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ORIGINAL ARTICLE

A Clinical Study to Evaluate the Association Between Metabolic Syndrome and Sensorineural Hearing Loss

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Abstract Metabolic syndrome is considered to be a triggering factor for deterioration of health related quality of life. In present study we assessed hearing loss consequent to metabolic syndrome. A total of 100 patients diagnosed for metabolic syndrome (IDF criteria) were included in the study. All the patients underwent pure tone audiometry and impedance audiometry. All the patients underwent anthropometric measurements, lipid profile, blood sugar and blood pressure assessments. Data was analyzed using SPSS 21.0 software. A total of 62% patients had sensorineural hearing loss. Maximum (35%) had mild hearing loss, followed by moderate hearing loss (23%). Only 4 (4%) cases had severe hearing loss. Older age, wider waist circumference, higher fasting blood glucose levels and lower blood pressure were found to be significantly associated with sensorineural hearing loss and its severity on univariate analysis. However, on multivariate assessment only age and waist circumference showed a significant association with hearing loss.

Keywords Metabolic syndrome · Sensorineural hearing loss · Obesity · Waist circumference · Blood pressure · Fasting glucose

Introduction

The metabolic syndrome (MetS) can be defined as a combination of disorders that include: obesity, insulin resistance, glucose intolerance, impaired regulation of body fat and high blood pressure [1]. It is a cluster of cardiovascular risk factors: diabetes and raised fasting plasma glucose, abdominal obesity, high cholesterol and high blood pressure and high insulin resistance [2]. Complications resulting from metabolic syndrome significantly reduces quality of patient's life and represents a huge socio-economic burden [3]. It is estimated that around 20–25 per cent of the world's adult population have the metabolic syndrome [4]. Hearing loss is one of the many complications associated with metabolic syndrome. In the recent years, it has been showed by different studies that metabolic syndrome and its components are associated with gradual sensorineural hearing loss [5–9]. In present study, we made an attempt to study the prevalence of sensorineural hearing loss in metabolic syndrome patients at a tertiary care centre in North India.

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Material and Methods

The present study was carried out as a cross-sectional study. Sample size was calculated at a targeted prevalence of sensorineural hearing loss in metabolic syndrome to the tune of 47% as reported by Lee et al. [7] in their study. The sample size was calculated as 96 at 95% confidence and 10% error allowance. However, the sample size was kept at 100 after making contingency provisions.

A total of 100 patients fulfilling the IDF criteria for metabolic syndrome [10] (Box 1) were randomly selected from amongst patients attending the Medicine OPD of Era's Lucknow Medical College, Lucknow after obtaining clearance from Institutional Ethics Committee and getting informed consent from the patients. Patients below 18 years and above 65 years of age, those having hearing loss > 80 dB due to noise exposure, having any ear disease causing conductive hearing loss (*e.g.* otitis media, cholesteatoma, ear canal stenosis, etc.), having history of ototoxic drug intake (e.g. aspirin, quinolones, aminoglysides, etc.), having history of ear surgery and those having congenital hearing loss were excluded from the study.

A complete physical examination of patients was done. Their waist circumference was measured. Blood pressure (systolic/diastolic) was also measured. Fasting glucose and lipid profile assessment.

Tuning fork tests, PTA and impedance audiometry was done for assessment of hearing loss.

WHO classification (1980) on the basis of PTA taking the average of the thresholds of hearing for frequencies of 500, 1000, and 2000 was used [11]. Degree of hearing loss—mild: 26–40 dB, moderate: 41–55 dB, moderately severe: 56–70 dB, severe: 71–90 dB, and profound: more than 90 dB. Findings of worse of two ears were taken as representative.

Data so obtained was subjected to analysis using Statistical Package for Social Sciences (SPSS) version 21.0. For univariate analysis, Chi-square, ANOVA and Independent samples '*t*'-tests were used. Multivariate analysis was done using binary logistic regression. A '*p*' value less than 0.05 was considered to be statistically significant.

