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Research Paper

Evaluation of Anterior Inferior Cerebellar Artery Vascular Loop by T2 -3D DRIVE MRI Sequence in Patients with Vestibular-Auditory Symptoms

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ABSTRACT:

BACKGROUND:

The cerebellopontine angle and internal auditory canal are cerebrospinal fluid filled spaces located at the posterior cranial fossa within the edges of temporal bones, the anatomical relation of anterior inferior cerebellar artery is variable within each spaces and it's a possible etiology of an unexplained vestibular-auditory symptoms including tinnitus, vertigo, and sensory neural hearing loss, by forming vascular loops affecting the course of vestibulocochlear nerves. This condition may be detected more precisely by using high resolution 3tesla MRI machine.

OBJECTIVE:

To compare anatomical relation of anterior inferior vascular loop and vestibulocochlear nerves in relation to vestibular-auditory symptoms.

PATIENTS AND METHODS:

This study is a cross-sectional case control including 116 adult individuals, 86 patients presented with unexplained vestibular-auditory symptoms comparing with 30 control adults who were investigated at Al-Yarmouk teaching hospital from December 2021 to October 2022. Data collected from patients through direct interview and fulfilling prepared questionnaire. MRI imaging use, 3D DRIVE thin slice T2-wieghted images in order to identify the vascular loops in all individuals in relation to vestibulocochlear nerves and classify the finding through two grading systems and correlate them with patient's symptom.

RESULTS:

No statistically significant association detected between presence of different grades or types of vascular contact and any patients complaining from any audio-vestibular symptoms according to both types of included classification systems (Chavda and Gorrie).

CONCLUSION:

There are independence between MRI findings and the clinical profile, suggesting that there is no direct, exclusive relationship between the diagnosis of vascular loop on an MRI scan and the corresponding otoneurological profile.

KEYWORDS: vascular loop, vestibulo-auditory, vestibulocochlear, internal auditory .

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INTRODUCTION:

The most common vestibular-auditory symptoms are sensorineural hearing loss (SNHL), tinnitus and vertigo, which can affect the personal quality of life, social habit, cognitive, and functional developments [(1)]. Anatomical and functional changes in one or more regions of central or peripheral vestibular and auditory pathways are involved as causative effect, although, in the absence of inner ear disease, the precise cause is not always identified [(2)]. The anterior inferior cerebellar artery (AICA) is thought to be the vessel responsible for vascular compression syndrome of the eighth cranial nerve [(3)]. MRI is an important tool for investigating the internal auditory canal

(IAC) and cerebellopontine angle (CPA), especially preceding surgical procedures, to gain a better understanding of the anatomical variations. Thin sections T2W MRI can satisfactorily show the relationship between vascular structures and nearby cranial nerves, especially in patients with vascular compression symptoms [4].

PATIENTS AND METHODS:

Patients collection

A cross-sectional case control study was carried out at Al- Yarmouk teaching hospital radiology department MRI unit in Bagdad, Iraq. A total number 116 adult individuals, 86 patients presented with vestibular-auditory symptoms comparing with 30 non-complain adults recruited as controls; arranged for MRI study between December 2021 and October 2022. The study's goal was to analyze patients with unexplained audio vestibular symptoms by using T2-3D DRIVE MR imaging to correlate clinical subtypes of audio vestibular symptoms with the location of anterior inferior cerebellar artery(AICA) in relation to the vestibulocochlear nerve at both internal auditory canal and cerebellopontine angle.

Inclusion criteria

1. The study covered all patients with unexplained audio-vestibular complaints, referred from neurologists and otolaryngologist.
2. As a control, additional 30 individuals with non-symptomatic ears were included.

Exclusion criteria

1. Deformities of inner ear.
2. Retrocochlear lesion (IAC stenosis, schwannoma, etc.).
3. Prior acoustical or neurological trauma.
4. Central nerves system dysfunction (ischaemia, migraine, etc.).
5. Sever systemic or metabolic illness.

