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Audiovestibular Impairment in Patients with Systemic Autoimmune Rheumatic Diseases of Different Pathogenesis

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ABSTRACT

Background: Hearing impairment (HI) is classified into conductive, sensorineural, and mixed types. Sensorineural hearing loss in autoimmune diseases (AD), although not uncommon, is underdiagnosed. Autoimmune diseases may affect the vestibulocochlear system at variable degrees which is usually underdiagnosed due to unidentified specific antigens.

Objectives: to assess audiovestibular system in a cohort of patients to aid in early recognition and management of a vital overlooked aspect of such comorbidity.

Subjects and Methods: A total of ninety-eight adult patients complaining of different systemic autoimmune rheumatic diseases followed-up at outpatient rheumatology clinics were enrolled in this cross-sectional study. Patients were categorized into three sub-groups: rheumatoid arthritis (RA), systemic lupus erythematosus (SLE), and Behçet's disease (BD). Clinical, laboratory, audiological and vestibular assessment of disease activity among different groups was done.

Results: Pure tone audiometry **(**PTA) values showed significantly increased prevalence of hearing loss in our AD patients compared to healthy control group (P <0.000). Regarding vestibular assessment, pathological saccades were discovered using the vHIT, particularly in horizontal canals. The patient's gain values were slightly lower than the control group; however, gain and gain asymmetry differed significantly in a few canals. Disease duration significantly correlated with hearing thresholds at high frequency in RA and SLE patients. DAS-28 in RA patients significantly correlated with hearing thresholds, however SLEDAI in SLE didn't reveal any correlation.

Conclusions: Early audiovestibular screening in patients with autoimmune rheumatic diseases should be considered, especially in those with long disease duration as neglected impairment is prevalent.

Keywords: Hearing loss, Rheumatoid arthritis, Lupus erythematosus, Behçet's disease.

INTRODUCTION

Autoimmunity is aberrant immune reaction to particular self-antigens resulting in tissue damage. Autoimmune diseases (ADs) can either be tissue-specific, where specific antigens are targeted to harm only that tissue, or more systemic, where various systems are impacted. Rheumatic diseases are mostly systemic of inflammatory nature and autoimmune pathogenesis [(1,2)]. Audiovestibular impairment in ADs are usually asymptomatic or overlooked. Audiovestibular affection has been reported in several autoimmune rheumatic diseases, such as systemic lupus erythematosus (SLE), rheumatoid arthritis (RA), and several types of vasculitis including Behçet's disease (BD) [(2)].

Even though pathogenesis of damage to vital organs, such as nephritis in SLE, synovitis in RA is becoming better recognized, certain minor manifestations are subtle and remain challenging to explain via mechanisms either attributed to ageing and degeneration, formation of autoantibodies due to proinflammatory T and B cell responses or drug-induced ototoxicity [(2,3)]. Vasculitis, immune complex-mediated injury, and occasionally antiphospholipid antibodies production are the most recognized explanations for audiovestibular disturbances in rheumatic autoimmune diseases [(2, 4)].

Rheumatoid arthritis (RA) is a chronic inflammatory autoimmune disorder with diverse articular and extraarticular manifestations affecting around 1% of the world's population [(5)]. Among the extra-articular features is hearing impairment. RA patients could experience any type of hearing loss (HL); sensorineural (SNHL), conductive (CHL), or mixed, with reviews referring to the broad variation in prevalence of each type among different populations, however SNHL is considered more prevalent [(5,6)]. Inflammatory arthritis of the synovial incudostapedial and incudomalleolar joints is the most accepted explanation for CHL in RA [(2,6)]. The mechanisms behind SNHL in RA are assumed to be auditory neuropathy due to vasculitis, damage to cochlear hair cell via immune-complex mediated antibodies, autoantibodies attacking antigenic epitopes in the inner ear or anti-rheumatic drug-induced ototoxicity [(7)].

