Audiological Abnormalities in Vitiligo Patients: A Hospital-Based Cross-Sectional Study

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Introduction

Vitiligo is an acquired discoloration of skin caused by loss or damage of epidermal melanocyte and characterized by well-defined depigmented macules. It occurs worldwide with an overall prevalence of 1%. In a study from India, the point prevalence was 9.882 from four zones of India namely North, South, East and West on 20 November 2012. Adults and children of both genders are equally affected, and the greater number of reports among females could be explained by the social consequences to females affected by vitiligo. Almost 50% of vitiligo patients present with symptoms before 20 years of age and nearly 70 to 80% before 30 years of age.

The exact etiology of vitiligo is not known. However, genetic, neural, immunological and self-destructive pathomechanisms are said to be involved. Autoantibodies are directed against the antigens of melanocytes, which lead to the destruction of melanocytes. Melanocytes are located in the epidermis, hair bulbs, uveal tract, retinal pigmented epithelium, leptomeninges, and inner ear.

Hence, the mechanisms responsible for the destruction of melanocyte in the skin affect melanocytes in other locations as well.

Abstract

There are some discrepancies in the literature about the influence of vitiligo on auditory functions. According to some authors, vitiligo influences hearing, whereas others question such influence. Therefore, we conducted a study to evaluate audiological functions in vitiligo patients.

Objectives To determine the effect of vitiligo on auditory functions.

Methods A hospital-based observational study was done from January 2017 to July 2017. Clinically diagnosed cases of vitiligo were enrolled for the study. A complete otological examination was conducted in all patients.

Results Fifty-two patients (male: female 28:24) were included in the study. Ten patients (19.2%) had sensorineural hearing loss (SNHL). Seven patients (13.5%) had bilateral and 3 (5.7%) had unilateral SNHL. High frequency loss was seen in 17 out of 20 ears (10 affected patients), 6 ears had both low and high-frequency hearing loss. Of 12 ears with speech frequency involvement, mild hearing loss was seen in 5 and moderate to severe in 1 ear. Most cases of SNHL were detected in the age group 41 to 60 years old (63.6%), which was statistically significant (p-value 0.00).

Conclusion The results of this study suggest that vitiligo patients require routine monitoring for auditory functions for early identification of SNHL. Older subjects with vitiligo might be at a higher risk for audiological abnormalities. These patients should also be informed regarding the associated risk with noise and ototoxic drug exposure.
well. There are some discrepancies in the literature about the influence of vitiligo on auditory functions. According to some authors, vitiligo influences hearing,1–3 whereas others question such influence.10–13 Accordingly, this study was designed to evaluate the audiological functions in vitiligo patients.

Materials and Methods
A hospital-based prospective observational study was done from January 2017 to July 2017 after obtaining permission from the institutional ethics committee. After obtaining a written informed consent, clinically diagnosed cases of vitiligo patients were enrolled for the study. The demographic profile, duration and evolution of vitiligo, personal and family history, medical history, cutaneous and otological examination were recorded in a predesigned proforma. Pregnant females, history or evidence of otological disease, documented hearing loss, familial hearing loss, ototoxic drug intake, chronic exposure to noise, neurological, vascular, or systemic diseases, such as diabetes and hypertension, were excluded.

A complete otological examination was conducted in all patients by an otorhinolaryngologist. Otological examination included external examination, tuning fork and pure tone audiometry. Audiological evaluation was performed in a sound-treated room using a single-channel audiometer. The audiometer, which was used for threshold estimation, was Triveni-TAM-500ME (Andheri, Mumbai, India). Both air-conduction thresholds and bone-conduction thresholds were measured. The thresholds (minimum level of hearing) for air conduction were estimated using standard headphone TDH39 (770 Park Ave, Huntington, NY 11743, US), from frequency range 250 Hz to 8 KHz, with intensity level –10 dBHL to 120 dBHL, and the pure tone average was measured using an average of three frequencies, that is, 500 Hz, 1 KHz, and 2 KHz. Bone conduction was tested with test frequencies from 250 Hz to 4 KHz, with intensity level from –10 dBHL to 70 dBHL (with standard bone conductor B71, Radio ear, Audiometer alle1, 5500 Middelfart, Denmark). For measuring hearing thresholds at higher frequencies above 8 KHz, MAICO MA 42 (Sicklinggenstr. 70–71, 10553 Berlin, Germany), a dual channel audiometer was used. The MAICO MA 42 audiometer delivers test frequencies from 125 Hz to 20 KHz, with intensity levels from –10 dBHL to 120 dBHL.