Study protocol

A 3-tesla magnetic resonance scanner machine (achieva Philips medical systems Nederland B.V), using typical circularly polarized head coil.

A brain MRI study arranged for each subject utilizing the following sequences:

• Turbo spine echo (TSE) axial T1-weighted images, Axial T2-weighted image, coronal fluid attenuation inversion recovery with large FOV cover the area from vertex to skull base, to evaluate the anatomy and any abnormal signal intensity within brain and petrous temporal region.

• Diffusion weighted image and ADC map use as a routine sequence to identify acute ischemic vascular disease in brain or any other pathology.

• 3D DRIVE sequence, which is a thin slice heavy T2 MR image that performed in three dimensions (axil, coronal, and sagittal) with a small field of view (FOV) covering the level of the internal auditory canal and the cerebellopontine angle cisterna on both sides, using values of (1-mm slice thickness, field of view 100 mm, 376 x 290 matrix, plane resolution 0.40 x 0.52 mm).

Image analysis

Two radiologists combined and analyzed the MRI data. Any disagreement was reevaluated collectively in order to reach a final decision. Assessment of an abnormal pathology of the auditory and vestibular systems, the structure, position of AICA in the internal auditory canal and CPA, these were tracked and classified using two systems:

1. Chavda classification system [5].
2. Gorrie classification system [6].

In the identification of AICA and vestibulocochlear nerve, these appear as very low signal intensity in comparison to very high signal CSF within both the internal auditory canal and the cerebellopontine cisterna, assign the degree of contact between the vessel and the cranial nerve using 3D DRIVE Imaging. Vascular loops were assessed and classify according to whether they are true adhesion, angulation, or simply passing beside the vestibulocochlear nerve, and then compare the collected data with the patients' vestibulo-auditory symptoms. The t-test was used to determine whether the presence of a vascular loop was associated with tinnitus, hearing loss, or vertigo. Probability P values of 0.05 or less were used as the significance value level. The kappa test was used to assess the examiners' agreement on the type of vascular loop discovered.

Statistical analysis

The patients' data was entered into Microsoft Office Excel 2010, and the statistical analysis was carried out with SPSS for Windows, v.25.0; IBM Corp, Armonk, New York, UA. The data is presented in the form of mean ± standard deviation, or numbers and percentages. The Chi-Square test was used to compare categorical data, and the presence of vascular loops in different patients was analyzed using the independent unpaired student t-test.

RESULTS:

Demographic Characteristics of the Patients:

This study involved a total of 116 adults [Table 1], resulting in the analysis of 232 ears. The patients' non-symptomatic ears were embraced in the control group. The sample included 62 women (53.45%), (44 as patient, 18 control), and 54 men (46.55%), (42 as patient, 12 as control), with no significant gender differences. The mean age was 46.87±12.6 years, compared to 49.23±14.5 years, in symptomatic and control groups respectively, there was no significant difference.

Table 1: Demographic characteristics of the patients.

Characteristics	Patients (N= 86) Ears (N=172)	Control (N= 30) Ears (N= 60)	p-value
Sex			
Male	42(48.84%)	12(40%)	0.403
Female	44(51.16%)	18(60%)	
Age (years)			
Mean±SD	46.87±12.6	49.23±14.5	0.645
Range	(20-70)	(18-75)	

Clinical and imaging Characteristics of the Patients

A total of 232 ears were studied to assess the relationship between AICA and the vestibulocochlear nerve when traveling through the internal auditory canal and the cerebellopontine cisterna; it was observed that 39 ears had tinnitus compared to 193 without tinnitus, 20 ears with sensory hearing loss vs 212 without sensory hearing loss and 84 ears with vertigo vs 148 without vertigo [Table 2], Some patients have multiple symptoms in both ears, while others have both symptomatic ears.

