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Noise Level of Drilling Instruments during Mastoidectomy

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Abstract

Exposure to intense noise has been identified as a potential risk in the development of hearing impairment. Social concern about excessive noise is increasing and this also extends to the operating room. A noise level study was performed in the operating room during mastoidectomy with a sound level meter and it was analyzed by a sound-analyzing program. The drilling instruments used included the Stryker, Midas, M.P.S. and Med-Next. The operator was exposed to sound levels from 69 to 83 dBA. The loudest drilling instrument was the Midas and it produced an average sound level of 83 dBA to the operator. The mean exposure time was 41 minutes during mastoidectomy. This is below the occupational noise-level regulations in Korea. However, considering that individual susceptibility to noise varies and that the otologic surgeon is repeatedly exposed to prolonged drilling noise, ear protection is recommended for the operators of high-speed drilling instruments.

Key Words: Noise, noise-induced hearing loss, mastoidectomy, drilling instrument

INTRODUCTION

Continuous exposure to noise is known to cause side effects such as hearing impairment,[1] tachycardia[2] and elevation in serum cortisol and cholesterol.[3] Various risk criteria have been proposed to prevent hearing impairment. Recently, concern about noise pollution has increased and numerous reports about noise pollution in the operating room and intensive care units have been reported. However, less attention has been paid in the field of otorhinolaryngology, even though the noise produced by a drilling instrument during mastoidectomy is probably hazardous. The authors measured and analyzed the sound levels during mastoidectomy to verify the possible effects of noise trauma to personnel working in the operating room.

MATERIALS AND METHODS

Noise produced during 10 mastoidectomies in patients with chronic otitis media was measured with a Quest 2700 sound level meter (Quest, Oconnomowoc, Wisconsin, USA) (Fig. 1). The temporal bones were all sclerotic. The first author performed all the operations, alone. The operator, assistant, nurse and anesthesiologist all remained at a constant distance from the operating bed and the noise produced by a drilling instrument at the site of the operating ear was measured at each person's position (Fig. 2). The average distances measured from a drill to the surgeon, assistant, nurse and anesthesiologist were 68, 78, 102 and 192 cm, respectively. The number of drilling instruments used included the Stryker (Humer-II, Ostero-Stryker, Michigan, Illinoi, USA): 5, Midas (Midas-rex III, Midas-LP, Dalas, Texas, USA): 2, M.P.S. (MPS-2000, Xomed, Jacksonville, Florida, USA): 2 and Med-Next (Med^{next} high-

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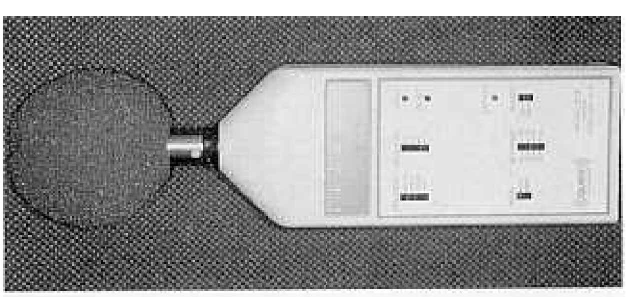

Fig. 1. Quest 2700 sound level meter.

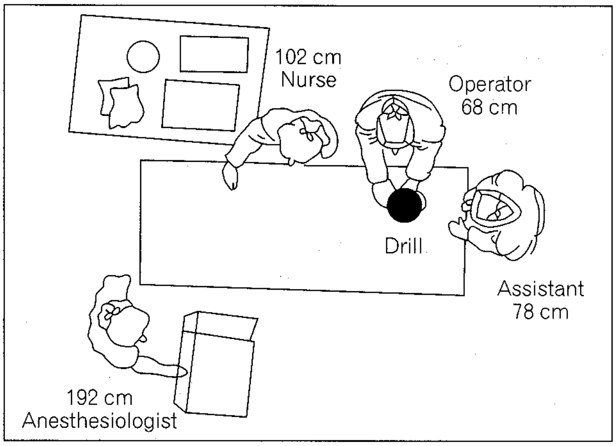

Fig. 2. Position of personnel in operating room. The distances from the hand-piece of drilling instrument to the ear of personnel were recorded.

speed drill system, Med[next], Santaclaria, California, USA): 1. When the sound level became steady for a 10-second period, the level was recorded 3 times during each operation. The mean sound levels from drilling with a cutting burr and a diamond burr were calculated. The frequency of noise above 90 dBA per minute was recorded. Noise was recorded on a tape recorder and analyzed with a speech analysis program, Doctor speech science version 3.0 (Tiger Electronics, Penpuitch, Utah, USA). Statistical analyses were performed using paired t-test and Pearson correlation.

