The relationship between age-related hearing impairment and age-related macular degeneration (AMD)

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ABSTRACT

AIM: to assess the rates and severity of senile hearing loss among patients with AMD

METHOD: This prospective study was conducted at the ophthalmology and otolaryngology (ENT) clinics in King Hussein Medical Centre between January 2022 and July 2023. All patients who attended the ophthalmology clinic and were found to have AMD were enrolled in the study. Data regarding the demographic features of the patients was initially obtained. Then, all patients were referred to the otolaryngologist for a hearing assessment. The results of ocular examination and severity of AMD were recorded based on slit lamp examination and imaging using OCT and OCTA when necessary. Audiometry was performed at the ENT clinic, and hearing loss rates and severity were assessed. The results obtained were analyzed.

RESULTS: One hundred fifty patients diagnosed with AMD were enrolled in the study. The mean age of the patients was 70.7±7.4 years (ranging between 55 and 85 years). 36.0% of them were males. 33.3% of patients with a mean age of (62.32±3.33 years) had early AMD and 26.7% of patients with a mean age of (70.22±2.70 years) had Intermediate AMD. On the other hand, 6.7% and 33.3% of patients had geographical macular atrophy and wet AMD with a mean age of (77.3±3.40 and 78.24±2.70 years) respectively. Among patients with early AMD 95.6% displayed either normal hearing or mild impairment. For those with advanced AMD, 14.2% of individuals with geographical atrophy and 27.5% with wet AMD demonstrated normal or mildly impaired hearing. In contrast, 64.3% and 57.5% of those with geographical atrophy and wet AMD, respectively, suffered from severe or profound hearing impairment. The stage of hearing loss and stage of AMD were significantly dependent (p-value < 0.001). In unilateral AMD, 91.7% and 83.3% exhibited normal or mild hearing loss in early and intermediate stages, respectively, while no instances were observed in advanced AMD cases 27.7% of bilateral AMD patients experienced severe or profound hearing loss, only 2.6% of unilateral AMD cases exhibited such impairment

CONCLUSION: Senile hearing loss was higher in patients with AMD. More severe forms of hearing loss were encountered among patients with bilateral and advanced AMD cases.

KEYWORDS: Age-related macular degeneration, senile hearing loss.

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INTRODUCTION

Hearing impairment is associated with various ocular conditions affecting the anterior and posterior eye segments (1). Alport Syndrome, Vogt-Koyanagi-Harada (VKH) disease, Usher syndrome, Stickler syndrome, Marfan syndrome, congenital rubella, and hereditary optic neuropathies are common eye diseases that are associated with hearing problems (2,3). In addition, studies have also shown an association between senile hearing loss (presbycusis) and pseudo exfoliation syndrome, and diabetic retinopathy (4,5,6,7). Age-related macular degeneration (AMD) was also suggested to be associated with sensorineural hearing loss (8,9).

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AMD is a common disease affecting the macula that may result in irreversible visual impairment. It is classified into two major subtypes: exudative (wet AMD) and non-exudative (dry AMD) (10). Although about 90% of AMD is the dry type, most of visual loss is caused by the wet type (11). Besides age, smoking and genetic factors were implicated in the development of AMD (12). The prevalence of AMD in the general population between 55 and 85 years of age is 8.7% (13). On the other hand, the prevalence of presbycusis was found to be between 29.0% and 33.0% among patients aged 65 or older (14). This study aimed to evaluate the rates and severity of presbycusis among patients with AMD in relation to the age and severity of visual impairment.

METHODS:

This prospective study was conducted at the ophthalmology and otolaryngology (ENT) clinics within King Hussein Medical Center from January 2022 to July 2023. The study encompassed all patients who sought care at the ophthalmology clinic and were diagnosed with age-related macular degeneration (AMD). The study commenced by collecting comprehensive demographic information from each enrolled patient. Subsequently, all participants were referred to the otolaryngologist for a thorough hearing assessment. Ocular examinations were conducted, and the severity of AMD was documented through slit lamp examinations, complemented by imaging techniques such as Optical Coherence Tomography (OCT) and Optical Coherence Tomography Angiography (OCTA) whenever deemed necessary. The stage of AMD was assessed using the Age-Related Eye Disease Study (AREDS) criteria (15). Simultaneously, Pure Tone Audiometry (PTA)was performed at the ENT clinic, enabling an evaluation of the rate and severity of hearing loss among the participants using the International Bureau for Audio Phonology (BIAP) grading system where it classified the hearing levels as follows: normal hearing (PTA $\leq$ 20 dB), mild hearing impairment (PTA between 21 and 40 dB HL), moderate hearing impairment (PTA between 41 and 70 dB), severe hearing impairment (PTA between 71 and 95 dB), and profound hearing impairment (PTA $\geq$ 95 dB).

