Original Article

Assessment Of The Audio Vestibular System In Patients With Rheumatoid Arthritis

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DOI: 10.47750/pnr.2023.14.02.409

Abstract

Background Synovial inflammation in the diarthrodial joints (also known as diaphragmatic joints) in people with rheumatoid arthritis may cause cartilage degradation and bone erosion as well as a weakening and breaking down of the structures of the joint's ligaments, tendons, and capsular lining. As a result of this inflammation, ligaments and tendons might be damaged (RA). We wanted to assess RA patients' hearing and vestibular capacities and compare them to the general population's. We also considered the relationship between these findings and the seriousness and regularity of sickness incidence. In this prospective study, 50 instances of both men and women with an average age of 33.7 years (range from 23 to 66 years) were included, along with 50 healthy individuals with an average age of 33.7 years (ranging from 22 to 66 years), who did not fulfil the diagnostic criteria for RA. If a participant had a history of hearing loss, head-and-neck birth deformities, a work that required them to be around loud noises, a recent head injury, or a neurological condition, they were not permitted to participate in the study. There were three healthy individuals in each group. **Result** The Water caloric test, Pursuit test, and Saccade test revealed a sizable difference between the two groups. The difference between the two groups was also quite large for the milliseconds of the interpeak delay of Waves III-V, Waves I-V, and the amplitude ratio of Wave V to Wave I. The results of the videonystagmography did not significantly correlate with the severity of the illness, the ESR, or the RF. **Conclusion** There is a connection between RA and degradation of the audiovestibular system, regardless of the clinical or demographic characteristics of the patients. We hypothesise that RA more commonly than previously thought impacts hearing and vestibular function. Patients with RA who experience high-frequency hearing loss may have cochlear involvement.

Keywords: Audiovestibular system, Rheumatoid Arthritis, Hearing and vestibular Function

BACKGROUND

One percent of the population is affected by rheumatoid arthritis, also referred to as RA, an autoimmune disease that can be brought on by a number of different conditions. Leukocytes, the majority of which are CD4+ T cells and monocytes, travel from the blood vessels into the inflammatory synovial tissue and synovial fluid, making it different from other situations. An ongoing inflammatory reaction results from this. Older persons are more likely to get RA, and more women than men experience it (1).

More than one organ system is involved in the disease's symptoms that are not limited to the joints. Examples include when the eyes, skin, lungs, heart, or skin are impacted. The larynx, the inner ear, the temporomandibular joint, and the cervical spine are a few potential sites of discomfort in the head and neck region. Because they are frequently the first symptom of rheumatologic diseases with no other symptoms, ear, nose, and throat symptoms of connective tissue disorders are challenging to diagnose (2).

There are conflicting findings on the types of hearing loss that might occur and if disease activity and severity markers are related to hearing levels when it comes to the hearing system. **(3)**.

According to the findings of Ferrara and colleagues, numerous individuals with RA had symptoms of vestibular impairment. However, Kakani and colleagues were unable to demonstrate that patients with RA had altered caloric responses or abnormal saccadic eye movements, despite the fact that some patients reported that they sometimes experienced dizziness in their day-to-day lives. According to Wennmo and Wennmo, some people who have RA may experience lightheadedness as an adverse impact of some of the drugs they take, like nonsteroidal anti-inflammatory drugs (NSAIDs) **(4)**.

Yilmaz and colleagues discovered a correlation between RA and issues affecting the vestibular system. This was the case irrespective of the patient's age, gender, length of illness, vertigo symptoms, laboratory test findings, sensorineural hearing loss (SNHL), or medicines [5].

The participants in this research were split into two groups: one with RA, which had their hearing and balance evaluated, and another group that served as a control. In addition, we compared these findings to the severity of the illness as well as its activity.