Systemic lupus erythematous (SLE) is a chronic autoimmune disease that commonly attacks females specifically during childbearing period more than males with a ratio of 9:1 [(8)]. Several studies reported SNHL in SLE occurring unilateral or bilateral and interestingly

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striking suddenly, due to effect of SLE on the inner ear [9]. Proposed mechanisms include immune-complex deposition in temporal bone microvasculature, microinfarctions especially in those with positive antiphospholipid profile. There have also been reports of an endolymphatic hydrops, spiral ganglion and hair cell loss, stria vascularis atrophy, and immune complex deposition at the perisaccular level [10].

Behçet's disease (BD) is a chronic systemic vasculitis of relapsing course that involves small blood vessels. In addition to its classic clinical presentation of recurrent ulcers (oral and genital) and uveitis, BD is considered a multisystem disease with heterogenous manifestations involving central nervous system (CNS), gastrointestinal system (GIT), vascular system, skin, and joints [11,12]. Viral, bacterial agents and immunological factors have been suggested as potential triggers to development of BD, with subsequent autoimmunity and vasculitis developing and manifesting with invasion of vessel walls by inflammatory cells, increased vessel wall permeability, and aberrant platelet function [12,13]. Several studies reported incidence of HL in BD ranging from 12 to 80%, with high frequency SNHL being the major type among these patients. Vestibular dysfunction has also been reported in literature [13].

Previous research delineated audiovestibular disturbances in many autoimmune diseases; however, patients with subclinical audiovestibular features were not clearly studied. The goal of the current study is to evaluate this aspect in a cohort of patients that may aid in the early recognition and management of a significant, neglected aspect of this comorbidity.

SUBJECTS AND METHODS

Study population:

Ninety-eight adult patients with different autoimmune rheumatic diseases followed-up at the outpatient rheumatology clinic were recruited in our cross-sectional study from June till December 2021. Patients were subcategorized into three groups: RA, SLE, and BD. All patients fulfilled the classification criteria for their disease [14-16]. Ninety-nine patients age and sex matched apparently healthy individuals were enrolled to serve as controls. Exclusion criteria included individuals with congenital hearing loss history, trauma of head and/or neck, anatomical abnormalities, otorrhea, surgery of middle ear, and Meniere's disease.

Clinical and laboratory assessment of disease activity among different groups:

Disease activity score 28 (DAS28-CRP) [17], a validated tool in clinical practice and research, was used to assess disease activity in RA patients. SLE disease activity was evaluated via SLE disease activity index-2000 (SLEDAI-2000) [18]. As regarding BD patients, the validated Arabic version of Behcet's Disease Current Activity Form (Ar-BDCAF) [19] has been used.

All patients had laboratory assessment in form of complete blood count (CBC), C-reactive protein (CRP), liver and renal functions. For RA patients; rheumatoid factor (RF) and anticyclic citrullinated peptide (anti-CCP) antibodies. Regarding SLE group; anti-nuclear antibody (ANA) (indirect immunofluorescence), anti-double stranded DNA antibodies (anti-dsDNA) (ELISA), serum complement C3 and C4 levels by immunoturbidimetry assay were measured.

Audiological Evaluation:

A thorough ear-nose-throat evaluation was performed for all participants, which included the following: complaints of hearing loss (HL), tinnitus, discharge, vertigo, or headache, receiving any ototoxic drug, examination of pre- and post-auricular regions, ear pinna, tympanic membrane, and external acoustic canal, and audiological evaluation, done by a single expert and included the following: (a) Pure tone audiometry (at frequencies from 250-8000 Hz for air conduction thresholds; from 250-4000 Hz for bone conduction thresholds), (b) Speech audiometry (Using Arabic spondee words for speech reception threshold and Arabic phonetically balanced words for word discrimination scores), (c) Tympanometry (tympanogram consistent with Jerger's types as well as acoustic reflex threshold measurements at octave frequencies from 500-4000 Hz ipsilateral).