For degree of hearing loss, the following scale was used:

- minimal > 16 to 25 dB;
- mild > 25 to 40 dB;
- moderate > 40 to 55 dB;
- moderate to severe > 55 to 70 dB;
- severe > 70 to 90 dB;
- profound > 90 dB hearing loss

The data analysis was done with the help of the statistical software SPSS version 25 (IBM Corp., Armonk, NY, USA). The data was summarized using descriptive statistics, frequencies, and percentage. Statistical differences between categorical variables were assessed using the Chi-square test. A p-value < 0.05 was considered statistically significant.

Results
Fifty-two patients (male: female 28:24) were included in the study. The clinico-epidemiological profile of vitiligo patients is shown in Table 1 and 2. The mean age of patients was 26.7 years, ranging from 7 years to 60 years. The mean age of onset of vitiligo was 21.7 years, ranging from 4 years to 50 years. Eight patients (15.3%) had positive family history and included first-degree relatives in 4 (7.6%), second-degree relatives in 3 (5.7%) patients, and

| Age group | Number of cases with SNHL (%) | Number of cases without SNHL (%) | p-value |
|-----------|------------------------------|---------------------------------|---------|
| 1–20 years | 1 (5.3)                      | 18 (94.7)                       | 0.00    |
| 21–40 years| 2 (9.1)                      | 20 (90.9)                       |         |
| 41–60 years| 7 (36.3)                     | 4 (36.4)                        |         |

| Age of onset | Number of cases with SNHL (%) | Number of cases without SNHL (%) | p-value |
|--------------|--------------------------------|---------------------------------|---------|
| 1–10 years   | 1 (7.7)                        | 12 (92.3)                       | 0.598   |
| 11–20 years  | 2 (11.1)                       | 16 (88.9)                       |         |
| 21–30 years  | 0 (0)                          | 6 (100)                         |         |
| 31–40 years  | 2 (28.6)                       | 5 (71.4)                        |         |
| > 40 years   | 5 (62.5)                       | 3 (37.5)                        |         |

| Gender | Number of cases with SNHL (%) | Number of cases without SNHL (%) | p-value |
|--------|------------------------------|---------------------------------|---------|
| Male   | 8 (28.6)                     | 20 (71.4)                       | 0.065   |
| Female | 2 (8.3)                      | 22 (91.7)                       |         |

| Vitiligo type | Number of cases with SNHL (%) | Number of cases without SNHL (%) | p-value |
|---------------|------------------------------|---------------------------------|---------|
| Vitiligo vulgaris | 4 (21.1)                  | 15 (78.9)                        | 0.863   |
| Acrofacial    | 2 (20.0)                    | 8 (80.0)                         |         |
| Facial        | 1 (11.3)                    | 8 (88.9)                         |         |
| Acral         | 2 (28.6)                    | 5 (71.4)                         |         |
| Focal         | 0 (0)                       | 3 (100)                          |         |
| Mucosal       | 0 (0)                       | 1 (100)                          |         |
| Vitiligo universalis | 1 (50)                  | 1 (50)                           |         |
| Segmental     | 0 (0)                       | 1 (100)                          |         |

| Site of onset | Number of cases with SNHL (%) | Number of cases without SNHL (%) | p-value |
|---------------|------------------------------|---------------------------------|---------|
| Head and neck | 3 (13.6)                    | 19 (86.4)                        | 0.791   |
| Lower limb    | 2 (16.7)                    | 10 (83.3)                        |         |
| Upper limb    | 2 (22.2)                    | 7 (77.8)                         |         |
| Trunk         | 2 (33.3)                    | 4 (66.7)                         |         |
| Mucosa        | 1 (33.3)                    | 2 (66.7)                         |         |

Abbreviations: F, female; M, male; SNHL, sensorineural hearing loss.