Methods

People with rheumatoid arthritis (RA) who went to the Rheumatology Outpatient Clinics at the Beni Suef University Hospital were asked to take part in the study. According to the 2010 American college of rheumatology (ACR)/EULAR criteria (6), patients were diagnosed with RA, and their average age was 33.7 years (ranging from 23 to 66 years). The healthy controls for this study were selected from the general community and ranged in age from 22 to 66. If participants had a history of hearing loss, they were not permitted to participate in the study., birth defects in the head and neck, a job that exposed them to loud noises, a recent head injury, or a neurological disease. In each group, there were three people who were in good health.The following criteria were employed with the intention of assessing the amount of disease activity: arthritis of more than 10 joints with at least 1 small joint; positive ESR or CRP; high or low positive RF test and or Anti CCP; in more than 6 weeks are all symptoms of rheumatoid disease. Patients in this trial received methotrexate, (NSAIDS), and systemic corticosteroids as their therapy. The criteria for exclusion Otologic or neurologic problems, or exposure to noise where all reasons why participants were not permitted to participate in the research.All participants in the research provided written, informed consent. Everyone who participated in this study did the following: A thorough medical examination, an otological examination, and an audiological assessment are: Following a thorough physical examination, the Otolaryngology Department performed an audiologic evaluation using a Maico MI 44 Analyzer and a Maico MA 53 audiometric equipment (both manufactured by MAICO Diagnostics, Berlin, Germany). This test includes measurements of the tympanic membrane compliance, speech reception thresholds, and acoustic reflexes in addition to pure-tone audiometry for octaves frequencies ranging from 0.250 to 8 kHz for bone and air conduction. Tympanometry measurements were made using a Maico MI 44 Analyzer (MAICO Diagnostics, Berlin, Germany). Tympanometry data were classified as type A, type B, or type C tympanograms based on what was discovered. Immitancemetry was carried out with a single-component, single-frequency tympanometer using a GSI 33 (Grason-Stadler, USA) and a 226 Hz probing tone. A single, seasoned researcher who had no knowledge of the research's methodology carried out this approach. The auditory reflex threshold for ipsilateral and contralateral evoked responses as well as the evaluation of the vestibular system were discovered using pure tones with frequencies of 500, 1000, 2000, and 4000 Hz.

The VF 405 Videonystagmography (VNG) machine (Interacoustics A/S, Assens, Denmark) was used to administer positional, caloric, and smooth pursuit tests to the patients. With the aid of a chart videonystagmography for Windows tool, the data from each subject was combined. The smooth chase test asks participants to move their eyes horizontally between 0.2 and 0.7 Hz while tracking a target on a light bar. The benefit of a smooth chase was determined using computer software. To learn more about 70% of the problems the patients claimed to be having, they were advised to keep their focus on a visual target on the light bar during the saccade test. The object was shifted from the right axis to the left axis with amplitudes between 5 and 30. Software was used to calculate the maximum speed, accuracy, and delay. It was exceptional since the accuracy was only 80%, the fastest speed was 300 s-1, and the latency was 280 ms. When at least one of the accuracy or peak velocity scores was outside of the reference range, it was assumed that the patient had less saccadic movement.

When the Dix-Hallpike test was done, Frenzel glasses were used. Before the patient is moved so that their head hangs over the end of the examining console, they are put at a 45-degree angle to the left or right of the console. Eye movements of the subject were tracked for at least a minute and a half. At the end of the surgery, the patient was told to sit on the lap of the observer. It was found that the caloric stimulation caused nystagmus in both ears (Instrumentation DIFRA S.A, Welkenraedt, Belgium). First, the participants' answers were taken for three minutes with their eyes closed. Then, they were taken again with their eyes open. It was decided that a person had a disability if they had at least 20% canal paresis and at least 25% directional predominance.

BAEP testing was done at Beni-Suef University Hospital's Neuro-Diagnostic and Research Center (NDRC) with Nihon Kohden EMG/EP® equipment, MEB 2300 Neuropack X1 Desktop System model, made in Japan. The BAEP were recorded from each ear on its own for the click stimuli that were presented at 80 dB or HL. All of the recordings were done in a quiet room with a bed where the patients could lie down comfortably. Insert earphones sent clicks at 8/s and 120 dB pe SPL to the right ear, while white noise at 60 dB pe SPL and rarefaction polarity blocked the view of the other ear. Electrodes in the form of surface discs were implanted in the vertex Cz, mastoids (M1 and M2) as well as in the lower forehead (Fpz). The electrical activity of the scalp was increased from 10 to 30 Hz to 2,500 to 3,000 Hz as a result of the treatment (-3 dB). There was an average of at least 4,000 amplified replies. For the purpose of ensuring that the results were reliable and accurate, each waveform was captured not once, but twice. For each ear separately, the absolute latencies, interpeak latencies, and wave shapes of BAEP responses were looked at. The peak was judged to be abnormal if the absolute latency of Waves I, III, and V, as well as the interpeak latencies of I–III, III–V, and I–V, and the interaural latencies, were more than two standard deviations (SDs) above the mean values of control subjects of the same age and gender.
Wave V by itself, Waves V and III together, a bad waveform shapes (a waveform with no clear peaks) or no peaks at all were all seen as abnormal.