STATISTICAL ANALYSIS:

The categorical data expressed in frequency and percentage, while the scale data represented in mean and standard deviation. Furthermore, the Chi-square test or fisher exact test were used as appropriate to explore the association between the categorical data, alpha level set at 0.05 to make type one error rate, the power of study was assumed at 0.8%, if p-value less than alpha the association considers statistically significant. SPSS IBM software version 28.0 was used to analyze the data

RESULTS:

One hundred fifty patients diagnosed with AMD were enrolled in the study. The mean age of the patients was 70.7±7.4 years (ranging between 55 and 85 years). 36.0% of them were males. 33.3% of patients with a mean age of (62.32±3.33 years) had early AMD and 26.7% of patients with a mean age of (70.22±2.70 years) had Intermediate AMD. On the other hand, 6.7% and 33.3% of patients had geographical macular atrophy and wet AMD with a mean age of (77.3±3.40 and 78.24±2.70 years) respectively. The demographic features of the patients are summarized in Table 1. Approximately 59.2% of cases exhibited some degree of hearing impairment. Among patients with early AMD, the majority (95.6%) displayed either normal hearing or mild impairment, with no instances of severe or profound loss noted. Conversely, in the intermediate AMD group, 69.3% showed normal hearing or mild impairment, while 10.2% experienced severe or profound loss. For those with advanced AMD, a notable disparity emerged. Only 14.2% of individuals with geographical atrophy and 27.5% with wet AMD demonstrated normal or mildly impaired hearing. In contrast, 64.3% and 57.5% of those with geographical atrophy and wet AMD, respectively, suffered from severe or profound hearing impairment. The stage of hearing loss and stage of AMD were significantly dependent (p-value < 0.001). The results of all patients are summarized in Table 2. Unilateral AMD was detected in 25.3% of patients, with 63.2%, 31.6%, 2.6%, and 2.6% manifesting early, intermediate, geographical atrophy, and wet AMD, respectively. Among those with unilateral AMD, 91.7% and 83.3% exhibited normal or mild hearing loss in early and intermediate stages, respectively, while no instances were observed in advanced AMD cases. Conversely, severe or profound hearing loss was absent in unilateral AMD cases except for one patient with wet AMD.

Right eye involvement was seen in 50.0% of the eyes. The side of involvement was not correlated with the severity of AMD or hearing loss (P value <0.05). In bilateral cases, 29.5%, 29.5%, 5.8%, and 35.2% presented with early, intermediate, geographical atrophy, and wet AMD, respectively. Notably, 58.9% of patients with bilateral AMD had normal or mild hearing loss, contrasting with 84.2% in unilateral cases. Furthermore, while 27.7% of bilateral AMD patients experienced severe or profound hearing loss, only 2.6% of unilateral AMD cases exhibited such impairment Additionally, the mean hearing level was 25.5±5.5 dB among patients with unilateral AMD, markedly lower than the 57.5±21.8 dB recorded in bilateral AMD cases. The hearing assessment results in unilateral and bilateral AMD cases are shown in Tables 3 and 4, respectively.

