INTRODUCTION

Sound is a vibration, which travels in air as sound waves, and perceiving it is a very subjective experience. Sound may be perceived as being pleasant or unpleasant, whereas noise is generally considered as a combination of undesirable tones or sounds. These limits are not easily distinguishable as certain frequencies, which are perceived as sound by one may be perceived as noise by others. Exposure to such noise over long period can be uncomfortable and sometimes even painful, eventually leading to hearing loss.

In dentistry, studies have shown that most of the dentists are prone to have hearing impairment.1 Studies have also shown that in right-handed dentists, the left ear is more affected than the right. It may be due to the noises made by airotor, suction, and other cutting and trimming instruments. These noises depend on the intensity, frequency, and daily intervals of exposure to noise.2 Dentists are exposed to high noise from their undergraduate and postgraduate days in certain departments, such as prosthodontics, conservative and endodontics, periodontics, and pedodontics, as there is a continuous use of airotor, micromotor, suction, ultrasonic scalers, and so on. The continuous use of dental chairs and air conditioners also contribute to noise in these departments.3,4

Aim: Dental professionals are prone to have hearing impairment due to prolonged exposure of noise in dental college. The aim of the study was to assess the hearing ability of dental personnel working in Yenepoya Deemed to be University, Mangaluru, Karnataka, India. Materials and Methods: A cross-sectional exploratory study was conducted on 60 subjects (30 male and 30 female). Audiometric analysis was carried out using pure-tone audiometry (PTA) and otoacoustic emission test (OAE). Statistical Analysis: Data were calculated and analyzed using two-way analysis of variance and Tukey’s honestly significant difference test. Results: No statistically significant difference was observed between hearing loss and its association with age, gender, working experience, mean daily working time, and specialization. PTA results showed a statistically significant hearing loss in the left ear, showing a dip at frequency of 4000 Hz among working experience group of 11–15 years and at 6000 Hz for 21–25 years. Also, a statistically significant hearing loss was observed in the left ear at 6000 and 8000 Hz for the age-group of 51–55 years. OAE results were consistent with PTA findings. Conclusion: Dentists and dental personnel are at a higher risk of noise-induced hearing loss. As the working experience increases, the threshold shift is seen to shift from 4000 to 6000 Hz, which is indicative of sensorineural hearing loss due to noise-induced dental environment.

KEYWORDS: Dental noise, dental technicians, dentist’s, hearing assessment

Revised : 13-03-2020.
Accepted : 13-03-2020.
Published : 28-08-2020.
the production of noise. Normal hearing ranges from 0 to 20 dB.

Mojarad et al. observed that the maximum sound level recorded was 85.8 dB in dental offices and 92.0 dB in dental laboratories. In dental clinics, the highest noise was produced by the ultrasonic scaler (85.8 dB) and the lowest noise (49.7 dB) was produced by the high-volume aspirator, whereas in the dental laboratory, the highest noise was attributed to dental stone cutter (92.0 dB) and the lowest to the denture-polishing unit (41.0 dB).

Acute damage to the hearing is due to constant exposure to sound levels exceeding 85 dB. Also, constant exposure to extremely high sound levels associated with blasts or explosions in close proximity to the ear leads to permanent hearing impairment. Although the maximum noise level in dental office is below the damaging noise level to human ear, but it is very close to the limit of hearing loss (85.0 dB).

Kryter suggested that continuous exposure to sound intensity levels in excess of 80 dB for 8 h a day and 5 days a week would cause permanent loss of hearing. Altinöz et al. concluded that under any working condition, high-speed dental air turbines emit frequencies high enough to cause hearing loss. A study conducted by Taylor et al. on 45 dentists for several years established that experienced group of dentists has high-frequency hearing loss. Skurr and Bulteau concluded that 59% of dental students showed significant hearing loss. The age-group of 21–23 years usually shows early manifestation, and the age of 35 years is usually regarded as the starting point of hearing impairment.

