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Research Paper

The menopause triggers hearing decline in healthy women

C. Hederstierna [a,*], M. Hultcrantz [a], A. Collins [b], U. Rosenhall [a]

[a] Division of Otorhinolaryngology and Hearing, Department of Clinical Neuroscience, Karolinska Institute, Stockholm, Sweden
[b] Division of Psychology, Department of Clinical Neuroscience, Karolinska Institute, Stockholm, Sweden

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ABSTRACT

Background: Epidemiological studies have shown that women have better high-frequency thresholds than men in virtually all age groups, and that age-related hearing decline starts after 30 in men but not until after the age of 50 in women. This coincides with the menopausal transition in most women, thus leading us to hypothesize that the menopause triggers auditory deterioration, possibly due to reduced levels of endogenous estrogens, which are known to have protective effects on the auditory system. *Methods*: 104 women with a mean age 51.2 at baseline, were tested with pure tone audiometry twice with an average interval of 7.5 years. The age at the final menstrual period (FMP) was reported by all women. Hearing decline at individual frequencies was calculated. *Results*: Women with a FMP 0–4 years ago, had a rate of high frequency hearing decline of 0.9–1.5 dB/year in the left ear, those with 5–7 years since the FMP had a corresponding rate of 1.1–1.5 dB/year in the right ear, and 8–13 years after the FMP the decline was more subtle, 0.7–1.1 dB/year in both ears. *Conclusion*: The menopause appears to act as a trigger of a relatively rapid age-related hearing decline in healthy women, starting in the left ear.

1. Introduction

Hearing impairment is a major cause of disability in the world, with continually rising prevalence rates as the life expectancy of most populations increases. In children and young adults the prevalence of hearing impairment is very low, and the vast majority of these age groups have excellent hearing. With an increasing median age of the population, age-related hearing impairment (ARHI) will account for a larger proportion of hearing impairment in the future. ARHI is a complex entity with a multitude of causative environmental and genetic factors (Van Eyken et al., 2007).

Hearing function in men and women differs already from birth with significantly stronger transient evoked otoacoustic emissions (TEOAE) in newborn girls than in newborn boys (Berninger, 2007; Khalfa et al., 1997; McFadden, 1993). In the Great Britain MRC Study of Hearing Loss, median hearing threshold levels in adults suggest that age-related high frequency hearing decline commences after 30 in men, but does not become apparent in women until after 50 years of age (Davis, 1995). The process that initiates ARHI is unknown, but in women the start of ARHI coincides with the period in life in which most women enter the menopausal transition. The gender difference in the high frequency range appears to have a peak in the 7th to 8th decade of life, where often a plateau effect is reached, or even a subsequent decrease in gender difference, especially at 3–6 kHz (Borchgrevink et al., 2005; Cruickshanks et al., 1998; Davis, 1995; Gates et al., 1990; Jönsson and Rosenhall, 1998; Pearson et al., 1995). The gender difference in the lower frequencies becomes more apparent after the 6th decade and is not as large, usually no more than 5 dB HL, as that seen in the high frequencies where differences of more than 20 dB HL in individual frequencies are seen between age-matched men and women (Borchgrevink et al., 2005; Jerger et al., 1993).

The cause for this incongruity between male and female hearing thresholds is not fully known although occupational and leisure-related noise-exposure patterns classically are very different in males and females. However, noise-exposure can only explain a part of the gender difference; it has been shown that the gender difference was apparent even in non-noise-exposed study populations (Jerger et al., 1993; Rosenhall and Pedersen, 1995). Another possible cause for the differences between male and female hearing thresholds has been ascribed to a possible protective effect on the auditory system of female sex hormones (Kilicdag et al., 2004; Kim et al., 2002), perhaps in combination with other effects of masculinizing androgens early during development (McFadden, 2002). Consistent with these possible endocrinological effects on auditory function, we hypothesized that the rather abrupt loss of circulating estrogens at the period of menopausal transition may be a possible initiator in the complex actions involved at the start of ARHI in women.

Abbreviations: ARHI, age-related hearing impairment; FMP, final menstrual period

* Corresponding author. Address: Department of Hearing and Balance, Karolinska University Hospital, Solna, S-17176 Stockholm, Sweden. Tel.: +46 8 5177 6964; fax: +46 8 5177 4041.
E-mail address: christina.hederstierna@karolinska.se (C. Hederstierna).

