Iron Deficiency and Hearing Problems in Adult Patients: Sample of Iraqi Patients

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Abstract

Background: Anemia causes insufficient oxygenation of various organs, which leads to impairment of cognitive function as well as behavioral dysfunction, and there is a possibility of iron effects on the inner ear system by inducing pathologic insults. **Objectives:** The aim of this article is to investigate the association of tinnitus and hearing loss with iron deficiency and iron deficiency anemia. **Materials and Methods:** A descriptive cross-sectional study included patients suffering from tinnitus who were tested by pure tone audiometry and categorized according to hearing status into those with normal hearing and those with hearing loss. A blood sample was taken from each one for performing a complete blood count and serum ferritin level measurements in order to show the presence of iron deficiency and/or iron deficiency anemia. **Results:** One hundred patients with tinnitus were enrolled, 62 patients of them have hearing loss, while 38 patients have normal hearing. Forty-eight percent of tinnitus patients have iron deficiency anemia and 13% have only iron deficiency. There is a significant association between sensorineural hearing loss and iron deficiency anemia in patients with tinnitus (P value is 0.00283, P value is significant if <0.05). The proportion of subjects with low ferritin and hearing loss is significantly higher than those with low ferritin and normal hearing (P value is 0.000106. The result is significant at $P < 0.05$). **Conclusion:** Tinnitus and sensorineural hearing loss are significantly associated with iron deficiency and iron deficiency anemia.

Keywords: Anemia, ferritin, hearing loss, iron deficiency, tinnitus

Introduction

One of the important elements in the body is iron which is utilized in different cellular processes.[1] Iron possesses many essential functions, namely, by hemoglobin inside the red blood cells, it acts as an oxygen carrier to tissues from the lungs, as a medium to transport electron in cells, deoxyribonucleic acid synthesis, and as an integrated critical component of important enzyme systems in different tissues in the body.[2]

Iron deficiency (ID) broadly referred of the state in which iron stores are low so they are insufficient to supply adequate body needs, irrespective to the state of anemia whether is present or not.[3]

Despite the fact that ID reduces the synthesis of hemoglobin, it is considered as anemia only when hemoglobin levels are below certain cut-off values. The World Health Organization (WHO) had set those at 130 g/L in males and 120 g/L in nonpregnant females.[3,4]

Ferritin is regarded as a good indicator of stores of iron in the body and is the most specific and sensitive available biomarker for assessment of ID.[5]

Anemia causes insufficient oxygenation of various organs, which leads to impairment of cognitive function as well as behavioral dysfunction.[5] Therefore, the insult of anemia on organs will be more severe in organ with high oxygen demand. In addition, anemia is a predisposing factor to infection and inflammation.[6]

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As it is metabolically active and due to the high metabolic demand of cochlear hair cells that are responsible for mechanoelectric transduction to acoustic stimuli, the cochlea is one of the organs highly susceptible to ischemia. Adding to this, scanty collateral circulation and the labrynthine artery are the only blood supply.[7]

Despite the possibility of iron effects on the inner ear system by inducing pathologic insults, no strong evidence is available to prove the link between anemia and tinnitus.[8]

An association between anemia and sudden hearing loss had been indicated by many case reports, but no strong direct correlation was shown between tinnitus and anemia.[9]

In 2014, another failure to show a direct significant correlation between subjective tinnitus and anemia has been reported by a questionnaire-based survey aimed at investigating tinnitus.[10]

This study aimed to investigate the association of tinnitus and hearing loss with ID and ID anemia.

Materials and Methods

Peripheral blood samples were obtained from patients with tinnitus who attended the out-patient clinic at the Department of Audiology, Al-Yarmook Teaching Hospital in Baghdad city. Patients did not know if they were anemic or not. After the exclusion of infection of the ear, pure tone audiometry was done for every subject enrolled in the study after taking verbal informed consent.

The results of pure tone audiometry were analyzed by expert audiologist and graded according to the severity of hearing loss into normal hearing, mild hearing loss, moderate hearing loss, and severe hearing loss.

Exclusion criteria

Patients were excluded from the study if they had a history of inherited anemia, family history of hearing loss, ear infection, smokers, taking iron supplements, comorbidities (heart disease, hypertension, diabetes, thyroid disease, renal disease), and noise exposure.

Study design

A descriptive cross-sectional study with samples being taken consecutively from March 2019 to March 2020.

