Journal of Otology 13 (2018) 135–137

Contents lists available at ScienceDirect

Journal of Otology

journal homepage: www.elsevier.com/locate/joto

A survey on hearing acuity of centenarians in Hainan Province

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ARTICLE INFO

Keywords:
Centenarians
Hearing acuity
Hearing loss

ABSTRACT

Objective: This study aimed to investigate hearing acuity of centenarians in Hainan Province and provide basis for interventional considerations.
Method: Door-to-door follow-up was conducted to investigate hearing acuity of centenarians (aged 100 years or above) in Hainan Province. Physical examination, pure tone audiometry and acoustic impedance test were performed, and the results were analyzed.
Result: A total of 460 centenarians (920 ears) were tested by pure tone audiometry. The rate of normal hearing was 0.2%, the rate of mild hearing loss was 1.5%, 12% for moderate hearing loss, 33.9% for moderate to severe hearing loss, 37.4% for severe hearing loss is and 15% for profound hearing loss. Acoustic impedance test was performed in 340 centenarians (668 ears). Tympanogram was type A in 41.2% of the ears, type As in 34.1% ears, type Ad in 6.4%, type B in 11.8%, and type C in 4.9% of the ears, while no response was elicited in 1.5% of the ears.
Conclusion: Age related sensorineural hearing loss is prevalent among centenarians in Hainan Province. A probably beneficial intervention may be the use of hearing aids for effective communication.

1. Introduction

The proportion of elderly people is rising year by year due to advances of medicine and longer life expectancy, which now reaches 11% (130 million) in China, and there is increasing incidence of age-related hearing loss (Yu et al., 2008). It is estimated that 80% of the people aged above 75 years suffer from age-related hearing loss. The number of patients with age-related hearing loss has exceeded 300 million globally, and by 2050, the number will be above 900 million. According to the Second National Sample Survey on Disability, there are over 13 million patients with age-related hearing loss in China (Yu et al., 2008). Hearing impairment not only affects social activity, but also brings heavy burden to mental health. Elderly people with impaired hearing may fall victims of depression and loneliness, anxiety, irritability and low quality of life. It is the responsibility of the whole society to ensure that the hearing needs in the elderly people is adequately addressed. In order to develop proper interventional measures and improve quality of life in elderly people, we conducted a preliminary investigation on hearing of centenarians in Hainan Province.

2. Materials and methods

2.1. Subjects

Hearing acuity of 518 centenarians (aged 100 years or above) in Hainan Province was surveyed from June 2014 to November 2015. Among them, there were 89 men (100–110 years, mean = 101.09 years), and 429 women (100–115 years, mean = 102.94 years) (male-to-female ratio = 1:4.82). Bilateral tympanic membrane perforation was seen in 1 subject, left tympanic membrane perforation in 3 subjects and right tympanic membrane perforation in 1 subject, respectively. One centenarian suffered from right ankylotia. Three centenarians (0.58%) wore hearing aids.

Peer review under responsibility of PLA General Hospital Department of Otolaryngology Head and Neck Surgery.
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https://doi.org/10.1016/j.joto.2018.11.008
Received 14 September 2018; Received in revised form 20 November 2018; Accepted 21 November 2018

2.2. Equipment

For pure tone audiometry, Madsen OB 822 Clinical Audiometer and supra-aural earphones were used. For acoustic impedance test, Madsen ZO 714 acoustic impedance analyzer was employed. All tests were undertaken by the Research Institute of Medical Acoustic Measurement, PLA General Hospital.

2.3. Test environment

The tests were conducted in a quiet room with background noise ≤45 dB A.

2.4. Test methods

Firstly, all centenarians received physical examination to ascertain no obstruction in the external auditory meatus and intact tympanic membrane with normal landmarks. Air and bone conduction pure tone thresholds were tested at 0.25, 0.5, 1, 2, 4 and 8 kHz. Acoustic immittance test was performed with a probe tone of 226 Hz.

2.5. Quality control

The staff was trained and familiar with hearing screening techniques and procedures.

2.6. Data input and statistical analysis

Data input and analysis were carried out by trained staff with a database built using the Excel software. The SPSS 13.0 software was employed for statistical analysis. Student t-test or X^2 test was employed when appropriate. $P < 0.05$ was used to indicate statistical significance.

