LOW FREQUENCY NOISE AND INTRA-CELLULAR EDEMA

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Introduction One of the most frequent findings observed in low frequency noise- (LFN) (<500 Hz, including infrasound) exposed rodents is cellular edema [1]. However, until recently, no uniform pattern could be discerned as to what duration of LFN exposure caused this effect, nor if all tissues were affected. Since all studies focused on LFN exposure time, and not much attention was paid to how long the animal was out of the LFN environment before sacrifice, no regular pattern was ever identified. The goal of this study is to observe the if there is intra-cellular edema in more than one tissue type and how it relates to LFN exposure.

Methods *Animals* Ten Wistar rats were exposed to continuous LFN for a total of 2160 hours. Five animals were sacrified immedately after exposure, and the remaining 5 after spending 1 week in post-exposure silence. Five control rats were kept in equal living conditions, but in continuous silence. All animals were fed standard rat food, had unrestrained access to water, and were treated in accordance with applicable legislation (86/609/CE). Rat weight, a routine procedure in any animal study, was recorded. *Noise Exposure.* An analog noise generator produced the amplified and frequency filtered acoustic signal. Acoustic energy was highly concentrated in the lower frequency bands, 50 Hz to 500 Hz, where levels exceeded $90dB_{Lin}$. The overall linear sound pressure level was above $109dB_{Lin}$, and the A-weighted level was around 98dBA. *Microscopy.* Animals were sacrificed by a lethal intravenous injection of sodium-pentobarbital. Tracheal and kidney cortex fragments were removed. Specimens prepared for scanning electron microscopy (SEM) (JEOL JSM-35C) were dehydrated, critical point-dried, coated with gold-palladium and examined with the electron microscope at an accelerating voltage of 15 kV.

Results Immediately after LFN exposure, edema is present in all examined micrographs. Figs. 1 & 2 compare control and exposed rat trachea;

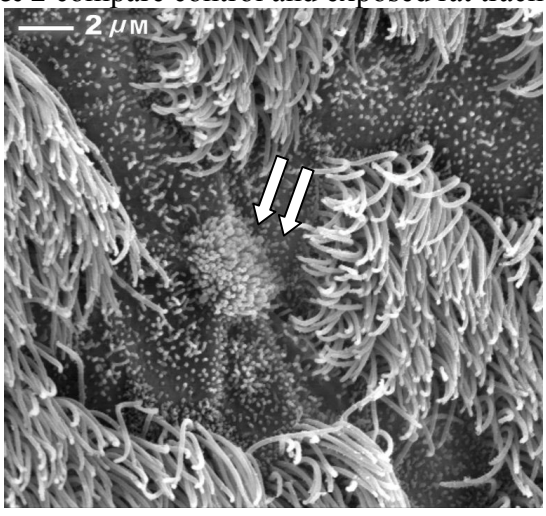

Fig. 1. Control rat – Trachea. Brush cell (arrow) surrrounded by flat secretory cells.

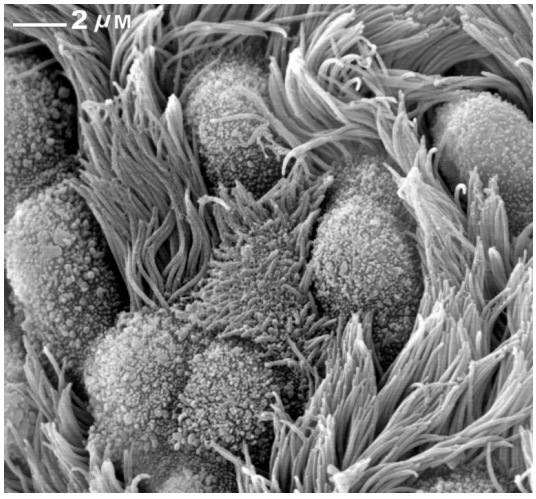

Fig. 2. Exposed rat – Trachea. Brush cell (arrow) surrounded by swollen secretory cells.

Figs. 3 & 4 compare control and exposed rat kidney. There is a visible swelling of the cells and structures in both organs, which disappears if they are kept in silence for 1 week before sacrifice. The average weight of the controls rats 299.4g, for those sacrificed immediately after exposure, 290.4g, and for those with an additional 1 week in silence, it was 204.0g.

