Hearing Loss in Singers: A Preliminary Study

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Summary: Objective. Singers need good hearing; however, they may be exposed to loud noises during their musical activities. The objectives of this study were to describe the incidence and type of hearing loss (HL) in singers.
Study design. Retrospective case cohort.
Methods. Billing records identified patients who had undergone videostroboscopy and audiogram during the same visit over a 3 year period. A singer was defined as anyone who self-identified as a singer (professional or avocational). Age and gender matched nonsingers were used as controls. Patients with otologic diagnoses, surgery, or complaints were excluded. Retrospective chart review was conducted for the presence of HL, type of HL, and pure tones audiogram results. Statistical analysis included descriptive statistics, Students *t* test, chi-square test, and Fisher exact test.
Results. Of 172 singers (44.7 years, 37.8% male), 31 (17.5%) had HL. Pure tone thresholds for the singers with HL subgroup at 3, 4, and 6 kHz were 21.0, 26.5, and 34.4 dB in the right, and 22.8, 30.3, and 38.8 dB in the left ear, respectively. Older age ($P = 0.000000000000001$), male gender ($P < 0.001$), longer number of years of singing ($P = 0.0000000003$), and baritone voice ($P < 0.001$) were associated with HL. There was no association with genre of music. When compared with controls, the incidence of HL (19.8%) was not significantly different ($\chi^2 = 0.300$, $P = 0.58$). Pure tones at 3, 4, and 6 kHz were not significantly different than controls with HL. Most common type of HL in singers was bilateral sensorineural (83.9%), which was significantly higher than controls (39.0%, $\chi^2 = 14.6$, $P < 0.001$).
Conclusions. The incidence of HL in singers was 17.5%, which was not significantly different from controls. Bilateral sensorineural HL was most common.
Key Words: Hearing loss–Singers–Noise-induced hearing loss.

INTRODUCTION

Singers need good hearing. Professional and avocational singers have hearing demands that exceed those of the general public.[1,2] Singers need to be able to hear background music accurately, follow fellow singers, and match frequencies over a broad range that may exceed frequencies used for normal conversational speech.[2] Singers use their hearing to monitor their vocal quality, provide feedback, and adjust their performance. Hearing loss (HL) may lead to difficulties in singing and result in artistically unacceptable performance.

Singers may be exposed to loud noises during their musical activities.[2] Sources of loud noises in the musical performance environment include background music, accompanying instruments, loud speakers, and the singers themselves. Studies have shown that the sound levels within orchestras range from 83 dBA to 112 dBA (decibels A-weighted sound pressure level).[2] Choir singers can produce sounds levels above 110 dB separate from the music that accompanies a singer on stage or in a studio.[3]

It is extremely important for singers to protect themselves from HL. To date, there has been only one study examining HL exclusively in singers. Steuer et al[3] examined HL in professional choir singers. Most of the literature focuses on instrumentalists.[1,2] Thus, there is a paucity of evidence in this area. The objectives of this study were: (1) To describe the incidence and type of HL in singers, and (2) To identify risk factors associated with HL in singers. It is beyond the scope of this study to discuss causes of the HL or comment on possible occupational HL for this population.

METHODS

This retrospective case cohort study was approved by the Institutional Review Board at Drexel University College of Medicine. Patients were identified from billing records. Any new patient who had an audiogram and videostroboscopy over the past 3 years was eligible for the study. A singer was defined as anyone who was self-identified as a singer (professional or avocational) during the initial visit. A patient who did not self-identify as a singer was entered into the control group. Age and gender matched controls were selected from this group. The exclusion criteria were any patient who had an otologic complaint, diagnosis, or previous otologic surgery. Audiograms had been performed as part of our routine initial assessment protocol for patients with voice complaints.

A chart review of demographic factors, clinical factors, and singing history was conducted. Audiograms were reviewed for the following:

1. Incidence of HL. All frequencies tested routinely were included to determine the incidence HL.
2. Pure tone thresholds at 500, 1000, 2000, 3000, 4000, 6000, and 8000 Hz for each ear.
3. Speech discrimination for each ear.
4. Type of HL (conductive, sensorineural, or mixed).[4]

Statistical analysis was performed using commercially available software (Microsoft Excel, version 2007, Microsoft,

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Seattle, WA). Measures of central tendency were calculated. To determine if there was a difference between the singers and the control group, paired Student *t* tests were performed. Chi-square test was used to compare categorical data between the singers and control groups. If any expected cell value was less than 5, a Fisher exact test was calculated instead of the chi-square test. An *a priori* probability level was set at 0.05 for all the previously mentioned tests. No sample size calculation was performed.