RESULTS

The sound levels produced by the drilling instrument at the operation site ranged from 69 to 83 dBA at the position of the surgeon, 68−80 dBA at the position of the assistant, 68−78 dBA at the position of the nurse and 66−75 dBA at the position of the anesthesiologist (Table 1 and 2). The surgeon was exposed to the loudest sound level for each drilling instrument ($p<0.05$). The average sound level measured at the position of the surgeon when using a cutting burr was M.P.S. 73 dBA, Stryker 77 dBA, Med-Next 78 dBA and Midas 83 dBA. At the position of the operator, Midas produced the loudest sound level ($p<0.05$). Correlation coefficients between R.P.M. (revolutions per minute) of the drilling machine and sound level at the position of the operator using cutting burrs and diamond burrs were 0.928 and 0.916, respectively (Table 3). At the position of the operator, the cutting burr had a tendency to produce a louder sound than the diamond

Table 1. Sound Level Produced during Mastoidectomy with Cutting Burr

Drilling instrument	Sound level (dBA) (mean±S.D.)			
	Operator*	Assistant	Nurse	Anesthesiologist
M.P.S.	73±0.95	72±3.59	70±2.45	67±2.38
Stryker	77±2.05	74±1.86	72±2.17	68±1.70
Med[Next]	78±2.50	74±1.15	72±0.55	65±1.70
Midas	83±2.26	78±0.95	77±3.35	75±3.20

*Operator was exposed to the loudest noise level for each drilling instrument ($p<0.05$).
Midas drilling instrument produced the loudest noise ($p<0.05$).

Table 2. Sound Level Produced during Mastoidectomy with Diamond Burr

Drilling instrument	Sound level (dBA) (mean±S.D.)			
	Operator*	Assistant	Nurse	Anesthesiologist
M.P.S.	69±0.70	68±5.65	68±3.55	66±1.41
Stryker	74±2.17	72±1.31	70±1.32	67±0.95
Med[Next]	77±1.91	74±2.08	71±1.15	65±0.50
Midas	83±1.85	80±1.60	78±1.81	74±1.98

*Operator was exposed to the loudest noise level when all the drilling instruments except M.P.S. were used ($p<0.05$).
Midas drilling instrument produced the loudest sound ($p<0.05$).

Table 3. The Correlation between the R.P.M. of Drill and the Sound Level in the Position of Operator

Drilling machine	R.P.M.	Sound level (dBA) (mean±S.D.)	
		Cutting burr	Diamond burr
M.P.S.	48000	73±0.95	69±0.70
Stryker	50000	77±2.05	74±2.17
Med[Next]	65000	78±2.50	77±1.91
Midas	100000	83±2.26	83±1.85
Correlation coefficient		0.928	0.916

R.P.M., revolutions per minute.

Table 4. Frequencies of Development of Noise over 90 dBA per Minute

Drilling instrument	Frequency of noise over 90 dBA per minute (cutting burr/diamond burr)			
	Operator*	Assistant	Nurse	Anesthesiologist
M.P.S.	4/5	3/1	1/0	0/0
Stryker	5/5	3/0	1/1	0/0
MedNext	4/4	3/2	2/1	0/0
Midas	8/6	4/3	2/2	0/0

*At the position of operator, every instrument produced noise over 90 dBA more than 4 times per minute.

burr, but it was not statistically significant (p=0.214). The frequency of sound levels over 90 dBA per minute was measured and is shown in Table 4. The operator exposed most frequently exposed to the highest noise level. At the position of the anesthesiologist, the sound level never exceeded 90 dBA. The average duration for using a drilling instrument per operation was 41 minutes. Analysis of the type of noise produced by drilling instruments with Doctor Speech Science was classified as white noise (Fig. 3).