3. Results

3.1. Results of pure tone audiometry

Pure tone audiometry could not be completed in 58 centenarians due to inability to cooperate. Pure tone results from the rest 460 centenarians (920 ears) indicated normal hearing in 2 ears, sensorineural hearing loss in 734 ears, mixed hearing loss in 184 ears, and no conductive hearing loss. The air conduction audiogram curve was flat in 593 ears, showing descending patterns in 291 ears and irregular in 36 ears (Table 1). One centenarian (0.2%) had normal hearing, 7 centenarians (1.5%) had mild hearing loss, 55 (12%) had moderate hearing loss, 156 (33.9%) had moderate to severe hearing loss, 172 (37.4%) had severe hearing loss and 69 (15%) had profound hearing loss (Table 2).

3.2. Tympanograms

Tympanograms were obtained from 340 of the 518 centenarians and showed type A curves in 275 ears (41.17%), type As curves in 228 ears (34.13%), type Ad curves in 43 ears (6.44%), type B curves in 79 ears (11.83%), type C curves in 33 ears (4.94%), and no response in 10 ears (1.5%).

Table 1
Summary of pure tone audiometry results (ears).

Hearing Test Results	Audiogram Pattern			Total
	Flat	Descending	Irregular	
Normal	2	0	0	2 (0.2%)
Sensorineural Loss	507	206	23	734 (79.8%)
Mixed Loss	86	85	13	184 (20.2%)
Conductive Loss	0	0	0	0
Total	593 (64.5%)	291 (31.6%)	36 (3.9%)	920

Table 2
Hearing status in 460 centenarians by gender.

Hearing Status	Men	Women	Total
Normal	1 (1.2%)	0	1 (0.2%)
Mild Loss	1 (1.2%)	6	7 (1.5%)
Moderate Loss	11 (13.1%)	44 (11.7%)	55(12%)
Moderate-Severe Loss	23 (27.4%)	133 (35.4%)	156 (33.9%)
Severe Loss	37 (44.0%)	135 (35.9%)	172 (37.4%)
Profound Loss	11 (13.1%)	58 (15.4%)	69 (15%)
Total	84 (100%)	376 (100%)	460 (100%)

4. Discussion

Age-related hearing loss refers to bilateral sensorineural hearing loss due to aging and degeneration of the inner ear, which presents with hearing loss at high frequencies initially and followed later by moderate and low frequencies (Reuter et al., 1998). The basilar membrane in the cochlear basal turn is more sensitive to high-frequency sound, and the closer the hair cells to the basilar membrane, the greater the oxygen demand (Shaw et al., 1996; Sakamoto et al., 2000). Therefore, hearing at high-frequencies is usually first affected by aging and other adverse factors (Gates and Mills, 2005). Since speech signals contain a large quantity of high-frequency components, elderly people with high-frequency hearing loss have difficulty in speech recognition. The major challenge for them is inability of recognizing speech rather than hearing the sound, especially in noisy environment. One important reason for age-related hearing loss is metabolic diseases, such as cochlear microvascular disorders. Damage of cochlear hair cells can also be caused by long-term exposure to noise. Degenerative changes of nerve fibers and neurons are another pathogenic factor (Jiang and Zou, 2006). Metabolic diseases are recognized as the primary pathogenic factor of age-related hearing loss, and degeneration changes of central auditory system are increasingly attracting researchers' attention (Li et al., 2011).

In our study, sensorineural hearing loss and mixed hearing loss were seen in 734 (79.8%) and 184 ears (20.2%), respectively. Those with mixed hearing loss were featured by bone conduction disorder at low-mid frequencies, with significant bone conduction loss and air-bone gaps below 30 dB. Flat air conduction threshold curves were found in 593 ears (64.5%), with similar hearing loss across all frequencies. Descending audiogram curves was found in 291 ears (31.6%) with more severe hearing loss at high frequencies and low-mid frequencies loss < 56 dB HL(often moderate to severe loss). Our results were similar to that by Zhongping Mao (Mao et al., 2013).