Results

Mean age of patients was 37.06 ± 7.13 years. Majority of patients were females (65%) (Table 1). Majority (62%) of patients had hearing loss. With respect to severity of hearing loss, maximum (35%) had mild hearing loss, followed by moderate hearing loss (23%). Only 4 (4%) cases had severe hearing loss (Table 2). On univariate analysis, patients with hearing loss had significantly higher mean age, waist circumference and fasting blood glucose levels as compared to those having normal hearing whereas patients with normal hearing had significantly higher systolic and diastolic blood pressure as compared to those having hearing loss (Table 3). On assessing the association between severity of hearing loss and different demographic and clinical variables, age, waist circumference, fasting blood sugar, systolic and diastolic blood pressure were found to be significantly associated with severity of hearing loss (Table 4). On binary logistic regression (multivariate assessment) only age and waist circumference showed a significant association with hearing loss (Table 5).

Discussion

In present study, sensorineural hearing loss was detected in 62% of patients of metabolic syndrome. Prevalence of hearing loss in metabolic syndrome has been reported to range from 11.9 to 47% in different contemporary studies [5, 7, 9]. However, all these studies were conducted in environments where healthcare systems are much developed than ours. Although, there are no Indian studies evaluating the prevalence of sensorineural hearing loss in metabolic syndrome patients, however, at component level, there are studies that have reported results similar to present study. In one such study, Srinivas et al. [12] and Dadhich et al. [13] also found prevalence of sensorineural hearing loss to be 66% and 73% in type 2 diabetes mellitus patients. In another study, Parmar et al. [14] reported a prevalence of sensorineural hearing loss to the tune of 62% among diabetic and/or hyperlipidemia patients. Thus prevalence of hearing loss in metabolic syndrome patients in present study is in accordance with contemporary similar studies.

In present study, maximum mild hearing loss was seen in 35%, moderate in 23% and severe hearing loss in 4% cases. Similar to present study, Dadhich et al. [13] also reported a dominance of mild (48%), followed by moderate (21%) hearing loss and reported severe hearing loss in only 1% case. Swaminathan et al. [15] too in their study reported the nature of hearing loss among diabetics and hyperlipidemic patients to be of mild to moderate order.

In present study, univariate assessment showed hearing loss to be significantly associated with higher mean age, waist circumference and fasting blood glucose levels. In fact, age and waist circumference showed a significant association with hearing loss in multivariate assessment too. As far as risk factors associated with hearing loss are concerned, older age has been reported as the significant factors in a number of studies, however, there are differences with respect to other factors. Lee et al. [7] in their study also found older age as a significant factor associated

Table 1 Age and Gender profile of subjects enrolled in the study

Variable	No	%
Age		
20–29 yr	10	10.0
30–39 yr	53	53.0
40–49 yr	30	30.0
> = 50 yr	7	7.0
Mean Age	37.06 ± 7.13	
Gender		
Male	35	35.0
Female	65	65.0
Total	100	100.0

Table 2 Distribution of cases according to hearing status

Hearing loss	No	%
No	38	38.0
Mild	35	35.0
Moderate	23	23.0
Severe	4	4.0
Total	100	100.0

with hearing loss, however, they also found male sex, very low body mass index ($\leq$ 17.5 kg/m^2), lower education level, smoking history, and occupational noise exposure as the other significant factors associated with it. In present study, we did not study socioeconomic factors, personal habits and occupational factors, however, we must not agree that these factors also have a decisive role. Chang et al. [8] in their study also recognized age as an important determinant of hearing loss in metabolic syndrome patients while at the same time they identified insulin-resistance as another significant factor influencing the hearing loss. With respect to role of fasting glucose levels, it can be related with the micro and macro-vascular changes bringing about hyperglycemia induced pathological changes in ear such as influencing the thickness of basal membrane of stria vascularis capillaries [13, 16–18]. The association between obesity (waist circumference) and sensorineural hearing loss is not settled. While some workers like, Lalwani et al. [19] report it to be a significant factor in adolescents, other workers like Chang et al. [8] do not find it to be a significant predictor of hearing loss in metabolic syndrome patients. As such the opinion is generally divided and no direct link between obesity and hearing loss is established as yet [20]. Hence, the association of waist circumference with hearing loss as observed in present study could be let-off just as a temporal relationship that requires further empirical evidence.