Measurements of hematological parameters hemoglobin (Hb), hematocrit, mean cell volume (MCV), and mean cell hemoglobin (MCH) were done by hematology autoanalyzer.

Measurement of serum ferritin level was done by ELISA technique.

The patient is considered as having ID anemia if Hb level was below 130 g/L for male and below 120 g/L for female and red blood cell indices (MCV less than 80 fL, MCH less than 27 pg/dL). Values of ferritin less than 30 ng/mL for male and less than 20 ng/mL for female were considered low. Statistical analysis was performed using SPSS software version 25 (IBM SPSS Statistics version 25, IBM Corp USA). Pearson's chi-square (χ^2) test was used to determine the significance of any observed differences in the studied groups. *P* values of less than 0.05 were regarded as statistically significant.

Ethical approval

The study was approved by the scientific committee of the Department of Pathology and Forensic Medicine/College of Medicine, Mustansiriyah University, Baghdad, Iraq.

Results

One hundred patients with tinnitus enrolled in the study included 60 males with median age 54 years and 40 females with median age 47 years.

Pure tone audiometry results of tinnitus patients showed sensorineural hearing loss in 62 cases and 38 cases had normal hearing. Hearing loss was seen as mild in 23 patients, moderate in 36 patients, and severe hearing loss was seen in only 3 cases.

Iron deficiency anemia and iron deficiency among tinnitus patients

Forty-eight (48%) cases with ID anemia (low hemoglobin, hypochromic microcytic red blood cell indices, and low ferritin) were seen in the 100 tinnitus patients, as in Table 1, 13 tinnitus-suffering patients have only low ferritin but normal hemoglobin (i.e., ID without anemia).

So, the total of both those with ID anemia and those with low ferritin in the presence of normal hemoglobin and red blood cell indices are 61, as seen in Table 1.

From the 48 patients with tinnitus and anemia, 30 patients were male representing about 62.5%, while the female patients were 18 representing about 37.5% of total those with tinnitus and anemia as in Table 2.

Table 1: Distribution of patients with tinnitus according to the presence of iron deficiency anemia and ferritin status

Ferritin status	Patients with tinnitus		
	Tinnitus patients with anemia	Tinnitus patients without anemia	Total
Low ferritin	48	13	61
Normal ferritin	0	39	39
	48	52	100

Table 2: Distribution of patients with tinnitus and iron deficiency anemia according to sex

Sex	Distribution of patients with tinnitus and anemia
According to sex	
Male	(30) 62.5%
Female	(18) 37.5%
Total	(48) 100%

Table 3: Distribution of patients according to hearing status, presence or absence of iron deficiency anemia, and ferritin level

	Group 1: patients with hearing loss		Patient with low ferritin level in Group 1	Group 2: patients with normal hearing		Patient with low ferritin level in Group 2
Iron deficiency anemia	Present	37	37	Present	11	11
	Absent	25	10	Absent	27	3
	Total	62	47	Total	38	14

Table 4: Association between sensorineural hearing loss and iron deficiency anemia in patients with tinnitus

	Iron deficiency anemia	No anemia	Total
Number of cases with hearing loss	37	25	62
Number of cases with normal hearing	11	27	38
Total	48	52	100

The chi-square; the *P* value is 0.00283; significant at $P < 0.05$

Table 5: Ferritin status and hearing status in tinnitus patients

	Low ferritin	Normal ferritin	Total
Hearing loss	47	15	62
Normal hearing	14	24	38
Column total	61	39	100 (grand total)

The chi-square; the *P* value is 0.000106; the result is significant at $P < 0.05$

The percentage of male subjects with tinnitus and ID anemia was higher than female subjects.

Iron deficiency anemia and iron deficiency in patients with hearing loss and in those with normal hearing

Higher number of cases with ID anemia (low hemoglobin) (37 cases) than those without anemia (25 cases) were seen in Group 1 (patients with sensorineural hearing loss), shown in Table 3; while in Group 2 (with normal hearing), the number of cases with anemia (low hemoglobin) was 11 and those without anemia represents 27 patients.

Ten patients in Group 1 have low ferritin but normal hemoglobin and blood indices (ID without anemia), while in Group 2 only 3 patients out of 38 have low ferritin but normal hemoglobin and red blood cell indices.