The devices used for audiological assessment included: (a) 2-channel audiometer (Madsen Astera 2, ICS Otometrics, Denmark), (b) impedance audiometer (Grason-Stadler GSI 39, USA), (c) soundproof chamber (Amplaid, Italy). The mean of the frequencies 500, 1000, 2000, and 4000 Hz was used to calculate the hearing thresholds for each ear in accordance with the Bureau International d'Audiophonologie's (BIAP) recommendation 02/1 bis. Hearing was considered normal or subnormal at thresholds of 20 dB HL or less. A threshold between 21- and 40-dB HL was considered mild hearing loss; a threshold between 41- and 70-dB HL was considered moderate hearing loss; and a threshold between 71- and 90-dB HL was considered severe hearing loss; and very severe hearing loss was categorized as a threshold between 91- and 119-dB HL. Patients with 120-dB HL or greater thresholds were categorized as having profound hearing loss.

In addition, the existence or absence of an ipsilateral stapedius reflex was investigated. Acoustic stapedius reflex threshold 70–90 dB HL higher than the pure-tone threshold estimated at the same frequency was considered normal.

Vestibular Evaluation:

Video head impulse test (vHIT) was executed using the impulse device (ICS Otometrics, Denmark). The subject sits in a special chair 1 metre distant from the wall and at the level of his or her eyes, he/ she is asked to look at a specified area on the wall. Calibration is performed prior to each step of the test. To evaluate the condition of horizontal and vertical semicircular canals (SCC), the examiner stands behind the patient and gives at least 20 fast shocks with a minimum velocity of 100 degrees per second in the direction of the SCCs.

Vestibular-Ocular Reflex (VOR) gain was assessed for each SCCs and occurrence of covert and overt corrective saccades as well as the gain asymmetry ratio for each pair of SCCs were examined. For the horizontal (lateral) semicircular canals and the vertical canals (anterior and posterior), the normal rate of VOR gains were accepted to be ≥ 0.8 and 0.7, respectively. As earlier saccades are likely brought on by the visual fixation task, only a series of saccades (not just one) after the 50-ms suppression point (50-450 ms from head-impulse beginning) were considered in this research.

Before the head velocity decreases to zero during the high-velocity portion of the head movement, covert saccades take place. Overt saccades were frequently made when the head is stationary and visual feedback was available.

Ethical consent

The study was approved by the Faculty of Medicine Research Ethics Committee (FMREC), Minia University, Minia, Egypt (Approval no.35:3/2021), based on guidelines in the Declaration of Helsinki. An informed written consent was obtained from all subjects.

Statistical Analysis

Statistical analysis of data was assessed via SPSS version 25 (IBM, Chicago, IL, USA). Data distribution for normality was checked for using Kolmogorov-Smirnov test. Descriptive data were expressed as mean, standard deviation (SD), and range for quantitative variables and as frequency and percentage for qualitative variables. Continuous variables were compared using the parametric one-way ANOVA or the non-parametric Kruskal–Wallis H test, with Tukey's HSD test used for post-hoc analysis. Chi-square (X^2) was used for qualitative data. Correlations via Pearson and Spearman methods were used for parametric and non-parametric data, respectively. P-value <0.05 was considered statistically significant.

RESULTS

Ninety-eight patients were categorized into three different subgroups (RA, SLE, and BD) and 99 apparently healthy participants (control group) were enrolled in this study. Clinical characteristics of patients are shown in Table 1. Patients of the study group had a mean age of 36.0±6.08 years and included 64 (65.3%) females. The mean age of control group was 36.8±5.80 years and included 64 (64.6%) females, revealing comparable values to patients.