| Duration of vitiligo | Number of cases (%) |
|---------------------|---------------------|
| 1–6 months          | 11 (21.1)           |
| 6 months–1 year     | 6 (11.5)            |
| 1–5 years           | 17 (32.7)           |
| 5–10 years          | 9 (17.3)            |
| ≥ 10 years          | 9 (17)              |

Table 1 Sensorineural hearing loss in relation to age, age of onset, gender, vitiligo type and site of onset

Table 2 Duration of vitiligo
and second-degree relatives in 1 (1.9%) patient. Fifty-one patients (96%) had non-segmental vitiligo, and vitiligo vulgaris was the most common clinical type. Audiological examination was done in all patients. Ten patients (19.2%) had sensorineural hearing loss (SNHL). Details of vitiligo patients with SNHL are shown in Table 3. Seven patients (13.5%) had bilateral and 3 (5.7%) had unilateral SNHL. High frequency loss was seen in 17 out of 20 ears (10 affected patients), 6 ears had both low and high-frequency hearing loss. Of 12 ears with speech frequency involvement, mild hearing loss was seen in 5 ears and moderate to severe in 1 ear. The pattern of hearing loss and details of vitiligo are shown in Table 3.

Most cases of SNHL were detected in age group 41 to 60 years (63.6%), which was statistically significant ($p$-value $0.00$). Sensorineural hearing loss was present in 5 out of 10 patients (66.7%) having vitiligo for less than 5 years, and 5 out of 32 (86.5%) for more than 5 years.

### Table 3 Details of vitiligo patients with sensorineural hearing loss

| Serial number | Age/ Year/ Gender | Duration of vitiligo | Type of vitiligo | Ear Affected | Degree of SNHL | Frequencies affected (Hz) |
|---------------|-------------------|----------------------|------------------|--------------|----------------|--------------------------|
|               |                   |                      |                  |              | Right ear      | Left ear                  | Right ear | Left ear                  |
| 1             | 57/F              | 47 years             | Vitiligo universalis | Both         | Mild           | Moderately severe         | 500, 1,000, 2,000, 8,000 | 25, 500, 1,000, 2,000, 4,000, 8,000 |
| 2             | 45/M              | 2 years              | Vitiligo vulgaris  | Both         | High frequency loss | Mild                    | 4,000, 8,000 | 1,000, 2,000, 4,000, 8,000 |
| 3             | 50/F              | 8 years              | Vitiligo vulgaris  | Right        | Mild           | Normal                   | 1,000, 2,000, 4,000, 8,000 |
| 4             | 42/M              | 10 years             | Vitiligo vulgaris  | Both         | High frequency loss | High frequency loss     | 4,000         | 4,000                      |
| 5             | 36/M              | 5 years              | Acral             | Both         | High frequency loss | High frequency loss     | 4,000         | 4,000                      |
| 6             | 49/M              | 8 years              | Acrofacial        | Right        | High frequency loss | High frequency loss     | 1,000, 2,000, 4,000, 8,000 | 1,000, 2,000, 4,000 |
| 7             | 60/M              | 1 year               | Acrofacial        | Both         | High frequency loss | High frequency loss     | 4,000         | 4,000, 2,000, 4,000, 8,000 |
| 8             | 35/M              | 23 years             | Acral             | Both         | High frequency loss | High frequency loss     | 3,000, 4,000, 6,000 | 4,000, 6,000 |
| 9             | 46/M              | 1 year 6 months      | Vitiligo vulgaris  | Left         | Normal         | Mild                     | 1,000, 2,000, 3,000, 4,000 |
| 10            | 12/M              | 3 months             | Facial            | Both         | High frequency loss | High frequency loss     | 4,000, 8,000 | 3,000, 4,000, 6,000 |

Abbreviations: F = female; M = male; SNHL = sensorineural hearing loss.