Ethical Approval The study was approved by the Ethics Board of Beni-Suef University and the patients were given all the information they need about the trial. An informed written consent was taken from each participant in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical Analysis

The SPSS software application, version 15, for Windows, was used to do the data analysis (SPSS Inc., Chicago, IL, USA, 2006). The mean and standard deviation are used to explain the results. The results of the various research groups were compared using both the Student's t test and the Chi square test. Significant statistical evidence was indicated by P values less than 0.05.

Results

Table (1) Comparison between the studied groups as regard baseline data

	Group A (n=50)	**Group B (n=50)**	**Test**	**P**
Age			T=1.017	1.01
Mean ± SD	33.7±3.54	33.7±3.51		
Sex			χ^2=0.27	0.87
Male	28	27		
Female	22	23		
Disease duration, years	2.96± 1.39	-	-	-
ESR, (mm/1st hr)	49.9 ± 3.4	-	-	-
RF (IU/ml)	133.9 ± 19.8	-	-	-

Two-Sample Independent t Test, χ^2: Chi-square test
p: p value for comparing between different categories
*: Statistically significant at $p \leq 0.05$

Table (1) shows that there was non-significant difference between both groups as regard age or sex.

Table (2) Air conduction thresholds in pure tone audiometry (250- 8000 Hz) for RA patients and healthy controls

Right ear	Group A (n=50)	Group B (n=50)	Test	P
250	22.5±2.1	1±0.2	5.44	0.001*
500	19±1.8	9±0.85	T=4.48	0.004*
1000	14±1.3	9±0.91	3.91	0.009*
2000	14±1.3	10±0.8	2.64	0.058
4000	15±1.4	10±0.85	2.71	0.052
8000	15±1.4	15±1.3	1.15	0.79
Left ear				
250	20±2.1	10±1.00	4.41	0.005*
500	18±1.7	16±1.4	1.47	0.44
1000	16±1.5	9±0.84	3.11	0.02*
2000	15±0.9	9±0.78	1.33	0.58
4000	21±2.1	14±1.4	2.25	0.11
8000	22±2.2	20±2.1	1.097	0.88

T: Two-Sample Independent t Test
p: p value for comparing between different categories
*: Statistically significant at $p \leq 0.05$

Table (2) shows that there was significant difference between both groups as regard Air conduction thresholds in pure tone audiometry at 250, 500, 1000, 2000, 4000 at right ear frequency and at 250, 1000 at left ear frequency,

Table (3) Bone conduction thresholds in pure tone audiometry (250- 4000 Hz) for RA patients and healthy control

Right ear	Group A (n=50)	Group B (n=50)	Test	P
250	5.5±0.55	5±0.9	2.677	0.02*
500	5±0.8	10±1.85	5.34	0.001*
1000	4.9±0.3	9±0.95	10.02	0.00002*
2000	10±1.3	10±0.8	2.64	0.058
4000	9±1.4	5±0.85	2.71	0.052
Left ear				
250	4.8±0.19	4±0.45	5.60	0.00009*
500	5±0.7	10±1.42	4.1	0.001*
1000	5±0.5	6±0.80	2.56	0.03*
2000	10±0.9	9±0.75	1.44	0.47
4000	9±1.1	14±1.43	1.69	0.22

Two-Sample Independent t Test
p: p value for comparing between different categories
*: Statistically significant at $p \leq 0.05$

Table (3) shows that there were significant difference between both groups as regard bone conduction thresholds in pure tone audiometry at 250, 500, 1000, 2000, 4000 at right ear frequency and at 250, 500, 1000 at left ear frequency,

Table (4) Comparison between both control group and rheumatoid arthritis (RA) group on the findings of videonystagmography

	Group A (n=50)	Group B (n=50)	Test	P
Pursuit test			2.81	0.09
Normal	45	50		
Abnormal	5	0		
Saccade test			8.18	0.004*
Normal	28	50		
Abnormal	22	0		
Optokintic test			-	-
Normal	50	50		
Abnormal	0	0		
Positional test			-	-
Normal	50	50		

Abnormal	0	0		
Dix–Hallpike test			-	-
Normal	50	50		
Abnormal	0	0		
Water caloric test			4.86	0.02*
Normal	28	50		
Abnormal	22	0		

Two-Sample Independent t Test
p: p value for comparing between different categories
*: Statistically significant at $p \leq 0.05$

Table (4) shows that there was significant difference between both groups as regard Water caloric, Pursuit and Saccade tests.