Table 1: Clinical characteristics of studied patients

	RA (N=32)	SLE (N=36)	BD (N=30)	P-value
	Mean±SD; (Range); n (%)			
Age (years)	35.7±5.9	35.0±5.05	37.3±7.47	0.312
Women	28 (87.5%)	34 (94.4%)	2 (6.7%)	-
Disease duration (years)	7.71±5.35	6.44±3.22	5.67±4.12	0.444
Clinical disease features; *n (%)*				
- Musculoskeletal¶	28 (87.5%)	18 (50%)	10 (33.3%)	<0.0001
- Skin rash^	0 (0%)	14 (38.9%)	0 (0%)	<0.0001
- Oral ulcers	0 (0%)	8 (22.2%)	4 (13.3%)	0.02
- Genital ulcers	0 (0%)	4 (11.1%)	16 (53.3%)	<0.0001
- Neuropsychiatric	0 (0%)	6 (16.7%)	4 (13.3%)	0.061
- Vascular$	0 (0%)	6 (16.7%)	12 (40%)	<0.001
- Ocular	0 (0%)	0 (0%)	16 (53.3%)	<0.001
Disease activity scores*	3.46±1.08; (2-5)	8.50±8.41; (0-24)	9.82±6.22; (0-28)	-
Laboratory findings				
- CRP titer	10.22±9.63	6.30±4.55	4.43±4.73	0.057
- Rheumatoid Factor titer	21.0±12.97	-	-	-
- Anti-CCP positivity	10 (31.2%)	-	-	-
- ANA positivity	-	36 (100%)	-	-
- Anti-dsDNA positivity	-	13 (36.1%)	-	-
- Low Complement C3 and/or C4	-	3 (8.3%)	-	-
Medications				
- Methotrexate	18 (56.25)	8 (22.2%)	4 (13.3%)	<0.001
- Hydroxychloroquine	28 (87.5%)	28 (77.8%)	0 (0%)	<0.0001
- Leflunomide	12 (37.5%)	0 (0%)	0 (0%)	<0.0001
- Azathioprine	0 (0%)	18 (50%)	12 (40%)	<0.0001
- Cyclophosphamide	0 (0%)	2 (5.6%)	0 (0%)	0.172
- Cyclosporine A	0 (0%)	0 (0%)	4 (13.3%)	0.009
- Colchicine	0 (0%)	0 (0%)	8 (26.7%)	<0.001
- Anti-TNF	4 (12.5%)	0 (0%)	10 (33.3%)	<0.001
- NSAIDs	4 (12.5%)	0 (0%)	2 (6.7%)	0.10
- Prednisolone	5 (15.6%)	32 (88.9%)	20 (66.6%)	<0.0001
- Warfarin	0 (0%)	8 (22.2%)	4 (13.3%)	0.02

BD: Behçet's disease, RA: rheumatoid arthritis, SLE: Systemic lupus erythematosus, *: DAS-28 ESR for RA patients, SLEDAI-2000 for SLE patients, Ar-BDCAF score for BD patients; ¶: arthralgia and/or arthritis; ^: malar rash, discoid rash, subacute skin lesions, photosensitivity; $: Deep venous or arterial thrombosis.

A notable percentage of the study group had audiovestibular complaints; 43.7%, 27.8%, and 26.7% of patients gave history of hearing loss in RA, SLE, BD respectively with highly significant difference compared to healthy controls (4%). Regarding auditory symptoms, there was highly significant difference in tinnitus among all patients. Significant difference existed between different AD subgroups and controls in duration of symptoms, being longest among BD patients.

In concordance with patient complaints', audiological assessment of study population showed significant increase in frequency of hearing loss among patients compared to controls. However, detected HL percentage were higher than HL co

mplaints mainly among SLE and BD, indicating subclinical neglected cases. Also, there was significant difference in degree of HL. Observing types of HL among patients, SNHL exhibited highest percentage among BD, SLE, and RA patients, with significant difference than controls who suffered from CHL only. Speech reception threshold (SRT) mean was significantly increased among BD patients (normal up to 25). SRT of RA and SLE patients were considered within normal levels, however they were also significantly increased than controls (Table 2).

