AUDIO- & ECHOCARDIOGRAMS IN VIBROACOUSTIC DISEASE

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Introduction Vibroacoustic disease (VAD) is a whole-body pathology caused by long term exposure to low frequency noise (LFN) (≤500 Hz, including infrasound) [1]. Pericardial thickening in the absence of an inflammatory process, and with no diastolic dysfunction, is the hallmark of VAD [2]. However, since noise exposure is considered to only have consequences at the level of the auditory system, audiograms are usually the only clinical evalution that is conducted among noise-exposed workers. While this may be adequate when the acoustic energy is concentrated in the higher (> 1000 Hz), more audible frequencies, it may be a useless exercise when the subjects are exposed to acoustic environments where the lower frequencies (≤500 Hz, including infrasound) are more prevalent. The goal of this study is to compare the value of the information provided by audiograms with that provided by echocardiograms among LFN-exposed workers. In particular, the auditory losses at the 4000 Hz notch (the value at which professional hearing loss is estabished) are compared with the presence of thickened cardiac structures.

Methods
Population. The study group consisted of 134 male Caucasians, ave. age 42±7 years, employed as aircraft technicians for ≥ 10 years, exhibiting at least one sign of severe VAD. Exclusion critera: streptococcal infections (by history), diabetes milletus, pre-existing cardiovascular disease, tobacco abuse (>20 cig/day), alcohol abuse (>1 liter wine/day, 10-12% alcohol content), drug abuse (recreational or psychotropic). The control group was composed of 30, age-matched male Caucasians, not excessively exposed to LFN (in occupation, daily transportation, childhood environment, previous jobs, residential, leisurely), and subjected to the same exclusion criteria.
Evaluation. Tonal simple audiograms within a controlled acoustic environment were given to all subjects. Echocardiograms (HP 1500 SONOS) were performed on all subjects, with 2-D, M mode, color Doppler and spectral Doppler analysis. All echocardiograms were recorded on VHS video tape, and the following parameters were evaluated: thickening of 1) mitral valve, 2) tricuspid valve, 3) aortic valve, 4) endocardium, 5) pericardium, 6) aortic wall, and 8) E/A ratio. A three-grade score system from 0 (no thickening) to 2 points (maximal thickening) was used for thickening evaluation. Statistical analysis was performed using SPSS package.

Results. Within the control population, at the 4000 Hz notch, 4 had minor hearing losses, of which 3 exhibited discrete pericardial thickening. In the exposed group, 43% (N=58) had a trivial auditory deficit (<15 dB) while 5 individuals (3%) exhibited significant losses at the 4000 Hz notch (>50 dB). The remaining population exhibited significant losses (>15 dB) but not at the 4000 Hz notch. In the exposed population, the summation of the auditory deficit at all frequencies was independent of age (F=3.46) but dependent on exposure time, in years (F=4.47). Echocardiography revealed thickening of some cardiac structure in 100% of the

study population: thickening of the pericardium (N=130, 97%; 48 cases with score 2), mitral valve (N=96, 71%), and aortic wall (N=94, 70%). Diastolic dysfunction was identified in 41 patients (31%), 9% with A>E and 21% with A=E, and all were over the age of 50.

Discussion. Auditory losses at the 4000 Hz notch and LFN-induced pathology are not correlated. Although the 5 workers who exhibited significant hearing losses at the 4000 Hz notch had thickened pericardia, in all individuals who had >15 dB losses, none of these occurred significantly at the 4000 Hz notch. The fact that diastolic dysfunction was only observed in the older 41 patients, and that younger patients with more exposure time and higher scores of cardiac thickening did not exhibit this dysfunction, strongly supports the notion that, in this pathology, pericardial thickening is not related to the diastolic function. Moreover, the anatomical changes observed in these patients' pericardial fragments have already explained the lack of diastolic dysfunction despite pericardial thickening [3]. The results herein show that the audiogram is not an adequate tool to assess the effects of LFN-induced pathology, nor the progression of VAD. This is especially the case if only the 4000 Hz notch is considered. Losses at the 250 Hz and 500 Hz are significant in VAD patients, but are irrelevant for the establishment of the only legally-recognized pathology associated with noise exposure – hearing loss. Thus, despite current status quo concepts whereby acoustic phenomena only impinges on the human body via the auditory system [4], the reality is that hearing loss at the 4000 Hz notch is unrelated to the development of LFN-induced pathology. Futhermore, the complaints associated with losses within the lower frequency bands of the audiogram are quite distinct from those that arise from losses in the higher, more audible ranges. The foremost auditory complaint among LFN-exposed workers and VAD patients is "I hear too much", or "I can't stand noise, not even televison". The consequent behavior of these individuals is to isolate themselves, initially from social gatherings, and later, even from their families. This is not the behavior of the individual who has hearing losses at the 4000 Hz notch. An organic explanation for this response has been postulated to be related to the fusion of cochlear stereocilia, as seen in LFN-exposed rodents [5]. Echocardiography is herein shown to be a better tool for assessing the extent of LFN-induced pathology. However, the technician subjectivity that is introduced during echo-evaluation can produce conflicting results [6,7] and thus dooms echocardiography as *the* diagnostic method of choice for VAD. Ongoing research continues to search for an adequate diagnostic tool for VAD, and recent results indicate that respiratory functional tests may be the key. In conclusion, while audiograms are useful for assessing and preventing hearing loss among noise-exposed workers, the echocardiogram is a much more valuable tool for assessing LFN-induced pathology. Audiograms are only useful for gaining insight into possible LFN-induced pathology if losses at the 250 Hz and 500 Hz are taken into consideration.

Keywords: low frequency noise, pericardium, mitral valve, aortic valve, occupational exposure, hearing loss, occupational, pathology,

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