The association of iron deficiency anemia and iron deficiency with hearing loss

There is a significant association between sensorineural hearing loss and ID anemia in patients with tinnitus (*P* value is 0.00283, *P* value is significant if <0.05), as in Table 4.

The proportion of subjects with low ferritin and hearing loss is significantly higher than those with low ferritin and normal hearing (*P* value is 0.000106. The result is significant at $P < 0.05$).

The total number of cases with low ferritin is 47 patients in Group 1, while 14 cases with low ferritin were present in Group 2 [Table 5].

Discussion

Interpretation of the results of this study reported that most cases of tinnitus are male with median age 54 years which is higher than median age of female (47 years) with tinnitus. This is consistent with the data of previously published articles.[11-13]

The majority of patients suffering from tinnitus have sensorineural hearing loss. Comparable results are obtained by Tan *et al.*[14] and Xiong *et al.*[15]

ID anemia and ID indicated by low ferritin were reported in patients with tinnitus. Analogous results were described by a study done in Korea.[9] Although a previous study showed disappearance of tinnitus in most patients within 30 days after starting treatment of ID anemia,[8] there was a failure to find a significant association between tinnitus and anemia in other study done by Savastano.[16]

Anemia (low hemoglobin) may be a cause of tinnitus either by the hemodynamic change with increasing both vascular flow rate and pulse rate or by prolonged deficiency of oxygen delivery to the inner ear.[17]

In this study, percentage of male with tinnitus and anemia was higher than female which can be explained by the concept that tinnitus is more commonly observed in male than female as seen in our study and in the results of a population-based survey published in 2018.[9]

Low ferritin level observed in the majority of tinnitus patients in this study may represent prelatent or early latent stages in those who do not have anemia in addition to those with ID anemia.[18] Iron represents essential cofactors for many enzymes in the body, which is required for their proper action to catalyze large numbers of biochemical reactions important for brain function (e.g., conduction of nerve impulses, metabolism of dopamine), energy metabolism, and others, so the activity of these enzymes is reduced by ID.[19]

The association between ID anemia and ID with hearing loss observed in this study was previously reported by the results of a study published in 2017.[20] Similarly, a study performed by Chung *et al*.[10] found an association between hearing loss and ID anemia. A systemic review and meta-analysis published by Mohammed *et al.*[21] revealed a significant association between hearing loss and ID anemia, but it is unclear by which mechanism ID anemia exactly results in or contributes to loss of hearing and whether treatment of ID anemia can reduce the risk of hearing loss. Iron has a role in supporting oligodendrocyte signaling pathways and myelination, which are critical for auditory neurotransmission.[22] For proper sensory function, the velocity of conduction must be regulated by adequate and proper myelination.[23] So deficient production or damage of myelin surrounding the auditory nerve by deficiency of iron impairs velocity of conduction,[24] possibly due to changes to sodium channel density.[25] Adding to that is the major role of iron in the process of proper axonal maturation[26] to save cochlea homeostasis together with maintenance of integrity of blood labyrinth barrier.[27]

As it has no collateral circulation, the cochlea is highly susceptible to ischemia. ID anemia will affect delivery of oxygen to tissue increasing ischemic risk. The labyrinthine artery represents the sole blood supply to the cochlea; this makes it more vulnerable to a reduction in blood oxygenation as results of ID anemia.[28] The association of hearing loss with ID can be explained by the fact that anemia represents the late manifestation of ID. In addition, despite normal hemoglobin level, deficiency of iron can exist in different organs like the brain which is associated with mental illness and impairment of neurocognitive functions, including poor memory and slowness of neural processing which affects hearing process.[29]

Conclusion

Tinnitus is associated with ID and ID anemia. ID and ID anemia are associated with hearing loss.

Further works are needed to discover the exact relationship between ID and ID anemia with hearing loss and to consider examination of hearing in anemic patients. Follow-up studies to investigate if treatment of ID can improve hearing problems.

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Conflicts of interest

There are no conflicts of interest.

Author contributions

Maysem M. Alwash, Alaa Hussein Eluee, Shaymaa Wahbi Salman, and Imran Fadhil Lafta contributed to the conception of the study and performing the tests; Shaymaa Wahbi Salman and Sameh Samir Akkila performed the data collection and analyses; Maysem M. Alwash helped perform writing introduction and the analysis of data with constructive discussions; all authors contributed to the writing and revisions.

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