Table 2: Number of studied ears with symptomatic characteristic and their percentages.

Characteristics	Symptomatic Ears	Asymptomatic Ears	Total ears
Tinnitus	39 (16.81%)	193 (83.19%)	232
SNHL	20 (8.62%)	212 (91.38%)	232
Vertigo	84 (36.20%)	148 (63.80%)	232

Classification of vascular loops

All individual in patients and control groups has been assessed for the type of AICA vascular loop and degree of contact with vestibulocochlear nerve. Using Chavda classification, from a total of 232 examine ears, a 163 ears shown Grade I vascular loops, 57 ears shown Grade II and 12 ears shown Grade III. While using of Gorrie classification system, class A formed by 133 ears, class B 68 ears, class C 28 ears, and class D three ears.

Correlation of AICA vascular loops types in patients with and without tinnitus

The finding based according to Chavda classification was checked that 35 patients with a total of 39 ears (four of which have bilateral symptoms) complain of tinnitus. There are 27 ears (69.23%) demonstrate grade I loops, 8 ears (20.51%) with grade II loops and 4 ears (10.25%) with grade III loops. Conversely, total cases without tinnitus 193 ears (represent summation of non-symptomatic ears from patients with ears of controls), there are 136 ears (70.47%) that have grade I loops, 49 ears (25.39%) grade II and 8 ears (4.14%) grade III.

In Gorrie classification system, there are 20 ears (51.28%) class A, 11ears (28.20%) class B, 7 ears (17.95%) class C, and 1 ears (2.56%) class D. In contrast, of total cases without tinnitus, 113 ears (58.56%) class A, 57 ears (29.53%) class B, 21 ears (10.88%) class C, and 2 ear (1.03%) are class D.

In all patients there was no significant difference correlated with the presence or absence of vascular loops effects through its location and degree of contact to cranial nerve in cerebellopontine angle and internal auditory canal. A P value of 0.264 and 0.124 was calculated using Chavda and Gorrie classification respectively [table 3].

Table 3: Correlation and percentage between type of vascular loops MRI findings and number of ears with and without tinnitus.

MRI finding	Tinnitus				p-value
	Symptomatic Ears (39)	Asymptomatic Ears			
		Patients N=133	Control N=60	Total N=193	
Vascular loop according to Chavda classification					
Grade I	27(69.23%)	97	39	136(70.47%)	0.264
Grade II	8(20.51%)	32	17	49(25.39%)	
Grade III	4(10.25%)	4	4	8(4.14%)	
Vascular contact according to Adam Gorrie					
Class A	20(51.28%)	69	44	113(58.56%)	0.124
Class B	11(28.20%)	47	10	57(29.53%)	
Class C	7(17.95%)	15	6	21(10.88%)	
Class D	1(2.56%)	2	0	2(1.03%)	

Correlation of AICA vascular loops types in patients with and without sensory neural hearing loss

The finding based according to Chavda classification was checked that 18 patients with a total of 20 ears (two of which have bilateral symptoms) complain of sensory neural hearing loss. There are 11 ears (55%) demonstrate grade I loops, 6 ears (30%) with grade II loops and 3 ears (15%) with grade III loops. Conversely, total cases without SNHL 193 ears (represent summation of non-symptomatic ears from patients with ears of controls) there are 152 ears (71.7%) have grade I loops, 51 ears (24.04%) grade II and 9 ears (4.24%) grade III.

In Gorrie classification system, there are 11 ears (55%) class A, 6 ears (30%) class B, 3 ears (15%) class C, while no ear demonstrates class D. In contrast, of total cases without SNHL, 122 ears (58.5%) class A, 62 ears (29.23%) class B, 25 ears(11.8%) class C, and 3 ears (1.41%) are class D.

In all patients there was no significant difference correlated with the presence or absence of vascular loops effects through its location and degree of contact to cranial nerve in cerebellopontine angle and internal auditory canal. A P value of 0.079 and 0.192 was calculated using Chavda and Gorrie classification respectively [Table 4].