Table (5) BAEPs Bone conduction thresholds in pure tone audiometry (250- 4000 Hz) for RA patients and healthy control

	Group A (n=50)	**Group B (n=50)**	**Test**	**P**
Wave I latency (ms)	1.39±0.12	1.40±0.13	1.17361	0.68
Wave III latency (ms)	3.3±0.22	3.35±0.24	1.19	0.67
Wave V latency (ms)	4.9±0.3	4.95±0.32	1.13	0.71
Waves I–III latency (ms)	2.2±0.22	2.36±0.25	1.291	0.54
Waves III–V latency (ms)	1.8±0.19	2±0.45	5.60942	0.00009*
Waves I–V latency (ms)	3.78±0.7	4.2±0.8	4.1	0.001*
V–I amplitude ratio	2.45±0.5	1.90±0.80	2.56	0.03*
Interaural latency difference (ms)	0.1±0.05	0.4±0.1	1.44	0.47

Two-Sample Independent t Test
p: p value for comparing between different categories
*: Statistically significant at $p \leq 0.05$

The data presented in **table (5)** demonstrates that there was a statistically significant difference between the two groups with respect to the Waves III–V, Waves I–V latency, and the V–I amplitude ratio.

Table (6) Correlation between Videonystagmography results and different parameters

Pearson Correlation		
	Videonystagmography results	
	R	**P**
Disease duration, years	-0.051	0.78
ESR, (mm/1st hr)	-0.039	0.837
RF (IU/ml)	-0.011	0.95

Table (6) shows that there were insignificant Correlation between Videonystagmography results and Disease duration, ESR or RF.

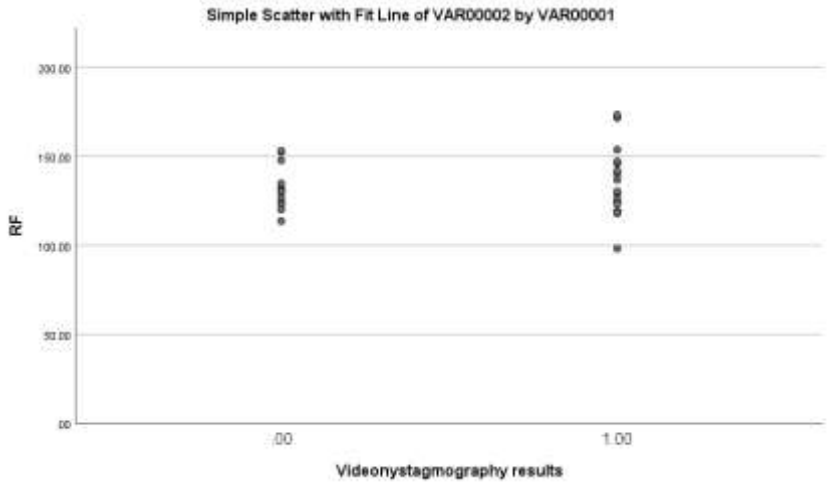

Figure (1) Correlation between Videonystagmography results and RF

Discussion

Chronic rheumatoid arthritis (RA) is an inflammatory illness that affects several body systems and produces inflammation of the synovial membranes that line the diarthrodial joints. This may result in the degeneration of cartilage, erosion of bone, and the weakening and eventual loss of ligaments, tendons, and joint capsules. In addition to affecting the cervical vertebrae and the temporomandibular joint, issues with the head and neck may also impact the larynx and the audiovestibular system [7].

The participants in this research were split into two groups: one with RA, which had their hearing and balance evaluated, and another group that served as a control. We also compared these results to the activity and severity of the disease.

This study showed that there was not much difference in age or gender between the two groups.
El Dessouky et al. (8) led a case-controlled research with 20 solid controls going in age from 25 to 66 years of age, utilizing the 2010 American School of Rheumatology/European Association against Stiffness order models. There was no genuinely huge contrast between the two gatherings concerning sexual direction. 95 RA victims partook in a concentrate by Gamal et al. (3). Ten were men and 85 were ladies, or 89.5% and 10.5% separately. The typical age at starting was 36.7 1.2 years, the typical illness length was 9.6 0.6 (0.5-30 years), and the typical age at death was 46.5 1.1 (20-60) years.