Table 2: Audiological assessment of studied patients and controls

		RA (N=32)	SLE (N=36)	BD (N=30)	Controls (N=99)	P-value
		Mean±SD; n (%)				
Auditory symptoms						
- Hearing Loss (HL)		14 (43.7%)	10 (27.8%)	8 (26.7%)	4 (4.04%)	<0.0001
- Tinnitus		4 (12.5%)	18 (50%)	2 (6.7%)	4 (4.04%)	<0.0001
- Side of affection	- unilateral	6 (18.75%)	10 (27.8%)	6 (20%)	3 (3.03%)	-
	- Bilateral	8 (25%)	8 (22.2%)	4 (13.3%)	1 (1.01%)	-
- Duration of symptoms (months)		12.4±6.03	10.31±2.44	27.8±13.26	2.5±1.33	0.007
Audiological evaluation						
- Frequency of HL		16 (50%)	22 (61.1%)	12 (40%)	4 (4.04%)	<0.0001
- Side of HL	- unilateral	6 (37.5%)	10 (45.5%)	4 (33.3%)	3 (75%)	-
	- Bilateral	10 (62.5%)	12 (54.5%)	8 (66.7%)	1 (25%)	-
- Degree of HL	- Slight	2 (12.5%)	1 (4.5%)	0 (0%)	3 (75%)	0.014
	- Mild	8 (50%)	10 (45.5%)	6 (50%)	1(25%)	
	- Moderate	4 (25%)	8 (36.4%)	3 (25%)	0 (0%)	
	- Severe¶	2 (12.5%)	3 (13.6%)	3 (25%)	0 (0%)	
- Type of HL	- CHL	5 (31.25%)	6 (27.3%)	0 (0%)	4 (100%)	0.012
	- SNHL	9 (56.25%)	10 (45.5%)	8 (66.7%)	0 (0%)	
	- Mixed HL	2 (12.5%)	6 (27.3%)	4 (33.3%)	0 (0%)	
- SRT (dB)		23.75±5.63	25.0±8.58	26.67±13.32	15.33±4.81	0.003
- Tympanometry (abnormal)		0 (0%)	1 (2.78%)	1 (3.33%)	0 (0%)	0.255
- Acoustic reflex (absent)		0 (0%)	2 (5.56%)	1 (3.33%)	0 (0%)	0.086