Table 4: Correlation and percentage between type of vascular loops MRI findings and number of eras with and without sensorineural hearing loss.

MRI finding	SNHL				p-value
	Symptomatic Ears (20)	Asymptomatic Ears			
		Patients N=152	Control N=60	Total N=212	
Vascular loop according to Chavda classification					
Grade I	11(55%)	113	39	152(71.7%)	0.079
Grade II	6(30%)	34	17	51(24.06%)	
Grade III	3(15%)	5	4	9(4.24%)	
Vascular contact according to Adam Gorrie et al					
Class A	11(55%)	78	44	122(57.54%)	0.194
Class B	6(30%)	52	10	62(29.24%)	
Class C	3(15%)	19	6	25(11.8%)	
Class D	0(0%)	3	0	3(1.42%)	

Correlation of AICA vascular loops types in patients with and without vertigo

The finding based according to Chavda classification was checked that 42 patients with a total of 84 ears complain of vertigo. There are 54 ears (64.29%) demonstrate grade I loops, 24 ears (28.57%) with grade II loops and 6 ears (7.14%) with grade III loops. Conversely, total cases without vertigo 148 ears there are 109 ears (73.65%) have grade I loops, 33 ears (22.3%) grade II and 6 ears (4.05%) grade III.

In Gorrie classification system, there are 42 ears (50%) class A, 28 ears (33.33%) class B, 12 ears (14.29%) class C and 2 ears (2.38%) class D. In contrast, of total cases without vertigo, 91 ears (61.49%) class A, 40 ears (27.03%) class B, 16 ears (10.81%) class C and 1 ears (0.67%) class D.

In all patients there was no significant difference correlated with the presence or absence of vascular loops effects through its location and degree of contact to cranial nerve in cerebellopontine angle and internal auditory canal. A P value of 0.284 and 0.296 was calculated using Chavda and Gorrie classification respectively [table 5]

Table 5: Correlation and percentage between type of vascular loops MRI findings and number of ears with and without vertigo.

MRI finding	Vertigo				p-value
	Ears with (N=84)	Ears without			
		Patients N=88	Control N=60	Total N=148	
Vascular loop according to Chavda classification					
Grade I	54(64.29%)	70	39	109(73.65%)	0.284
Grade II	24(28.57%)	16	17	33(22.3%)	
Grade III	6(7.14%)	2	4	6(4.05%)	
Vascular contact according to Adam Gorrie					
Class A	42(50%)	47	44	91(61.49%)	0.296
Class B	28(33.33%)	30	10	40(27.03%)	
Class C	12(14.29%)	10	6	16(10.81%)	
Class D	2(2.38%)	1	0	1(0.67%)	

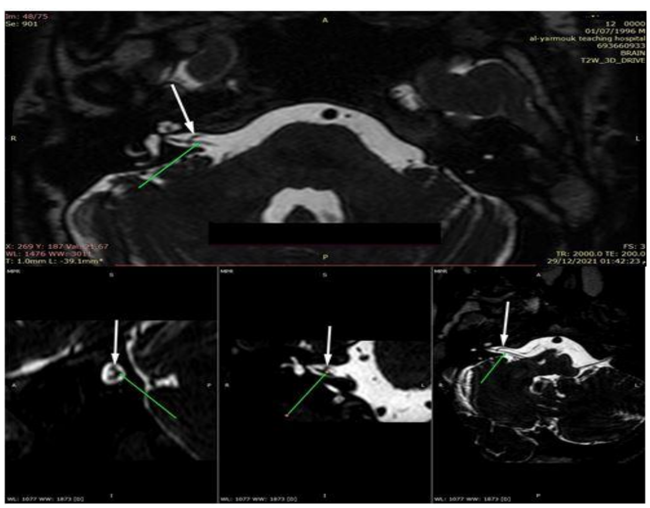

Figure 1: MRI of a 27-year-old male presented with headache, a T2 3D DRIVE sequence with axial, sagittal, and coronal views demonstrate a vascular loop (white arrow) passing adjacent to the vestibulocochlear nerve

(green arrow) and causing minor impingements (grade II, class D) (Adapted from AL-Yarmouk Teaching Hospital).