The 100 controls were indistinguishable regarding age and orientation (85 ladies and 15 men) (44.11 1.1, somewhere in the range of 20 and 60 years). 40 (42.1% of the patients) didn't smoke, while 3 (3.2%) had smoked previously, 5 (5.3%) were current smokers, and 47 (49.5%) were detached smokers. Ilham et al. (9) uncovered that our review comprised of 17 sound controls (mean age, 41.5 9.1) and 30 members with RA (mean age, 44.5 9.9 years; 90% were female). The two gatherings had a similar age and orientation ($p>0.05$). The otoscopies of each subject were all reasonable. As per this review, there were critical varieties in the two gatherings' air conduction edges for unadulterated tone audiometry at 250 and 1000 Hz for the left ear and at 250, 500, 1000, 2000, and 4000 Hz for the right ear. The bone conduction edges were different between the two gatherings in unadulterated tone audiometry at frequencies of 250, 500, 1000, 2000, and 4000 Hz for the right ear and at frequencies of 250, 500, and 1000 Hz for the left ear. The typical hearing limits in the right ear of people with RA and a benchmark group were shown by El Dessouky et al. (8). There was no measurably massive distinction between the two gatherings at 250, 500, 1000, or 2000 Hz. While RA patients' typical hearing limits were lower than those of the benchmark group at high frequencies (4000 and 8000 Hz). This variety was measurably significant.

The typical hearing limits in the left ear of RA patients were contrasted with those in a benchmark group by El Dessouky et al. (8). There was no genuinely huge contrast between the two gatherings at 250, 500, 1000, and 2000 Hz ($P>0.05$). While RA patients' typical hearing edges were lower than those of the benchmark group at high frequencies (4000 and 8000 Hz). This variety was measurably imperative. Ilham et al. (9) showed utilizing unadulterated tone audiometry that RA patients had genuinely more regrettable bone conduction edges at low frequencies and more terrible air conduction limits than controls. The Water Caloric Test and the Saccade Test uncovered massive contrasts between the two gatherings in this examination. The VNG information for the pursuit test, the saccade test, the optokintic test, the situating test, the Dix-Hallpike test, and the water caloric test were thought about by El Dessouky et al. (8). There was no measurably massive distinction in dizziness side effects between the RA bunch and the benchmark group, except for the saccade test and the water caloric test. The aftereffects of this study showed that the Waves III-V, Waves I-V deferral (ms), and the V-I abundancy proportion of the two gatherings were significantly unique.

Ismaiel et al. (10) concentrated on 25 solid females as a benchmark group and 25 rheumatoid patient gatherings. They tracked down that the recurrence of changed BEAP is 45 ears (90%) of RA patients examined with deferred dormancy of wave I in 22 (44%), of wave II in 8 (16%), of wave III in 8 (16%), of wave IV in 7 (14%), and of wave V in 9 (16%). It diminished the abundancy of wave Ia in 24 (48%) and of wave Va in 45 (90%) of RA patients. It likewise expanded interpeak idleness among III and V in 25 (half) and in 10 (20%) of RA patients. There is a genuinely tremendous contrast in the frequencies of all BEAP boundaries among control and RA bunches with $P > 0.05$. The mean distinctions in the interpeak latencies of waves (I-III) and (III-V) between the two gatherings were exceptionally critical

Shelja et al. (11) who showed that in the right ear, the distinction in the outright pinnacle dormancy of wave III of gatherings 1 and 2 was critical, while until the end of the waves, it was irrelevant. In the left ear, the distinction in outright pinnacle dormancy of waves I, IV, and V of gatherings 1 and 2 was huge, while until the end of the waves, it was unimportant ($P > 0.05$). The distinctions in interpeak latencies (I-III, III-V, and I-V) were unimportant ($P > 0.05$), when controls were contrasted and RA patients.

Waves I, III, and V qualities in the patient's gathering were not altogether not the same as those in the benchmark group, as per Srinivasan and partners Wilcoxon's marked positions test (12). This was shown by the way that the p esteem was more noteworthy than 0.05. Thus, the information from the ears was assembled and checked in more detail out. For the situation bunch, strange BAEP waveforms were viewed as in 42 of the 90 ears, or 46.7%. Wave V pinnacles were absent in 11 ears (12.22%) and Wave III pinnacles were absent in 9 ears (10%). Every one of the patients had Wave I, and every one of them were in the ordinary reach. The BAEP oddity that was seen most frequently was a more prominent outright deferral for Wave V (24.44 percent, n = 22 ears). This was trailed by higher interpeak stretches for Waves I-V (22.22 %, n = Twenty ears), and III-V (18.89 %, n = Seventeen ears.(

Inside the patient gathering, Wave III was the sort of BAEP peculiarity that happened the second most frequently, as indicated by Srinivasan et al. (12), 15.56 percent of ears (n = 14) had longer outright Wave III latencies, though 17.78 percent of ears (n = 16) had longer Waves I-III latencies. The size proportion of Waves V to I was significantly less in 4.44 percent of patients ears than in controls. Just two people with patients bunch announced impressively bigger interaural dormancy disparities. At the point when more noteworthy feeling paces of 80.1/S were utilized, wave V latencies were altogether longer in 13 ears (14.44 %), however they were missing in 16 ears (17.78 percent). With the exception of Wave III and the span between Waves I and III, the Mann-Whitney U test uncovered that the two gatherings were different in each respect.