Pure-tone audiometry (PTA) is the first test that quantitatively detects hearing loss and can be used to assess the nature and degree of damage in adults and children over the age of 4 years. Otoacoustic emission (OAE) can also be tested for the detection of early changes in the inner ear. These tests to detect deficiencies of hearing can help plan an early intervention and prevent progression of hearing loss. If appropriate testing is not initiated at this stage, it remains undetected by the individual as speech comprehension is not significantly affected. If untreated, the impairment progresses to the third stage of hearing loss, wherein the patient becomes aware of his loss in apprehending sounds of lower pitches mandatory for understanding speech and thus seeks medical attention. Unfortunately, the loss of hearing is permanent at this stage and does not improve even with medical intervention.

Although there is reference in literature as regard to dental noise leading to hearing loss, not many precautionary measures or guidelines are put into practice to prevent these noises from causing hearing impairment. Therefore, the aim of the study was to assess the hearing ability of dental personnel working in Yenepoya University, Mangaluru, Karnataka, India. The hypothesis was that no difference in hearing loss is associated with age, gender, working experience, mean daily working time, and specialization.

**Subjects and Methods**

This study was approved by YEC-1 (Yenepoya Ethics Committee-1) with the protocol number: 2019/031 titled “Hearing assessment of dental personnel: A cross-sectional exploratory study.”

A total of 60 subjects (30 male and 30 female) were selected for this cross-sectional exploratory study from Yenepoya Dental College, Mangaluru, Karnataka, India. Their ears were screened using an otoscopic examination and Weber test for the frequencies of 500, 1000, 2000, and 4000 Hz to differentiate between conductive or sensorineural hearing loss, thereafter an audiometric analysis was carried out using PTA (Clinical audiometer AC40) and OAE test (Neurosoft, Ivanovo, Russia). The whole procedure was performed by an ENT specialized doctor and audiologist in the Department of ENT, Yenepoya Medical Hospital, Mangaluru, Karnataka, India. Data were calculated and compared using two-way analysis of variance and Tukey’s honestly significant difference (HSD) test as a post hoc test. All data were analyzed using the Statistical Package for the Social Sciences (SPSS) software, version 23.0 (IBM, Armonk, North Castle & New York, USA). A P value of less than 0.05 was considered to be statistically significant.

**Inclusion criteria**

Dentists and dental technicians volunteering for the study were:

- Subjects with minimum working experience of 5 years
- Subjects older than 23 years and younger than 60 years
- Subjects of both genders
- Subjects from the specialties of prosthodontics, conservative and endodontics, periodontics, and pedodontics

**Exclusion criteria**

Subjects with a recent history of impaired hearing, cold, congenital disorders of the ear, and tinnitus, and subjects who use iPod at 70% sound level for more than 4.6 h a day were excluded from the study.
Results

The results of PTA test showed that the degree of hearing loss is comparatively more in the left ear than that in the right, and they were within the range of mild hearing loss, and the results of OAE test showed that in the left ear, 50 (83.3%) subjects had pass and 10 (16.6%) subjects had refer, whereas in the right ear 49 (81.6%) had pass and 11 (18.3%) had refer. This study showed males are more affected than females and the left ear is more affected than the right ear in a right-handed dentist. A statistically significant mean hearing threshold shift was observed in the left ear at 4000 and 6000 Hz in the group of working experience of 11–15 years and 21–25 years, respectively. Also, the mean change in distortion product (DP) amplitude of left ear at 6000 and 8000 Hz was statistically significant for left ear at the age-group of 51–55 years. This study compared various specializations and according to the results of OAE, department of pedodontics was prone to more hearing loss compared to other specializations studied.

Discussion

Occupational noise-induced hearing loss is bilateral sensorineural hearing loss that develops gradually over a period of years as a result of exposure to continuous or intermittent loud noise in the workplace.[10] Daily cumulative drill noise of 100 dB for 12–45 min falls within the recommended Occupational Safety and Health Administration (OSHA) guidelines, which allows 8 h of exposure to a 90 dB sound pressure level stimulus.[11] In a study conducted by Kadanakuppe et al.,[12] noise levels recorded by a precision meter in dental teaching institutions was found to be 64–97 dB. As dentists and dental personnel also fall in this category, the risk of hearing loss cannot be underestimated.[11]

Although there are many guidelines in place to prevent hearing impairment due to dental noise, not many precautionary measures are being followed during practice. Therefore, the aim of this study was to create awareness of hearing disorders among dental personnel and to assess the hearing ability of dental personnel working in Yenepoya University.