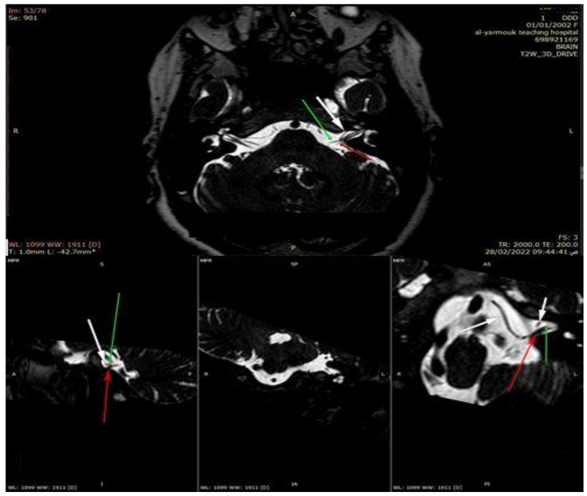

Figure 2: MR study of a 20-year-old female presented with LT-side tinnitus, T2-3D-DRIVE sequence at the level of the internal auditory canal (annotate on the LT side) shows a bilateral AICA vascular loop (white arrows) passing near the vestibulocochlear nerve (red arrows) and facial nerve (green arrows) with no attachment to each, (Adapted from AL-Yarmouk Teaching Hospital).

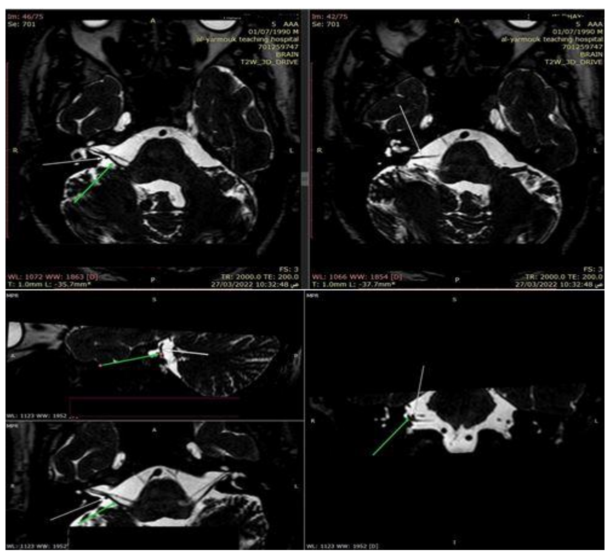

Figure 3: MR study of a 32-year-old male presented with tinnitus in the right ear, axial, coronal, and sagittal views show: At the RT cerebellopontine angle, the AICA vascular loop (white arrow) passes from the posterior aspect of the vestibulocochlear nerve (green arrow) and cause nerve angulation, (Adapted from AL-Yarmouk Teaching Hospital).

DISCUSSION:

In the current study a correlation between AICA and cranial nerve (vestibulocochlear), is intended to measure the gradence of entrance and extension of AICA through the length of IAC, or adherence to cranial nerve, to make knowledge whether it's a true compression effect or just a matter of fiction. In this study imaging appoint in using 3-tesla MRI machine, thin slice T2-wighted image to display relatively high quality image with the addition of DRIVE pulse to the 3D TSE approach. This will shorten the scan time and diminish susceptibility artifacts. Ciftci et al. [7] observed that including DRIVE pulse in T2-weighted 3D TSE sequence is beneficial in imaging cranial nerves surrounded by CSF or fluid-filled structures due to shorter scan duration with improved image quality and reduce flow artifacts.