The BAEP is said to show a bigger number of reciprocal irregularities than it does one-sided ones, as expressed by Musiek et al. (13). The results of this study demonstrate that the BAEP anomalies that manifest themselves the most frequently are of the Wave III and Wave V reaction sorts. The determinations made from various further investigations have all highlighted the equivalent overall example of conduct. The scientists Chiappa et al. (14), La Mantia et al. (15), Lima et al. (16), and Musiek et al. (13) uncovered issues in the hear-able neuronal circuits of the pons and the midbrain.The predominance of each BAEP anomaly (nonattendance of Wave V, Wave III, and Wave V at 80.1/s excitement rate, delayed outright latencies of Wave V, III, and I-III, delayed interpeak latencies I-V, III-V, and I-III, delayed interaural Wave V dormancy contrast, Wave V at 80.1/s feeling rate, and diminished Wave V-I abundancy proportion) is tantamount to what Musiek et al. (13) found when they utilized this shows an ascent in the extent of ears with an unusual Wave V reaction. This shows that a more prominent number of ears had an unusual Wave V reaction at the later time point in the review. Thusly, subsequently, checking the BAEP of an individual with MS while simultaneously expanding how much excitement they get is a compelling methodology for assessing whether that individual experiences difficulties with their BAEP.

Yet, in this review, the Wave V interaural dormancy was not the same length as what Musiek et al. (13) found. This could be on the grounds that the patient's gathering had a ton of BAEP irregularities in the two ears. Despite the fact that it can't be said without a doubt that huge contrasts in idleness are brought about by contrasts in PTA between gatherings, the impact of fringe hearing misfortune is probably going to be little since hearing limits don't change a lot of even at the higher frequencies (2-4 kHz).
This study showed that they were not important. Correlation between the results of videonystagmography and the length of the disease, the ESR, or the RF.

El Dessouky *et al.* [8] found a link between the length of RA and RF and how badly patients did on the pursuit test. This link made sense from a statistical point of view. There was also a statistically significant link between a bad water caloric test and RA or RF. There was no correlation found between the impaired saccade test and factors such as age, gender, duration of RA, lab findings, or symptoms of vertigo in RA patients.

Musiek *et al.* [13] discovered that the majority of hearing loss occurred at low and intermediate frequencies. It is far more probable that this is an early indicator of the sickness, which was verified by the fact that the persons who were afflicted were young. There is a connection between RA and the condition known as endolymphatic hydrops. It begins with a loss of hearing at low frequencies and then progresses to a loss of hearing at high frequencies; however, the patients who participated in the research did not report experiencing vertigo bouts, which are often linked with this symptom.

Goodwill *et al.* [17] found that there was no link between how active RA was and how often SNHL happened. However, they found that SNHL happened more often in people with rheumatoid nodules.
Furthermore, Takatsu et al. (18) revealed that their investigation failed to find a link between hearing loss, RA, and autoimmunity. However, they did find a link between the inner ear's involvement and ESR, plasma interleukin 6, and metalloproteinase-3. They proposed that the systemic inflammatory mediators might cause inner ear dysfunction by wreaking havoc on the tissues there.

Objective audiometric measurements of people with RA were not significantly different from those of people without RA, according to the findings of Halligan et al. (19). According to their own perceptions, RA patients were more likely to believe that they had hearing abnormalities, which may not always be a symptom of functional impairment but rather be an indicator of the illness as a whole.

Conclusion

There is a connection between rheumatoid arthritis (RA) and issues with the audiovestibular system, and this association exists independent of the patient's general health or past. Shearing and vestibular issues may be more prevalent in RA patients than was previously believed, according to our findings. Hearing loss that is predominant at high frequencies may be an indication that RA has affected the cochlea.

Declarations

Consent for publication I attest that all authors have agreed to submit the work.

Availability of data and material Available

Competing interests None

Funding No fund

Conflicts of interest no conflicts of interest.

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