DISCUSSION:

In this sample of patients diagnosed with AMD, the mean age of the patients was 70.7 years old. The advanced forms of AMD constituted 40.0% of cases. It was obvious that the severity of the isease increased with age: the mean ages of patients with the advanced forms of AMD (geographical ma- cular atrophy and wet AMD) (77.3 and 78.2 years), respectively, while the mean age for patients with early and intermediate AMD was 62.3 and 70.2 years respectively. Although many risk factors were reported to affect the prevalence of AMD, age is strongly related to the development and progression of AMD (16). Therefore, severe forms of AMD are expected to be more prevalent in older people. Colijn et al. found that the advanced forms of AMD were 100 times more prevalent among people older than 85 when compared to those aged 55–59 (17). Like results from global studies, AMD showed a female predilection in this sample (18). However, the female-to-male ratio was significantly higher in the advanced forms of AMD (2.5:1) compared to early and intermediate forms of AMD (1.4:1). This can be explained by the fact that the advanced forms of AMD have a higher mean age (78.1 years) compared to the early forms of AMD (65.8 years). Females are known to have greater life expectancy than males (19). In this study, 59.2% of cases had hearing loss. Unfortunately, no studies have been conducted among the Jordanian population assessing the prevalence of age-related hearing loss to compare with. However, this rate looks much higher when compared to its global prevalence. Gopinath et al. reported that 33.0% of subjects aged 49 or older had hearing loss (20). In addition, other studies showed that the prevalence of presbycusis ranged between 29.0% and 33.0% (14). This all suggests that hearing impairment was encountered at significantly higher levels among patients with AMD. Normal hearing assessment was reported in 107 patients (42.8%). Of those, 69.8% had early AMD. On the other hand, 38 patients (14.5%) had profound hearing loss, and 80.3% of those had advanced forms of AMD. The mean hearing levels in patients with geographical atrophy and wet AMD were 73.6 and 83.2 dB, respectively. From this, it can be postulated that the severity of hearing loss was strongly correlated with the severity of AMD. Supporting this, Klein et al. found higher rates of hearing loss among patients with advanced AMD (21).The mean hearing level among patients with unilateral AMD was 25.5 dB. This seems significantly low when compared to 57.5 dB in bilateral AMD cases. Two cases were encountered in the advanced forms of unilateral AMD: one of them was moderate, and the other was severe hearing loss. No profound hearing loss was experienced in patients with unilateral AMD. Furthermore, profound hearing loss was seen in 17.0% of bilateral cases. In addition, 57.9% of patients with unilateral AMD had a normal hearing assessment, while only 37.9% of bilateral AMD patients had a normal hearing assessment. All this suggests that hearing loss was encountered significantly more and more severely in bilateral AMD patients (p Value < 0.05). The exact pathology of AMD and senile hearing loss is not well understood, and age is considered the main risk factor for the disease (9). However, in this study, the two diseases seem to have similar features: the

severity of AMD was proportional to the severity of hearing loss, bilateral AMD was associated with more severe forms of hearing loss, and both had gender predictions. This suggests a significant correlation between age-related macular degeneration and senile hearing impairment. Supporting this, the retinal changes in AMD mainly occur in the retinal pigment epithelium (RPE), in which melanin plays an important role in the integrity and function of the RPE. When it is not well functioning, it results in oxidative stress and programmed cell death of the RPE (22). Likewise, melanin is present in the cochlea, which is supposed Like in other studies, this study found a high association between AMD and senile hearing loss. This study showed a uniquely strong correlation between the severity of AMD and the severity of hearing loss. In addition, more severe forms of hearing loss were encountered among patients with bilateral AMD compared to unilateral cases. The coexistence of age-related macular degeneration (AMD) and hearing loss diminishes the quality of life of patients in multiple domains including function as well as social interaction. The loss of two senses penetrates basic daily functions such as reading, seeing the face of a person and speaking with people, which reduces independence and boosts social seclusion. It also causes increased risk of accidents due to the inability to effectively navigate the surroundings, especially in the elderly population. All these manifold challenges raise the need for integrated care to mitigate the dual sensory impairments on overall health. (25). One of the major limitations of this study was the relatively small sample size. Another was that no studies have been conducted on the prevalence of age-related hearing loss in Jordan, and the rates of hearing loss in the study sample were compared to their global prevalence, which may be influenced by genetic or geographical variations.

CONCLUSION:

Senile hearing loss was encountered at higher rates in patients with AMD. More severe forms of hearing loss were encountered among patients with bilateral and advanced AMD cases.