Table 1 shows sample distribution of dentists and dental technicians following inclusion criteria. Results of PTA test indicate normal hearing in 36.7% of the left ear and 50% of the right ear subjects. In this study, 56.7% of the left ear and 45% of the right ear showed minimal hearing loss, and 6.7% of the left ear and 5% of the right ear showed mild hearing loss. In this study, the degree of hearing loss was more on the left ear compared to that on the right ear. This is attributed to the presence of high- and low-velocity suction devices on the left side of the dental unit for a right-handed dentist. This finding is in agreement with other previous studies conducted by Zubick et al.[2] and Alabdulwahhab et al.[8] who stated that right-handed dentists showed greater hearing loss in the left ear.

The results of OAE test indicate that 81.6% showed pass (normal inner ear functioning) and 18.3% subjects showed refer (inner ear dysfunction) for left ear, and for right ear, 83.33% showed pass (normal inner ear functioning) and 16.6% showed refer (inner ear dysfunction), which is also comparable with PTA finding, wherein the left ear is more affected than the right ear.

On comparing hearing abilities with work experience in years, PTA [Table 2] results were found to be statistically significant at frequencies of 4000 and 6000 Hz in the left ear.

| Table 1: Distribution of the sample | n (%) |
|-----------------------------------|-------|
| Gender                           |       |
| Male                             | 30 (50)|
| Female                           | 30 (50)|
| Age                              |       |
| 20–25                            | 7 (11.7)|
| 26–30                            | 12 (20)|
| 31–35                            | 16 (26.7)|
| 36–40                            | 11 (18.3)|
| 41–45                            | 6 (10)|
| 46–50                            | 6 (10)|
| 51–55                            | 2 (3.3)|
| Mean: 35.2 ± 7.9                 |       |
| Specialization                   |       |
| Prosthodontics                   | 19 (31.7)|
| Conservative and endodontics     | 12 (20)|
| Periodontics                     | 10 (16.7)|
| Pedodontics                      | 7 (11.7)|
| Dental technicians               | 12 (20)|
| Working experience (years)       |       |
| 0–5                              | 8 (13.3)|
| 6–10                             | 26 (43.3)|
| 11–15                            | 11 (18.3)|
| 16–20                            | 6 (10)|
| 21–25                            | 6 (10)|
| 26–30                            | 3 (5)|
| Mean: 11.9 ± 7                   |       |
| Working hours                    |       |
| 0–5                              | 0 (0)|
| 6–10                             | 52 (86.7)|
| 11–15                            | 8 (13.3)|
| Mean: 7.9 ± 2.1                  |       |
On multiple comparison by Tukey’s HSD test of the left ear [Table 3], a temporary hearing threshold shift was observed at frequency of 4000 Hz for working experience group of 11–15 years and also at 6000 Hz for 21–25 years of working experience, which is statistically significant ($P = 0.05$ for 4000 Hz and $P = 0.01$ for 6000 Hz) [Figure 1]. The results are indicative of further deterioration of hearing abilities as the working experience increases. These results are in agreement with a study conducted by Zubick et al.[2] The result of this study indicates that the hearing impairment starts from 11–15 years and gets further deteriorated as the working experience increases, this is in agreement with a study conducted by Messano and Petti,[13] wherein participants with a working experience with at least 10 years of practice are likely to be at greater risk of hearing impairment.

On analyzing OAE test, the results show that in the working experience group of 26–30 years, the sound-to-noise ratio (SNR) is less than six, indicative of inner ear dysfunction for both the left and right ear. There was a change in DP amplitude in all frequencies in working experience group of 26–30 years for both the ears and a larger DP shift at 4000, 6000, and 8000 Hz for working experience of 11 years onward [Figure 2]. On comparing hearing abilities and mean daily working time, PTA findings showed no statistically significant difference between hearing loss in any of the frequencies for both the ears. Also on analyzing OAE findings, no statistically significant difference was observed. All
subjects had a mean daily working hour of less than 8 h and a resting interval of almost every 4 h, which would have led to reversibility of hearing thresholds, leading to no significant findings.