**Discussion**

The otic melanocytes are located in the stria vasculosa, hair cells, endolymphatic sac, and vestibular organ. The function of these melanocytes is not exactly known. In the stria vasculosa, otic melanocytes modulate the function of Na⁺/K⁺-ATPase and potassium channels, which are essential for creating endocochlear potential. The electrical activity of ciliary cells in the labyrinth is closely connected with their physiological ability to send afferent information to brain areas involved in auditory and balance functions. Ardic et al. noticed lower pure tone thresholds at higher sound frequencies (from 4,000 to 16,000 Hz) in patients with vitiligo. Based on their observations, as well as the fact that social and environmental damage affects hearing at the same sound frequencies, the authors suggested a protective role of melanocytes for the sensitive inner ear cells. Murillo-Cuesta et al. also stated that otic melanocytes do not appear to be essential for normal hearing, but they are assumed to play a protective role against environmental damage. In the present study, lower pure tone thresholds at higher sound frequencies (from 4,000 to 16,000 Hz) were also found in 17 ears of 10 affected patients, which also favors the theory of the protective role of otic melanocytes.
vitiligo. Mahdi et al\textsuperscript{20} and Dawoud et al\textsuperscript{21} found, in addition to auditory affection, peripheral vestibular disorders in vitiligo patients.

Sensorineural hearing loss has been reported in 4 to 37\% of patients with vitiligo.\textsuperscript{3–9} In the present study, 10 patients (19.2\%) had SNHL. These patients were asymptomatic but, on audiological evaluation, were diagnosed with hearing loss. Conductive deafness was found in two studies.\textsuperscript{4,22} However, in the present and other studies, only SNHL was seen. Conductive loss in vitiligo is unlikely, as melanocytes do not take part in conductive mechanism of hearing since they are only present in inner ear. Conductive hearing loss can only be seen in a vitiligo if there is any coexisting middle ear pathology. On the other hand, other studies have not found audiological abnormalities in vitiligo patients.\textsuperscript{10–13} This controversy could be due to the use of different selection criteria and methodology among studies.

Gopal et al\textsuperscript{22} suggested that the hearing loss could result from other autoimmune diseases coexisting with vitiligo, such as diabetes mellitus and hypothyroidism. However, in the present study and other studies, hearing loss was seen in patients without autoimmune and/or other metabolic diseases.\textsuperscript{13,14} In our study, SNHL was found to be significantly higher in the older age group (41–60 years). The minimum age of patients with SNHL was 12 years, and the maximum age was 60 years. Shankar et al\textsuperscript{23} found that the > 30 years old age group was significantly associated with abnormal auditory findings. However, Sharma et al did not observe any association between age and SNHL in vitiligo.\textsuperscript{4} The association in our study could be due to the fact that we have included all age groups, unlike the study by Sharma et al\textsuperscript{4}, in which only the age group of 5 to 40 years was included.

Similar to the study by Ardic et al\textsuperscript{16} in our study, male subjects were predominantly affected by SNHL when compared with female subjects. Whereas other researchers found a higher incidence of hearing loss in female patients\textsuperscript{24} or equal incidence in both sexes.\textsuperscript{4,23} Similar to Maheshwari et al,\textsuperscript{14} we also noticed a 50\% incidence of SNHL in patients affected by vitiligo universalis. Hong et al\textsuperscript{6} noticed an association of SNHL with non-segmental vitiligo, while Sharma et al\textsuperscript{4} and Mohamed et al\textsuperscript{9} reported generalized vitiligo as a risk factor.

Similar to other studies, we could not find any significant association between SNHL and duration of vitiligo.\textsuperscript{4,5,20} According to Mahdi et al\textsuperscript{20} this could be explained by the possibility that otic melanocytes are affected at the start of vitiligo and then stabilize afterwards. However, in contrast to this, Aslan et al\textsuperscript{8} and Ardic et al\textsuperscript{16} found a statistically significant association between the duration of vitiligo and hearing loss.

Maheshwari et al\textsuperscript{14} reported that vitiligo originating in the head and neck region was strongly associated with hearing loss (54.55\%, 6 of 11 cases). In our study, the site of onset was the head and neck in 30\% of the cases with SNHL; however, we could not find a statistically significant association.

**Conclusion**

The results of this study suggest that vitiligo patients require routine monitoring for auditory functions for early identification of sensorineural hearing loss. Older subjects with vitiligo might be at a higher risk for audiological abnormalities. These patients should also be informed regarding the associated risk with noise and ototoxic drug exposure.

Source(s) of support
None to be declared.

Conflicts of Interest
The authors have no conflicts of interest to declare.

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