Among this group of centenarians, the prevalence of moderate to profound hearing loss was 57.1% for men and 51.3% for women, respectively, suggesting more severe age-related degeneration of the auditory organ in men. Han et al. detected higher incidence of mtDNA4977 deletion in temporal bone slices and cochlear nuclei in elderly people with impaired hearing compared to those with normal hearing. There is significant presence of mtDNA in the inner ear and cochlear nuclei, which is associated with greater aerobic metabolic activity. mtDNA is very sensitive to ischemia and hypoxia, both of which can produce massive oxygen free radicals. Some researchers believe that age-related hearing loss may be caused by mtDNA damage in the presence of excessive oxygen free radicals (Han et al., 2000). Dai et al. showed that mtDNA deletion was closely related to the degree of vascular lumen stenosis in the inner ear besides aging. Stenosis of vascular lumen in the inner ear may cause ischemia, leading to mtDNA deletion (Dai et al., 2000). Since females have a lower metabolic rate than males, fewer oxygen free radicals are produced in females and there are less mtDNA damages. That is probably why there is less

degeneration of the auditory organ in females than in males as aging.

Tympanograms can reflect various pathologic conditions of the middle ear, which is significant for diagnosis and differential diagnosis of middle ear diseases. In our study, 41.17% of the centenarians showed type A tympanograms, indicating normal function of the tympanum; 11.83% showed type B tympanograms, indicating high impedance of the middle ear; 4.94% showed type C tympanograms, indicating negative pressure in the middle ear.

In this group of centenarians, 13.7% showed normal hearing or only mild to moderate hearing loss. It is speculated that hearing loss-susceptible genes may explain this finding. Our results provide epidemiological data for understanding the mechanism of age-related hearing loss. It is expected that these centenarians will be investigated by molecular epidemiology in the future.

Conflicts of interest

We confirm that this work has not been published previously, is not being considered for publication elsewhere, and has been read and approved by all authors. There is no conflict of interest. Please address correspondences to Dr.Fuxin Luan.

Acknowledgements

The study was supported by The Natural Science Foundation of Hainan Province (20168358), Special Fund for the Clinical Research on the Mechanism of Longevity among Centenarians in Hainan Province (HNBSJ1415).

The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript. We sincerely thank all the family members for their participation and cooperation in this study.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.joto.2018.11.008.

References

Dai, P., Jiang, S., Gu, R., 2000. Cochlear hypoxia and mtDNA deletion: possible correlated factors to cause presbycusis. Zhonghua Yixue Zazhi 80 (12), 897–900.
Gates, G.A., Mills, J.H., 2005. Presbycusis. Lancet 366, 1111–1119.
Han, W., Han, D., Jiang, S., 2000. Mitochondrial DNA4977 deletions associated with human presbycusis. Zhonghua Er Bi Yan Hou Ke Za Zhi 35 (6), 416–419.
Jiang, Tao, Zou, Ling, 2006. Current status and latest progress in age-related hearing loss and interventional strategies. J. Audiol. Speech Pathol. 14 (5), 363–367.
Li, J.N., Ji, F., Yang, S.M., 2011. Current status of awareness of central auditory Processing disorder in presbycusis and research approaches. Zhonghua er bi yan hou tou jing wai ke za zhi 46 (6), 523–525.
Mao, Zhongping, Zhao, Lijun, Pu, Lichun, et al., 2013. How well can centenarians hear. PloS One 8 (6), 1–7.
Reuter, W., Schonfeld, U., Mansmana, U., et al., 1998. Extended high-frequency audiometry in pre-school children. Audiology 37, 285–294.
Sakamoto, M., Kaga, K., Kamio, T., et al., 2000. Extend high-frequency ototoxicity induced by the first administration of cisplatin[J]. Otolaryngol. Head Neck Surg. 122, 828–833.
Shaw, M.G., Jardine, C.A., Fridjhon, P., 1996. Apiolt investigation of high-frequency audiometry in obscure auditory dysfunction(OAD)patient. Br. J. Audiol. 30, 233–237.
Yu, Limei, Sun, Xibin, Zhiyun, Wei, Wang, Qi, Qu, Chengyi, 2008. A study on the status quo of aged population with hearing loss in China. Chinese Scientific J. Speech and Hearing Rehabilit. 3, 63–65.