On comparing hearing abilities and age, PTA findings [Table 4] showed a statistically significant difference at 6000 and 8000 Hz in the left ear ($P = 0.00$ for 6000 and 8000 Hz).

On multiple comparisons by Tukey’s HSD test of the left ear [Table 3], results showed a dip in the frequency of 6000 and 8000 Hz for the age-group of 51–55 years, which is statistically significant. This is attributed to presbycusis (sensorineural hearing loss caused due to natural aging of auditory system). General onset of presbycusis is after the age of 50 years, and the results of this study showed hearing loss in the age-group of 51–55 years, suggestive of age-related hearing loss.

The OAE test results indicated age related impairment of inner ear (outer hair cells) for all the tested frequencies for both left and right ear among the age group of 51–55 years. The DP amplitude shift was observed in 4000, 6000, and 8000 Hz from the age of 36 years onward for both ears.

On comparing hearing abilities and gender, PTA results showed a statistically significant difference for both left and right ear, irrespective of gender. On analyzing OAE, results indicate less than six SNR for males for various frequencies. This indicates that males are more affected than females.

On comparing hearing abilities and specialization, PTA results showed marginally statistically significant result at 250 Hz for the left ear ($P = 0.039$) with overall no significant association between hearing loss and dental specialization. As dental specialists worked both in specialty hospitals and private clinics, the noise-producing instruments were not restricted to a single dental specialty. The result of this study contradicts the study conducted by Messano and Petti,[13] wherein they found prosthodontists were significantly associated with presumptive hearing impairment.

OAE test result analysis showed SNR values less than six for majority of frequencies in the specialization of pedodontics for both left and right ear, indicative of inner ear dysfunction. The reason for ear dysfunctioning in the specialization of pedodontics is attributed to the cumulative aggregation of dental equipment noise and cries of babies and small children.

In this study, the dental technicians when compared to practicing dentists were exposed to less decibels of sound as they were not involved in clinical dentistry, and their quantum of work was within a fixed time frame, hence their results were not statistically significant.

The limitation of this study would be its smaller sample size. As it was an exploratory study without a control group, standardization was difficult. Also, all the subjects in this study were right handed. Hence, further studies with larger sample size and left-handed dental personnel should be included in the study for more conclusive results.

| Table 3: Multiple comparison using Tukey honest significant difference test for left ear |
| Working experience |
| Frequency | Group (I) | Group (J) | Sig | 95% Confidence interval |
| 4000 Hz | 11–15 | 0–5 | 0.025 | 1.04 | 24.08 |
| | 6–10 | 0.015 | 1.38 | 19.21 |
| 6000 Hz | 21–25 | 6–10 | 0.049 | 0.04 | 27.14 |
| Age |
| Frequency | Group (I) | Group (J) | Sig | 95% Confidence interval |
| 6000 Hz | 51–55 | 20–25 | 0.00 | 16.25 | 62.32 |
| | 25–30 | 0.00 | 12.23 | 56.11 |
| | 31–35 | 0.00 | 14.08 | 53.90 |
| | 36–40 | 0.01 | 9.74 | 58.46 |
| | 41–45 | 0.01 | 11.54 | 55.96 |
| | 46–50 | 0.02 | 9.04 | 55.96 |
| 8000 Hz | 51–55 | 20–25 | 0.00 | 16.61 | 56.96 |
| | 25–30 | 0.00 | 16.79 | 55.48 |
| | 31–35 | 0.00 | 17.07 | 54.81 |
| | 36–40 | 0.00 | 15.88 | 54.57 |
| | 41–45 | 0.00 | 16.12 | 57.21 |
| | 46–50 | 0.00 | 14.46 | 55.54 |