Discussion During intra-cellular edema, excessive water is retained within the cells which causes them to swell. If the animals are kept in silence for 1 week after exposure, cell edema disappears. This is associated with marked loss of weight. However, as can be seen in Fig. 3C, sequelae of edema is still visible in the wrinkled appearance of the epithelial cell extensions, which are even overlapping each other. The clinical implications of these results are still under study as to how they relate to the signs and symptoms observed in vibroacosutic disease (VAD) patients [2]. But one of the more immediate inferences can be made regarding deep-venous thrombosis (DVT) syndrome. Airline passenger cabins are acoustic environments that contain a very significant component of LFN which is known to lead to hypercoagulability [3]. Considering that cell edema is a systemic, immediate and sustained response to LFN exposure, then temporary hemo-concentration is a possible consequence. Thus, indivuduals who have a pre-disposition for thrombotic events could incur in a greater risk of developing such an event when exposed to LFN.

Keywords: vibroacoustic disease, noise exposure, kidney, glomeruli, trachea, Wistar rats, deep venous thrombosis syndrome

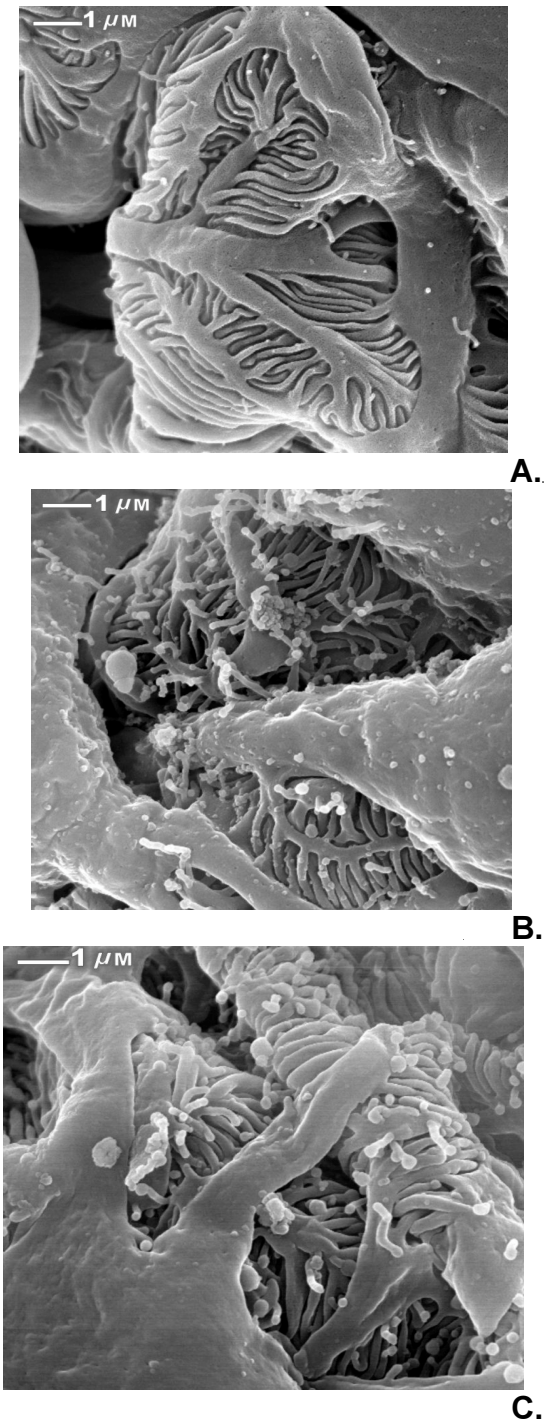

Fig. 3.**A.** Control rat – kidney. Neatly organized epithelial cell extensions and podocytes. **B.** Exposed rat - Sacrificed right after exposure: swollen, less organized, more microvilli; **C.** Exposed rat - Sacrificed after 1 wk of silence: deflated, less organized with overlapping of epithelial cell extensions.

References

[1] Castelo Branco NAA, Alves-Pereira M. et al. SEM and TEM study of rat respiratory epithelia exposed to low frequency noise. In: *Science and Technology Education in Microscopy: An Overview*, A. Mendez-Vilas (Ed.), Formatex: Badajoz, Spain, 2002, Vol. II: 505-33.

[2] Castelo Branco NAA. The clinical stages of vibroacoustic disease. *Aviat Space Environ Med* 1999; 70(3, Suppl): A32-9. [3] Alves-Pereira M, Castelo Branco MSNA, et al. Airflow-induced infrasound in commercial aircraft. *Internoise 2001*, Holland, August 2001: 1011-14.