In present study, we did not find a significant association of hearing loss with lipid levels. As such, hyperlipidemia has been stated to be associated with a higher risk of hearing loss in other studies [5, 14, 15]. However, it must be pertinent to mention here that all these studies have been carried out either as case–control studies or have been performed in a cross-section of individuals with and without metabolic syndrome. The present study was conducted among metabolic syndrome patients only, who tend to have lipid levels of higher order, thus it seems that the association of lipid levels with hearing loss as observed in normal population cannot be applied to an exclusive metabolic syndrome population. It seems that evolution

Table 3 Association of hearing loss with demographic and clinical profile of patients

SN	Characteristic	Hearing loss (n = 62)	No hearing loss (n = 38)	Statistical significance
1	Mean Age ± SD (Range), years	39.13 ± 7.20 (20–54)	33.66 ± 5.38 (20–44)	't' = 4.042; $p < 0.001$
2	Gender			
	Male	45 (72.6%)	21 (55.3%)	χ^2 = 3.149;
	Female	17 (27.4%)	17 (44.7%)	p = 0.076
3	Mean BMI ± SD, kg/m^2	29.95 ± 1.63	29.66 ± 1.60	't' = 0.880; p = 0.381
4	Mean waist circumference ± SD, cm	95.79 ± 2.50	88.92 ± 14.92	't' = 3.557; p = 0.001
5	Mean Fasting blood glucose ± SD, mg/dl	118.97 ± 19.32	106.45 ± 19.27	't' = 3.149; p = 0.002
6	Mean PP blood glucose ± SD, mg/dl	165.56 ± 34.70	158.71 ± 32.90	't' = 0.978; p = 0.331
7	Mean SBP ± SD, mmHg	141.13 ± 15.59	147.37 ± 8.60	't' = 2.263; p = 0.026
8	Mean DBP ± SD, mmHg	88.71 ± 9.83	94.21 ± 5.00	't' = 3.200; p = 0.002
9	Mean TG ± SD, mg/dl	198.08 ± 26.25	186.97 ± 38.64	't' = 1.711; p = 0.090
10	Mean HDL ± SD, mg/dl	36.79 ± 5.25	37.61 ± 5.75	't' = 0.727; p = 0.469
11	Mean LDL ± SD, mg/dl	127.11 ± 16.12	126.08 ± 14.42	't' = 0.324; p = 0.747
12	Mean TC ± SD, mg/dl	203.58 ± 16.18	201.13 ± 16.20	't' = 0.734; p = 0.464

Table 4 Comparison of MS parameters with hearing loss status

Parameter	Severity of hearing loss				Statistical significance (ANOVA)	
	No loss (n = 38)	Mild (n = 35)	Moderate (n = 23)	Severe (n = 4)	F	'p'
Age	33.59 ± 5.44	38.88 ± 7.98	39.65 ± 6.50	38.75 ± 6.18	5.38	0.002
BMI	29.65 ± 1.62	29.97 ± 1.64	29.78 ± 1.73	30.50 ± 1.29	0.46	0.711
WC (cm)	88.81 ± 15.10	95.91 ± 2.47	95.74 ± 2.68	94.50 ± 1.91	4.08	0.009
FBG (mg/dl)	105.95 ± 19.28	113.76 ± 20.46	125.52 ± 14.49	122.25 ± 27.07	5.27	0.002
PP BG (mg/dl)	158.16 ± 33.17	161.85 ± 36.54	175.48 ± 28.67	150.75 ± 44.27	1.48	0.225
SBP (mmHg)	147.30 ± 8.71	143.24 ± 13.42	134.78 ± 17.29	155.00 ± 5.77	5.73	0.001
DBP (mmHg)	94.32 ± 5.02	91.18 ± 8.08	83.91 ± 11.18	95.00 ± 5.77	8.62	< 0.001
TG (mg/dl)	188.70 ± 37.66	201.88 ± 18.20	196.87 ± 33.91	169.75 ± 25.30	1.99	0.120
HDL (mg/dl)	37.38 ± 5.65	36.12 ± 4.97	36.70 ± 5.46	43.50 ± 1.91	2.42	0.071
LDL (mg/dl)	126.81 ± 13.89	127.71 ± 14.61	129.52 ± 17.15	106.75 ± 12.84	2.70	0.050
TC (mg/dl)	201.97 ± 15.56	204.53 ± 13.98	205.26 ± 18.59	184.25 ± 9.60	2.23	0.090