The mean difference is significant at the 0.05 level.
Table 4: Pure-tone audiometry findings at different frequency associated with age

| Working experience (years) | Hearing threshold (dB) | Frequency | PTA Avg |
|---------------------------|------------------------|-----------|---------|
| Left ear                  |                        | 250 Hz    | 500 Hz  | 1000 Hz | 2000 Hz | 4000 Hz | 6000 Hz | 8000 Hz |        |
| 20–25                     | Mean                   | 16.43     | 17.14   | 13.57   | 15.71   | 15.00   | 15.71   | 15.71   | 15.35   |
|                           | SD                     | 6.26      | 4.88    | 5.56    | 6.07    | 4.08    | 5.34    | 5.34    | 4.77    |
| 25–30                     | Mean                   | 16.25     | 18.33   | 16.25   | 15.83   | 20.00   | 20.83   | 17.08   | 17.60   |
|                           | SD                     | 4.82      | 4.92    | 5.27    | 5.57    | 8.52    | 7.33    | 6.20    | 4.34    |
| 31–35                     | Mean                   | 13.44     | 14.06   | 15.94   | 16.88   | 20.31   | 19.38   | 16.56   | 16.79   |
|                           | SD                     | 6.51      | 5.83    | 5.83    | 5.73    | 7.18    | 7.04    | 5.39    | 5.16    |
| 36–40                     | Mean                   | 17.27     | 18.18   | 15.00   | 17.73   | 24.55   | 23.18   | 17.27   | 18.86   |
|                           | SD                     | 8.47      | 6.80    | 5.00    | 5.17    | 13.31   | 10.55   | 7.19    | 4.88    |
| 41–45                     | Mean                   | 10.00     | 10.83   | 10.83   | 15.83   | 20.00   | 20.00   | 15.83   | 14.37   |
|                           | SD                     | 7.071     | 6.64    | 3.76    | 7.36    | 8.94    | 8.94    | 8.61    | 5.40    |
| 46–50                     | Mean                   | 16.67     | 16.67   | 16.67   | 22.50   | 22.50   | 17.50   | 18.12   |         |
|                           | SD                     | 2.58      | 4.08    | 5.16    | 2.58    | 7.58    | 8.80    | 5.24    | 3.23    |
| 51–55                     | Mean                   | 12.50     | 12.50   | 10.00   | 22.50   | 35.00   | 55.00   | 52.50   | 20.00   |
|                           | SD                     | 10.60     | 10.60   | 14.14   | 10.60   | 14.14   | 35.35   | 38.89   | 12.37   |
| Right ear                 | Mean                   | 15.00     | 15.71   | 13.57   | 15.00   | 13.57   | 17.86   | 16.43   | 14.46   |
|                           | SD                     | 7.07      | 7.31    | 5.56    | 7.07    | 7.48    | 8.59    | 11.44   | 6.16    |
| 20–25                     | Mean                   | 14.58     | 15.83   | 15.00   | 19.58   | 20.00   | 17.50   | 16.35   |         |
|                           | SD                     | 8.64      | 7.33    | 7.97    | 7.07    | 7.52    | 6.39    | 8.91    | 5.67    |
| 25–30                     | Mean                   | 14.69     | 14.69   | 16.25   | 17.50   | 20.31   | 20.63   | 16.56   | 17.18   |
|                           | SD                     | 5.90      | 5.31    | 5.00    | 6.32    | 11.61   | 9.46    | 6.51    | 6.01    |
| 31–35                     | Mean                   | 14.55     | 15.00   | 14.55   | 16.36   | 24.09   | 23.64   | 15.45   | 17.50   |
|                           | SD                     | 2.69      | 3.16    | 5.22    | 5.04    | 12.81   | 13.61   | 2.69    | 5.24    |
| 36–40                     | Mean                   | 14.55     | 15.00   | 14.55   | 16.36   | 24.09   | 23.64   | 15.45   | 17.50   |
|                           | SD                     | 2.69      | 3.16    | 5.22    | 5.04    | 12.81   | 13.61   | 2.69    | 5.24    |
| 41–45                     | Mean                   | 9.17      | 9.17    | 13.33   | 15.83   | 20.00   | 19.17   | 14.17   | 14.58   |
|                           | SD                     | 4.91      | 4.91    | 5.16    | 3.76    | 7.74    | 8.01    | 8.61    | 4.44    |
| 46–50                     | Mean                   | 15.83     | 16.67   | 17.50   | 19.17   | 22.50   | 20.83   | 17.50   | 18.95   |
|                           | SD                     | 4.91      | 5.16    | 5.24    | 4.91    | 5.24    | 5.84    | 6.12    | 4.50    |
| 51–55                     | Mean                   | 12.50     | 12.50   | 10.00   | 12.50   | 25.00   | 27.50   | 25.00   | 15.00   |
|                           | SD                     | 3.53      | 3.53    | 7.07    | 3.53    | 14.14   | 17.67   | 14.14   | 1.76    |
| F                         | 0.829                  | 1.245     | 0.694   | 0.623   | 0.930   | 0.475   | 0.581   | 0.606   |
| Sig                       | 0.553                  | 0.299     | 0.655   | 0.711   | 0.481   | 0.824   | 0.744   | 0.724   |