According to the results obtained, no significant differences observed between variable grades of vascular loops achieved from Chavda classification; in both patients and control cases, with unexplained audio-vestibular symptoms. This result is in line with a study done by Grocoske et al. [8] found that the presence of a neurovascular conflict involving the eighth cranial nerve on MRI scans could not explain the oto-neurological signs and symptoms observed in subjects assessed. However, the current study is relatively opposed with McDermott et al. [5] who consider a link between vascular loops extending into the internal auditory canal and hearing loss but fail to discuss tinnitus or vertigo.

In the use of Gorrie classification[6], as a second ensuring system (which relies on direct contact of AICA vascular loop and its pressure effect on vestibulocochlear nerve irrespective to internal auditory span extension), the current study demonstrates a relatively large number of symptomatic and non-symptomatic control ears, which were classified as class A, B,C, D. Total numbers of 133(57.33%) ears for class A, 68 (29.31%) ears for class B, 28 (12.06%) ears for class C , and (only three) ears from symptomatic patient and asymptomatic control groups present as class D vascular loop with percentage (1.2%) out of total studied ears, no one of them had SNHL. This raise the concern of a multicenter specialized study. No significant differences were noticed in correlation with all vestibulo-auditory symptoms.

So, the presence of a vascular loop lying directly adjacent to or displacing the VIII cranial nerve was not found to be significantly associated with symptoms. Furthermore, this study did not operate to fathom the association between AICA and unexplained audio vestibular symptoms but only focused on non-invasive MRI with high resolution thin slice T2-weighted image.

Results of this study gained from Gorrie classification system was in line with a study of Gultekin et al. [9] who used a 3D-FIESTA sequence to examine patients with unexplained tinnitus compere with controls for the existence of neurovascular contact and nerve angulation by the artery, but findings suggest that compression of the vestibulocochlear nerve by vascular loop could not be a cause of tinnitus. Several studies using the same research techniques, failed to show a link between symptoms and Grade 2 and Grade 3 loops, Sirikci et al. [10] conclude that while MRI can clearly determine the presence of a vessel-nerve contact, the diagnosis of a neurovascular conflict should not be based solely on MRI data.

In the current study, the presence of AICA loop in patients with unexplained audio-vestibular symptom may be just an incidental finding and AICA loops could be an anatomical variation, and possibly, no need for unnecessary surgeries, these finding are similar to other studies. Bhatia, et al.in 2021[11] who reveal no significant correlation between AICA loops and audio-vestibular symptoms, using two grading systems that assessed the relationship between AICA loops, VCN, and IAC based on MRI findings and reported similar results with respect to vestibulocochlear symptoms.

In relative accordance to our study, an interesting multicenter study was proposed by Di Stadio et al. [12] in 2020 investigating the correlation between specific characteristics of the vascular loop with audio-vestibular symptoms using MRI scanning of CPA of asymptomatic patients, concluded the absence of correlation between the presence of vertigo or tinnitus and a single neurovascular contact, while significantly correlated with a multiple number of neurovascular contacts.

Limitations: Given the multiplicity of symptoms of vestibulocochlear nerve disorders and the subjectivity in presentation, the diagnosis of the condition might require developing a more objective and elaborate protocol.

CONCLUSION:

Using 3D DRIVE MRI imaging technique can offer better visualization and further clarification of the relation between vascular and neural structures in CPA and IAC.

Presence of vascular loops in contact with the vestibulocochlear nerve is not always considered pathological but likely to be an anatomical variant. Subsequently, this radiological finding alone should not be used to qualify patient for further invasive surgery.

Recommendations:
The subset of patients that had a vascular loop lying between (class C) or causing angulation (class D) of facial and\or vestibulocochlear nerves with presence of unexplained symptoms need further radiological and clinical evaluation.

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