SRT: speech reception threshold

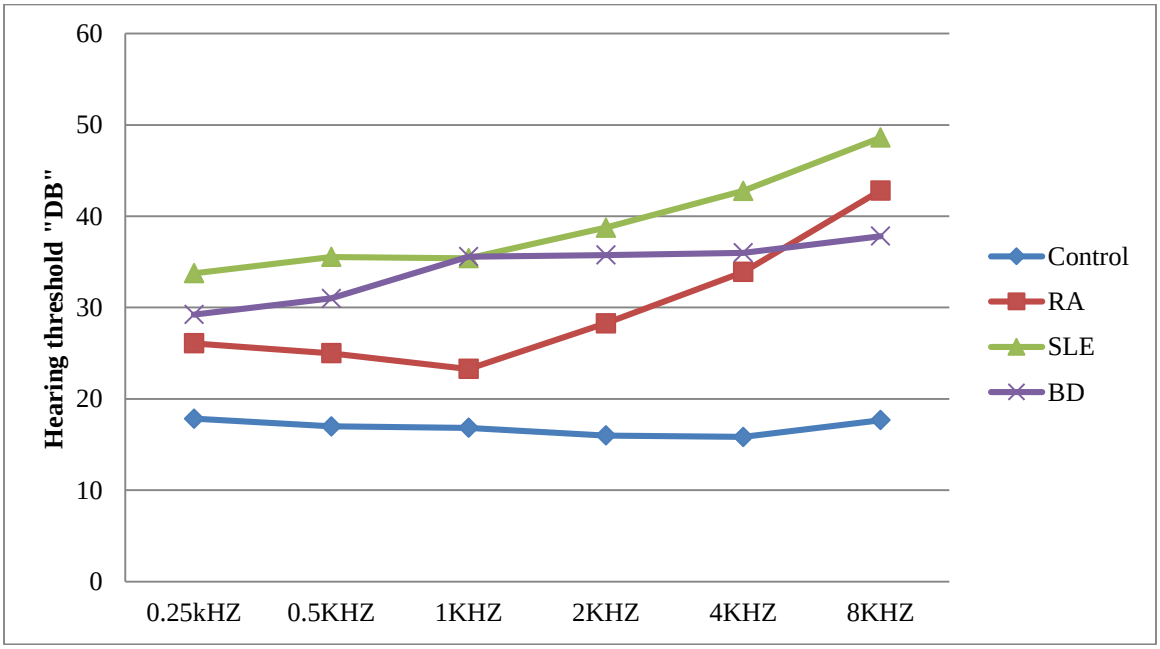

Figure 1: Hearing threshold average distribution in high frequency pure tone audiometry in RA, SLE, BD, and healthy controls

Comparing all patients' pure tone audiometry results to those of control group, significantly higher average hearing thresholds were found through all frequencies bilaterally, as illustrated in figure 1. However, post-hoc tests comparing the three patients' subgroups revealed no statistically significant difference in hearing thresholds apart from those between RA and SLE patients testing at frequency of 500 HZ on left side (P 0.016) and at 1000 HZ bilaterally (Rt. side P 0.047 and Lt. side P 0.002).

As demonstrated in table 3, frequency of vertigo was significantly increased among all patients compared to controls, however its duration was comparable among the different groups. Regarding vestibular assessment of studied patients and controls, for each semicircular canal, the vHIT results were assessed for the presence of saccades, gain values, and gain asymmetry levels. The presence of lateral saccades in horizontal canals was assessed, and patients with AD demonstrated a significant number of pathologic saccades (overt, covert saccades), whereas none of the normal participants demonstrated pathologic saccades.

Table 3: Vestibular assessment of studied patients and controls

		RA (N=32)	SLE (N=36)	BD (N=30)	Controls (N=99)	P-value
		Mean±SD; n (%)				
Vestibular symptoms						
- Vertigo		4 (12.5%)	12 (33.3%)	4 (13.3%)	2 (2.02%)	<0.0001
- Duration of vertigo (months)		4.11±2.81	1.92±0.81	0.90±0.40	0.85±0.21	0.506
Vestibular evaluation						
- Lateral Saccade	- Covert (present)	0 (0%)	2 (5.56%)	4 (13.3%)	0 (0%)	0.001
	- Overt (Present)	2 (6.25%)	4 (11.1%)	6 (20%)	0 (0%)	<0.001
- Anterior Saccade	- Covert (present)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	-
	- Overt (Present)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	-
- Posterior Saccade	- Covert (present)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	-
	- Overt (Present)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	-
- Lateral VOR gain		1.12±0.191	0.97±0.06	0.99±0.10	1.01±0.04	<0.0001
- Anterior VOR gain		1.05±0.107	0.99±0.181	0.91±0.39	1.02±0.025	0.001
- Posterior VOR gain		0.942±0.23	1.086±0.18	1.072±0.19	1.0±0.03	0.001

VOR: Vestibulo-Ocular Reflex

Patients' age and sex revealed no correlation with hearing threshold intensity throughout all frequencies bilaterally. Among RA patients, no correlations were found between hearing affection and rheumatoid nodules, rheumatoid factor level, and anti-CCP antibodies positivity (data not shown). Table 4 shows relationship between hearing loss, disease duration and activity via DAS-28 among RA patients. As for disease activity, significant positive correlation was found with hearing affection at higher frequencies 2000, 4000, 8000 HZ on left side and at all frequencies on right side. Y