Table 1: Demographic features of the patients with AMD in relation to age and gender*

Stage of AMD	Number of patients (%)	Mean age	Gender (M: F)
Early AMD	50 (33.3%)	62.32±3.33	1:1.5 (20:30)
Intermediate AMD	40 (26.7%)	70.22±2.70	1:1.4 (17:23)
Advanced AMD (geographical atrophy)	10 (6.7%)	77.30±3.40	1:2.3 (3:7)
Advanced AMD (neovascular)	50 (33.3%)	78.24±2.70	1:2.5 (14:36)
Total	150 (100%)	70.7±7.4	1:1.8 (54:96)

*In cases with asymmetrical eye involvement, the more severe one was reported

Table 2: Hearing assessment among patients in relation to the severity of AMD

Stage of AMD	Number of eyes (%)	Mean hearing levels in (dB)	Grades of hearing impairment				
			Normal (≤20 dB)	Mild (>20-<40 dB)	Moderate (≥40-<70 dB)	Severe (≥70-<95 dB)	Profound (≥95dB)
Early AMD	90 (34.4%)	28.3±2.58	62 (68.9%)	24 (26.7%)	4 (4.4%)	0 (0%)	0 (0%)
Intermediate AMD	78 (29.8%)	46.3±2.69	36 (46.2%)	18 (23.1%)	16(20.5%)	6 (7.6%)	2 (2.6%)
Advanced AMD - geographical atrophy	14 (5.3%)	73.6±2.17	1 (7.1%)	1 (7.1%)	3 (21.4%)	3 (21.4%)	6 (42.9%)
Advanced AMD - neovascular	80 (30.5%)	83.2±2.26	8 (10.0%)	14 (17.5%)	12 (15.0%)	16 (20.0%)	30 (37.5%)
Total	262 (100%)	52.8±23.1	107 40.8%)	57(21.8%)	35(13.4%)	25 (9.5%)	38 (14.5%)

Chi-square value=130.455, p<0.001

Table 3: Hearing assessment among patients with unilateral AMD

Stage of AMD	Number of eyes (%)	Right eye involvement (%)	Mean hearing levels in (dB)	Grades of hearing impairment				
				Normal (≤20 dB)	Mild (>20-<40 dB)	Moderate (≥40- <70 dB)	Severe (≥70-<95 dB)	Profound (≥95dB)
Early AMD	24 (63.2%)	13/24 (54.2%)	20.4±2.14	16 (66.7%)	6 (25.0%)	2 (8.3%)	0 (0.0%)	0 (0.0%)
Intermediate AMD	12 (31.6%)	5/12 (41.7%)	27.5±2.23	6 (50.0%)	4 (33.3%)	2 (16.7%)	0 (0.0%)	0 (0.0%)
Advanced AMD (geographical atrophy)	1 (2.6%)	0/1 (0.0%)	63.0	0 (0.0%)	0 (0.0%)	1/1 (100%)	0 (0.0%)	0 (0.0%)
Advanced AMD (neovascular)	1 (2.6%)	1/1 (100%)	85.0	0 (0.0%)	0 (0.0%)	0 (0.0%)	1/1 (100%)	0 (0.0%)
Total	38 (100%)	19/38 (50%)	25.5±12.5	22 (57.9%)	10 (26.3%)	5 (13.2%)	1 (2.6%)	0 (0.0%)

Fisher test=16.481, p=0.041

Table 4: Hearing assessment among patients with bilateral AMD

Stage of AMD	Number of eyes (%)	Mean hearing levels in (dB)	Grades of hearing impairment				
			Normal (≤20 dB)	Mild (>20-<40 dB)	Moderate (≥40- <70 dB)	Severe (≥70-<95 dB)	Profound (≥95dB)
Early AMD	66	31.2±2.6	46(69.7%)	18(27.3%)	2 (3.0%)	0 (0.0%)	0 (0.0%)
Intermediate AMD	66	49.7±2.14	30(45.4%)	14(21.2%)	14(21.2%)	6 (9.1%)	2 (3.0%)
Advanced AMD (geographical atrophy)	13	74.4±2.7	1(7.7%)	1 (7.7%)	2 (15.4%)	3 (23.1%)	6 (46.1%)
Advanced AMD (neovascular)	79	83.2±1.8	8 (10.1%)	14(17.7%)	12 (15.2%)	15(19.0%)	30(38.0%)
Total	224 (100%)	57.5±21.8	85(37.9%)	47(21.0%)	30(13.4%)	24(10.7%)	38(17.0%)

Chi-square value=109.008, p<0.001

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