Table 5 Multivariate assessment (Binary Logistic Regression)

	B	S.E	Wald	df	Sig	Exp(B) (OR)	95.0% C.I. for EXP(B)	
							Lower	Upper
Age	.091	.044	4.311	1	0.038	1.096	1.005	1.194
WC	.434	.104	17.494	1	< 0.001	1.543	1.259	1.890
FBS	.024	.015	2.372	1	0.124	1.024	.994	1.055
SBP	.006	.029	.049	1	0.826	.994	.939	1.051
DBP	.084	.043	3.704	1	0.054	.920	.845	1.002
Constant	37.593	10.888	11.922	1	0.001	.000		

Box 1 International diabetes federation criteria for metabolic syndrome

Central Obesity—Waist Circumference (> 90 cm in males and > 80 cm in females)

Hypertension: *Blood Pressure Assessment* (> 130/85 mm hg) or treatment of previously diagnosed hypertension

Biochemical

(a) Blood Sugar Levels–Fasting (> 100 mg/dl or > 6.1 mmol/L) or previously diagnosed type 2 diabetes

(b) Lipid Profile –

(1) Triglyceride level (> 150 mg/dl or > 1.69 mmol/L) or specific treatment for this lipid abnormality

(2) HDL levels (< 40 mg/dLor < 1.0 mol/L for men and < 50 mg/dL or < 1.3 mmol/L for women) or specifictreatment for this lipid abnormality

According to International Diabetes Foundation (IDF) guidelines, presence of 2 or more of the above factors along with central obesity (Waist circumference) confirms the diagnosis of Metabolic Syndrome

and progression of hearing loss in metabolic syndrome follows some peculiar pathways influenced by multiple risk factors that supposedly tend to regress the effect of each other and thus only those having a dominating role emerge as significant predictors while others show an unexpected behavior. In present study, we also found that lower mean blood pressure was associated with increased risk of sensorineural hearing loss. On evaluating the literature related with prevalence of hearing loss among metabolic syndrome patients, we did not find any single study showing association of blood pressure with hearing loss. In present study, we also found that in multivariate assessment blood pressure does not seem to play a role in evolution of hearing loss.

The present study was one of the first attempts to study the problem of hearing loss in an already identified exclusive metabolic syndrome population and it revealed that compared to general population, where almost all metabolic syndrome factors have been stated to be related with an increased risk of hearing loss, their roles seem to change somewhat. These findings indicate the multivariability of factors influencing the hearing loss. Unfortunately, the present study was limited to study the magnitude of problem of sensorineural hearing loss in metabolic syndrome patients and the scope of study was limited to study the influence of different metabolic syndrome factors only, apart from age and gender of the patient, however, we feel that role of environmental, sociodemographic and occupational factors might also help in understanding this relationship in a better way in order to ascertain the exact cause-effect aspect.

Conclusion

The present study showed a high risk of hearing loss among patients with metabolic syndrome which was associated mainly with the ageing and obesity. It is recommended that metabolic syndrome patients should be motivated to control their weight, particularly in later years of their life so as to minimize the ageing related impact of hearing loss.

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Declarations

Conflict of interest There are no conflicts of interest.

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