Table 4: Associations in Rheumatoid arthritis patients

Intensity		RA disease duration	RA disease activity
Rt250	r	0.231	**0.350**
HZ	P-value	0.203	**0.049**
Rt500	r	0.097	**0.497**
HZ	P-value	0.598	**0.004**
Rt100	r	0.101	**0.489**
0HZ	P-value	0.582	**0.005**
Rt200	r	0.243	**0.592**
0HZ	P-value	0.180	**0.000**
Rt400	r	0.346	**0.513**
0HZ	P-value	0.053	**0.003**
Rt800	r	**0.408**	**0.537**
0HZ	P-value	**0.021**	**0.002**
Lt250	r	**0.594**	-0.103
HZ	P-value	**0.000**	0.576
Lt500	r	**0.354**	-0.018
HZ	P-value	**0.047**	0.922
Lt100	r	**0.417**	0.232
0HZ	P-value	**0.018**	0.202
Lt200	r	**0.244**	**0.498**
0HZ	P-value	**0.028**	**0.004**
Lt400	r	**0.737**	**0.450**
0HZ	P-value	**0.032**	**0.010**
Lt800	r	**0.325**	**0.554**
0HZ	P-value	**0.020**	**0.001**

Exploring correlations of hearing loss with clinical characteristics among SLE patients, showed that disease duration was significantly correlated with hearing loss bilaterally at frequencies of 1000, 2000 and 8000 HZ on right side and at frequency of 4000 HZ on left side, however no correlations existed with SLEDAI scores, elevated ds-DNA titers, reduced complement, and positive anti-phospholipid profile. Hearing loss in our BD patients didn't correlate through any frequency with BDCAF scores, disease duration or any clinical features among patients including ocular, CNS, or major vessel affection. Further regression analysis confirmed disease duration in RA as a predictor of hearing loss at high frequencies (4000, 8000 HZ) (P 0.014, 0.046) respectively.

DISCUSSION

Audio-vestibular disturbances among systemic autoimmune disorders can manifest clinically in a variety of ways with significant inter-individual variations. The most prevalent condition is hearing loss, followed by tinnitus and vertigo [20]. In the present study, RA patients complained most of HL, while those with SLE suffered mostly from tinnitus, however BD patients exhibited the longest auditory complaints duration. Auditory evaluation of patients revealed various degrees of HL with SNHL type being more prominent. SRT was abnormally prolonged among BD patients, while PTA values were the highest among SLE patients in almost all frequencies. Among RA patients HL correlated significantly with disease activity and duration. Vestibular assessment revealed the highest percentage of vertigo in SLE patients, with no significant difference among subgroups as well as healthy controls.

Compared to other subgroups, RA patients exhibited the longest disease duration with moderate disease activity and the highest CRP levels. Most patients were on hydroxychloroquine, methotrexate and leflunomide, however none were on azathioprine or cyclosporine. 43.7% had complaints of HL, however, on auditory assessment this percentage increased to 50%, indicating subclinical cases. This finding is supported by several observational and meta-analysis studies, which found RA patients to be at increased risk of SNHL compared to healthy individuals, but not CHL, or MHL, recommending early screening of RA patients regardless their complaints [21,22]. Our results showed an increased prevalence of hearing impairment in RA patients, especially SNHL, being significantly increased compared to controls. This agrees with several studies [3,4,23], however other studies found this increased prevalence non-significant [1]. Most of RA patients were bilateral, mild, consistently with several studies [3,5,7].

Despite falling within upper limit of normal range, SRT values were significantly higher than controls. No abnormal tympanometry or acoustic reflexes were detected, with no significant difference than other groups as well as controls. This comes in line with several studies [1,20], however **Ozcan *et al***. [3] detected a high prevalence of abnormal tympanograms compared to healthy controls.

In the present study, PTA results were significantly higher throughout all tested frequencies compared to controls. Similarly, several studies reported such finding [3,20], whereas others found significant difference at high frequencies only [5,18,23]. In contrary, few studies didn't detect statistical differences between RA patients and controls [24].

Regarding correlations of hearing loss in RA patients, it correlated only with disease duration and activity via DAS28, however no correlations existed with age, RF positivity, ESR, rheumatoid nodules, degree of disability, or certain types of medications. Despite concordance with some studies [1,4,5], other studies found different correlations [25,26], or used different functional or disability indices [3]. Furthermore, the present study reported disease duration as a predictor of hearing loss among RA patients. This disagrees with **Pascual-Ramos *et al.*** [7] which found age to be main predictor of HL among RA patients.

