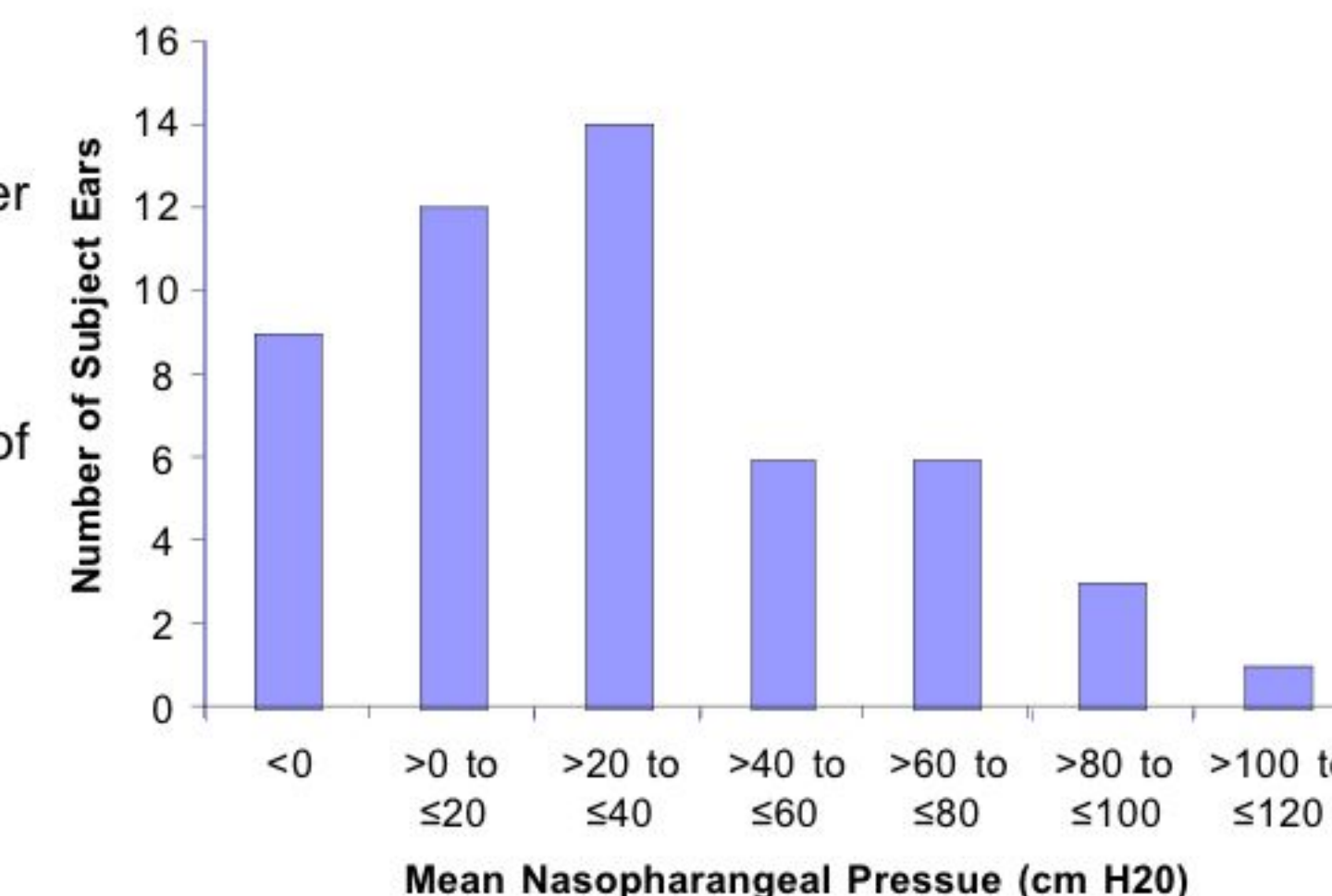


Figure 3. Distribution of nasopharyngeal pressure at Eustachian tube function in 20 subjects

DISCUSSION

- ❖ Immediate objectives are to:
 - Update the pressure transducers to measure negative NP pressures more accurately.
 - Measure NP pressures that are characteristic of the techniques for middle ear equalization.
 - Utilize an instrument (Ear Popper™) to inflate the nasopharynx independently of equilibration method.
- ❖ Subsequently, use the instrument with divers to investigate the association of aural barotrauma with NP equilibration pressure.
 - Factors related to diver health, medical history, repetitive diving, and rate of descent will be controlled statistically.

CONCLUSIONS

- ❖ 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.

REFERENCES

Denoble PJ et al. UHM 2006; 33:364.