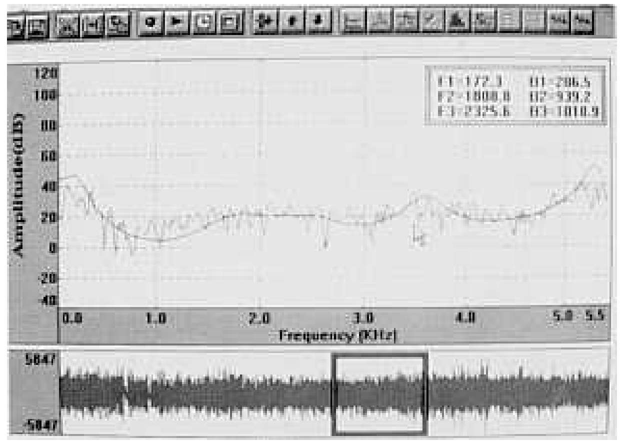

Fig. 3. Recorded noise with sound analyzing program, Doctor Speech Science version 3.0. Analyzed noise was a typical white noise.

DISCUSSION

Exposure to excessive noise is known to produce damage to hair cells in the organ of Corti (hearing impairment), tachycardia, elevations in serum cortisol and cholesterol, sleep disturbance, as well as various psychological, cardiovascular and pulmonary problems.[1-3] Recently, the environment and pollution have become focuses of public interest, which has also led to increased concern about noise pollution in the working environment. Until now, research on noise-induced hearing loss has been limited to mine workers and aircraft personnel,[4,5] and a damage criteria has been proposed. According to the Environmental Protection Agency[6] and Occupational Safety and Health Act,[7] 8 hours of daily noise exposure above 75 dBA and 8 hours of daily noise exposure above 90 dBA have been prescribed as the damage criteria, respectively.

In the medical area, noise pollution has been studied in the fields of urology, orthopedics and dentistry. Noise protection is suggested during Extracorporeal Shock Wave Lithotripsy (ESWL) because there have been reports that it may produce noise levels from 75−110 dBA, depending on the instrument used.[8,9] A plaster saw used during orthopedic surgery can produce up to 100 dBA of noise, and there have been reports that 50% of orthopedic surgeons suffer from noise-induced hearing loss.[10-13] A hand-piece used during dental surgery normally produces 80−90 dBA of noise.[14]

During mastoidectomy, the surgeon is exposed to the noise from a drilling instrument for quite a long time. According to our study, these drilling instruments produced more than 75 dBA of noise (cutting burr), with the exception of the M.P.S. drill. The character of noise produced was a typical white noise, as is the case in many noise-producing working environments. The average number of times noise exceeded 90 dBA to the operator was more than 4 times per minute, whatever drilling instrument was being used. Considering that intermittent loud noise has a higher probability of producing noise-induced hearing loss than persistent noise, due to the lack of protective function of the stapedial reflex,[9] intermittent loud noise during mastoidectomy drilling work may therefore produce some hazardous effects to the cochlea. The difference of noise level between a cutting burr and a diamond burr was not statistically significant. However, noise increased as the R.P.M. of the drilling instrument increased, and considering that faster drilling instruments are more popular, these devices should be used very carefully. Exposure to sound pressure levels averaging 83 dBA for an average 41 minutes for each mastoid surgical procedure with a high-speed drill (that with the R.P.M. of 100,000 or more) is not sufficient to produce an auditory hazard according to the hearing damage criteria of the Occupational Safety and Health Act. Although this is below the noise level for occupational regulations in Korea, that is not to say that there is no hazard whatsoever. Considering that individual susceptibility to noise varies and that the otologic surgeon is repeatedly exposed to prolonged drilling noise, active prevention of noise-induced hearing loss may be required for the operator using high-speed drilling intruments. Preventive methods include the use of ear protectors and measurement of noise-induced temporary threshold shift (TTS).[15]

Although a prospective study on noise-induced hearing loss based on regular hearing check-ups is required in order to determine the effect of noise in surgical personnel, the sound level measured during mastoidectomy was relatively high and may produce some hazardous effects to the surgeon using high-speed drilling instruments. We recommend an active prevention program, including protective devices and regular hearing tests for the surgical team, especially for the surgeon who uses the high-speed drilling instruments.

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