Considering our SLE patients, 27.8% of them complained of hearing loss, however actual audiological assessment revealed a much higher percentage (61.1%). These results are considered comparable to other studies

which reported lower percentages [4,27,28]; 31.7%, 21%, 26.7%, respectively, as well as a study [29], which reported a higher incidence of 66% hearing loss in SLE patients. According to literature, SNHL is the most common audiovestibular symptom in SLE, with a prevalence of between 6% and 70% [10]. Our results endorse this fact with a percentage of 45.5%, showing predominance of mild degree and bilateral presentation.

PTA values of SLE patients were the highest throughout almost all frequencies, compared to other subgroups as well as healthy controls, in accordance with several studies [1,2,8,30], but opposing **Tsirves *et al.*** [4] who found PTA of RA patients was significantly higher than those of SLE patients. Our results didn't find any correlation regarding hearing loss with clinical, serological features, disease activity, or drugs. This comes in line with **Tsirves *et al.*** [4], but contrasts a couple of studies [1,8], who detected correlation of HL with cumulative steroid dose, clinical manifestations, and SLEDAI scores. **Gad *et al.*** [30] described a strong association of SNHL with APL positive pediatric SLE patients.

Audiologic assessment of our BD patients revealed HL in 40% of patients; two thirds of them had previous complaints. Bilateral SNHL was detected in 66.7% of them, mostly of mild degree. High PTA as well as abnormal SRT values were found with significant difference compared to controls. Several studies support our findings with varying ranges of SNHL from 32% up to 64.3% [31-35]. **Bakhshaee *et al.*** [31] and **Sota *et al.*** [32], in their studies, found SNHL was the fourth most common clinical finding in BD after oral ulcers, ocular lesions and skin lesions. Correlation analysis of the present study as well as other studies [31,36] did not reveal any significant correlation with disease duration, clinical manifestations, or disease activity. However, **Bakhshaee *et al.*** [31] reported a positive correlation of HL with those having a negative pathergy test, while another study [11] found SNHL to correlate with age and disease duration in BD patients.

Prior research into the vestibular system's involvement in BD found abnormal results in vestibular tests (caloric tests, rotation tests) [33], as well as hypometric or hypermetric saccades in video nystagmography tests, to be associated with vestibular impairment with central nervous system involvement [37]. Few studies have examined vestibular dysfunction in BD patients using vestibular evoked myogenic potentials (VEMP), connecting central nervous system involvement with chronic inflammation on the sacculocollic pathways [34].

The VOR gain of each semicircular canal under study was determined using the relatively new test known as vHIT. It also allows for the identification of overt and covert saccades. The results of this investigation showed that abnormal overt and covert saccades were mostly evoked in the horizontal (lateral) canals, significantly more so than in other subgroups, while no saccades were seen in the vertical canals. Furthermore, no abnormal saccades were seen in any of the healthy subjects. Although patient gain levels were often lower, there was no statistically significant difference. **Ertugrul *et al.*** [35] provided findings that supported our findings. To the best of our knowledge, no studies have previously used vHIT to evaluate vestibular impairment in individuals with RA or SLE.

CONCLUSION

Audiovestibular manifestations could have a major role in the diagnosis of autoimmune diseases, with the possibility of early presentation and, in some cases, being the only sign of autoimmunity. Exhibiting audiovestibular symptoms such as progressive or fluctuating SNHL without any other apparent explanation, systemic autoimmune illnesses should always be taken into consideration. Subclinical asymptomatic cases are well-established in literature and was confirmed in our results. The current study revealed the correlation of hearing impairment with RA disease duration and activity, with disease duration serving as a strong predictor of hearing loss at high frequencies (4000 and 8000 HZ) among those patients.

DECLARATIONS

- **Conflict of Interest:** Nil
- **Disclosures:** Nil
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