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2. Material and methods

2.1. Participants

This study is part of an ongoing prospective longitudinal study of peri-menopausal women. The initial sample in the audiological part of the study included 143 healthy women. The selection process, from a population-based sample, has been described in detail in a previous report (Hederstierna et al., 2007) but did not specifically include otological considerations. However this group of women cannot be regarded as otologically unscreened, as persons with serious hearing impairment are less likely to have a regular employment. Furthermore women living in the urban area of Stockholm are less likely to have been exposed to occupational noise. This selection, which was not intended initially, offers an opportunity to study the hearing in women at the starting-point of ARHI where other otological conditions are minimized as a confounding issue. The participants were not intentionally otologically screened, but none was deaf or profoundly hearing impaired. At the start of the follow-up 120 women from the original group were still living in the Stockholm area, and were invited to participate. Four declined due to lack of time or interest, or due to illness. A final group of 116 women had been assessed with pure tone audiometry at two occasions, starting in the year 2000. The average interval between tests was 7.5 years, (S.D. 0.5 years). The mean age at baseline was 51.2 years, (S.D. 1.5 years), and at the follow-up 58.7 years, (S.D. 1.4 years). In all women the age at their final menstrual period (FMP) was known by means of self-reported information supplied the same day as the audiometry was performed. All but two women reported that their FMP had occurred at least one year earlier. The number of years since the FMP at follow-up varied between 0 and 24 years, mean time 6.5 years, (see Fig. 1). Six women with 16–24 years since the FMP were excluded, as this small group was rather heterogeneous regarding the number of years since the FMP, and too small for statistical analyses. Further, one woman who had undergone a hysterectomy nine years earlier was excluded, as we did not have information as to whether the procedure included ovariectomy or not. Finally five women with unilateral hearing loss, conductive or sensorineural, were excluded since such conditions indicate a risk of a subclinical process in the contralateral ear, and therefore a possible source of bias, thus yielding a final group of 104 women. Moreover, the women provided information regarding whether they were using hormone replacement therapy (HRT) or not. Less than one fifth of the final group of women had been using estrogen, progesterone or combination replacement therapy for at least half of the follow-up time. The number of women on estrogen or combination treatment was somewhat higher in the group of women with a recent FMP, and progesterone replacement was slightly more common when the FMP had occurred longer ago. Since the total number of women using any type of HRT was relatively small, and these women were distributed between the three groups, we concluded that separate statistical analyses regarding influence of HRT on hearing in these women would not be reliable.

2.2. Methods

Pure tone audiometry including air conduction thresholds at 0.125–8 kHz and bone conduction thresholds at 0.5–4 kHz was performed on a Grason–Stadler GSI-16 audiometer according to ISO 8253-1 standard (ISO, 1989), using Telephonics TDH-39 ear phones in a soundproof booth. The annual rate of hearing decline was calculated for each frequency as the difference between the second and the first hearing threshold levels, divided by the time difference in years. The 104 women were divided into three fairly equal-sized groups according to the number of years since the FMP at follow-up; FMP 0–4, no more than four years since the FMP ($n = 28$, mean age 58.5), FMP 5–7, between five and seven years since the FMP ($n = 41$, mean age 58.4) or 8–13 years since menopause ($n = 35$, mean age 59.3).

The Kruskal–Wallis analysis of variance of non-parametric data was used to assess differences in hearing decline between groups. If there was a statistically significant main effect, multiple comparisons of mean ranks for all groups were performed. All statistical analyses were performed with the computer software program Statistica (Statsoft® Scandinavia AB).

The study was approved by the Ethical Committee of the Karolinska Institute (00-091 and 07-969-32).

3. Results

The mean hearing thresholds for the left and the right ears at baseline and at follow-up are presented in Fig. 2. At baseline, the mean thresholds at all frequencies were better than 20 dB HL. At follow-up, the mean thresholds at 6 and 8 kHz were poorer than 20 dB HL. In the low frequencies the thresholds were generally better in the left ear, and in the high frequencies the reverse was seen.

The left–right difference at follow-up is presented in Fig. 3, and compared with the most closely corresponding age group in the study of Pirilä et al. (1992).

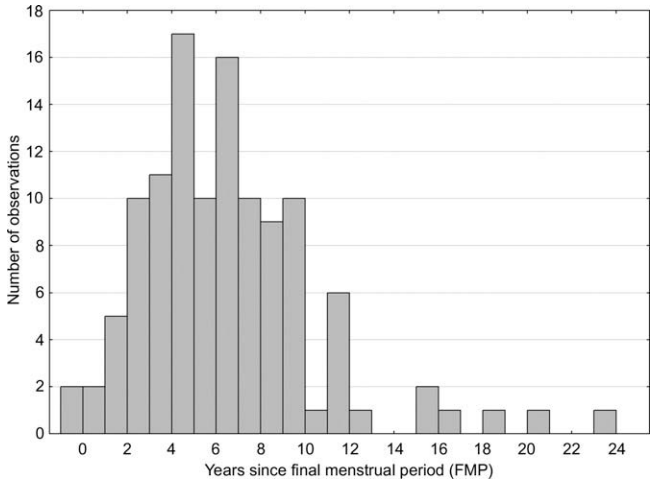

Fig. 1. Histogram – number of observations according to time in years since the final menstrual period (FMP) at follow-up, before exclusions, $n = 116$.

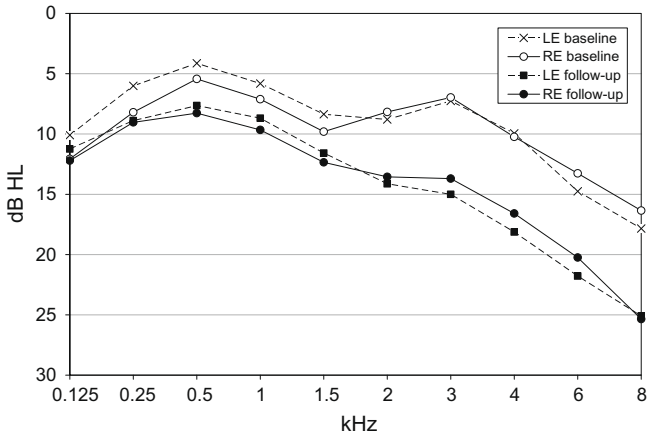

Fig. 2. Mean hearing thresholds for the right (RE) and the left (LE) ears at baseline and at follow-up, $n = 104$.