RESULTS

One hundred seventy seven singers were identified in the study period. Five singers were excluded because of an otologic history. Three singers had Meniere disease, one had an acoustic neuroma, and one had a history of a tympanic membrane perforation repaired by tympanoplasty. Patients with otologic history were also excluded from the control group (eg autoimmune ear disease, congenital HL, tympanic membrane perforations, cholesteotoma, otosclerosis, acoustic neuroma, previous mastoidectomies, ossicular reconstructions, fistula repairs, and so forth.)

Table 1 shows the demographic data for the singers. Most of the patients were female, with a mean age of 45, and an average of 24 years of singing. There were six voice types, and the most common was soprano (30.2%). Ten music genres were represented, and the most common was classical/opera (26.5%).

Out of 172 singers, 31 (17.5%) had HL. Older age ($P = 0.000000000000001$), male gender ($\chi^2 = 14.4$, $P < 0.001$), longer number of years of singing ($P = 0.0000000003$), and baritone voice ($\chi^2 = 11.6$, $P < 0.001$) were associated with HL. There was no association with genre of music (Table 2). For example, five of the 24 (20.8%) rock singers had HL. This incidence was not significantly different from the 17.5% overall incidence of HL in the singers ($P = 0.78$). For the subgroup of rock singers, the pure tone thresholds at 3, 4, 6 kHz were 17.5, 20.3, 26.0 dB for the right ear and 17.5, 17.7, and 20.0 dB for the left ear, respectively. These results were not significantly different from pure tone thresholds for all the singers ($P = 0.98$, 0.77, 0.71 for the right pure tone thresholds at 3, 4, 6 kHz, and $P = 0.71$, 0.97, and 0.79 for the left pure tone thresholds, respectively).

To eliminate the confounding factors of age and gender, we compared the singers to a group of age and gender matched controls (Table 3). When compared with controls, the incidence of HL (19.8%, n = 35) was not significantly different ($\chi^2 = 0.300$, $P = 0.58$). The means of the pure tones were significantly higher for the controls than the singers, and this difference ranged from 3.4–9.7 dB (Table 3). There was no significant difference in speech discrimination between the two groups (Table 3).

The incidence of reported loud noise exposure was equal in both groups (4.0%, n = 7) (Table 3). In the singers group, three reported playing a musical instrument (drums, guitar, keyboard), two reported gunfire/military service, two reported loud music exposure, and one reported exposure to loud machinery. In the control group, five reported gunfire/military service, one reported working in a print shop, and one reported exposure to loud music.

TABLE 1.
Demographic Data of the Study Population (n = 172)

Age (mean ± standard deviation) in years	44.7 ± 18.8
Range (minimum to maximum)	8 to 77 years
Male/female (n [%])	65 (37.8)/107 (62.2)
Years of singing (mean ± standard deviation)	24.3 ± 15.6 years
Range (minimum to maximum)	1 to 67 years
Hours of singing per week (mean ± standard deviation)	9.4 ± 8.4 hours
Range (minimum to maximum)	0 to 36 hours
Voice type (n [%])	
Soprano	52 (30.2)
Mezzo-soprano	22 (12.8)
Alto	15 (8.7)
Tenor	24 (14.0)
Baritone	23 (13.4)
Bass	2 (1.2)
Unknown	34 (19.8)
Subtotal	172 (100)
Music genre (n [%])	
Classical/opera	69 (25.4)
Musical theater	42 (15.4)
Pop	30 (11.0)
Choral	24 (8.8)
Rock	24 (8.8)
Religious music	20 (7.4)
Choir	19 (7.0)
Jazz	13 (4.8)
Folk	10 (3.7)
R&B	7 (2.6)
Unknown	7 (2.6)
Other (eg, country, children's)	7 (2.6)
Subtotal	272 (100)*

* Some singers sang more than one genre of music.

HL was judged at all frequencies, from 0.5 to 8 kHz. HL was then classified as unilateral or bilateral, and conductive, sensorineural, or mixed. The most common type of HL in singers was bilateral sensorineural (83.9%), which was significantly higher than controls (39.0%, $\chi^2 = 14.6$, $P < 0.001$) (Tables 3 and 4).

The subgroup of the patients with HL in both the singers and controls was examined more closely. The pure tone thresholds in all the frequencies from 0.5 to 8 kHz are shown in Table 5. The singers' pure tone thresholds at 3, 4, and 6 kHz were 21.0, 26.5, and 34.4 dB in the right ear, and 22.8, 30.3, and 38.8 dB in the left ear, respectively; and they were not significantly different from the controls. The controls' pure tones at 0.5, 1, 8 kHz for both ears and 2 kHz for the left ear were significantly higher than the singers' (Table 5).

DISCUSSION

This study was one of the few to examine HL specifically in singers. The incidence of HL in singers was 17.5%, which