PTA = pure-tone audiometry, SD = standard deviation
Bold values indicate $P < 0.05$ which is statistically significant

Figure 1: Audiogram from pure-tone audiometry test
CONCLUSION

On the basis of the observations and results of this study, the following conclusions were drawn:

- As the working experience increases, a statistically significant threshold shift is seen from 4000 to 6000 Hz, which is indicative of sensorineural hearing loss due to noise-induced dental environment.
- As the age increases, a statistically significant threshold dip was observed at a frequency of 6000 and 8000 Hz in the age-group of 51–55 years, suggestive of presbycusis.
- No statistically significant difference was noted between hearing abilities and the mean daily working time, gender, and dental specialization.
- Among the specialization included in the study, dentists working in pedodontics specialties are more prone to hearing loss compared to others.
- This study showed that dentists had more inclination toward hearing loss when compared with dental technicians.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Myers J, John AB, Kimball S, Fruits T. Prevalence of tinnitus and noise-induced hearing loss in dentists. Noise Health 2016;18:347-54.
2. Zubick HH, Tolentino AT, Boffia J. Hearing loss and the high speed dental handpiece. Am J Public Health 1980;70:633-5.
3. Mojaraad F, Massum T, Samavat HA. Noise levels in dental offices and laboratories in Hamedan, Iran. J Dent Tehran Univ Med Sci 2009;4:181-6.
4. Willershausen B, Callaway A, Wolf TG, Ehlers V, Scholz L, Wolf D, et al. Hearing assessment in dental practitioners and other academic professionals from an urban setting. Head Face Med 2014;10:1.
5. Kryter KD, Ward WD, Miller JD, Eldredge DH. Hazardous exposure to intermittent and steady-state noise. J Acoust Soc Am 1966;39:451-64.
6. Taylor W, Pearson J, Mair A. The hearing threshold levels of dental practitioners exposed to air turbine drill noise. Br Dent J 1965;118:206-10.
7. Skurr BA, Bulteau VG. Dentists' hearing: the effect of high speed drill. Aust Dent J 1970;15:259-60.
8. Alabdulwahhab BM, Alduraiby RI, Ahmed MA, Albatli LI, Alhumain MS, Softah NA, et al. Hearing loss and its association with occupational noise exposure among Saudi dentists: a cross-sectional study. BDJ Open 2016;2:16006.
9. Kumar PR, Sharma P, Kalavathy N, Kashinath KR. Hearing damage and it's prevention in dental practice. J Dent Sci Res 2011;2:1-5.
10. Khaimook W, Suksmae P, Choosong T, Chayarpham S, Tantisarasart R. The prevalence of noise-induced occupational hearing loss in dentistry personnel. Workplace Health Saf 2014;62:357-60.
11. Wilson CE, Vaidyanathan TK, Cinotti WR, Cohen SM, Wang SJ. Hearing-damage risk and communication interference in dental practice. J Dent Res 1990;69:489-93.
12. Kadankuppe S, Bhat PK, Jyothi C, Ramagowda C. Assessment of noise levels of the equipments used in the dental teaching institution, Bangalore. Indian J Dent Res 2011;22:424-31.
13. Messano GA, Petri S. General dental practitioners and hearing impairment. J Dent 2012;40:821-8.