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Research Article

Are Vestibulocochlear Symptoms Associated with the Course of Anterior Inferior Cerebellar Artery: Evaluation by Two MRI-based Classifications

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Abstract

Objectives: The association of the compression of vestibulocochlear nerve by anterior inferior cerebellar artery (AICA) and vestibulocochlear symptoms is controversial. We aimed to investigate the possible role of the compression of vestibulocochlear nerve by AICA loop on vestibulocochlear symptoms and to evaluate by two mostly used MRI-based classifications.

Methods: In this retrospective study, a total of 358 consecutive patients with either tinnitus or hearing loss in any ear and 22 healthy controls without symptoms were enrolled. The anatomical relationship between AICA and vestibulocochlear nerve in bilateral cerebellopontine cisterns was evaluated in axial 3D-FIESTA sequence.

Results: According to both MRI classifications, the group without vascular loops was the most common MRI feature in patients with tinnitus and hearing loss. When ears with and without tinnitus and hearing loss were compared in terms of vascular loop findings on MRI, no significant difference was found.

Conclusion: Relationship between vestibulocochlear nerve and AICA loop were not found to be associated with vestibulocochlear symptoms when evaluated by two MRI-based classifications. Treatment decisions for vascular compression syndrome should not be based on radiologic findings alone. Possible effects of AICA on vestibulocochlear nerve should be investigated in further prospective randomized studies.

Keywords: Anterior inferior cerebellar artery, vestibulocochlear nerve, magnetic resonance imaging

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Cerebellopontine cistern is a space in which neurovascular structures such as trigeminal nerve, facial nerve, vestibulocochlear nerve and anterior inferior cerebellar artery (AICA) are in close relationship between each other.[1] The close relationship can cause different symptoms. However, first Janetta has suggested that compression of vascular loop by AICA through vestibulocochlear nerve can cause hearing loss, tinnitus,[2] vertigo, and hemifacial spasm, compression of vestibulocochlear nerve by AICA and the association of the neurootologic symptoms is controversial.[1-7] Although several clinical and anatomical studies mentioned to have an association between microvascular compression of the vestibulocochlear nerve and neurootologic symptoms,[2,5-7] others studies were stated that the vascular loops formed by AICA may not be pathological and they may not cause a vascular compression syndrome.[1,8-11]

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In this study, we aimed to investigate the possible role of the vestibulocochlear nerve compression by vascular loop of AICA on vestibulocochlear symptoms and to compare two magnetic resonance imaging(MRI)-based classifications.

Methods

In this retrospective study, a total of 336 consecutive patients (mean age: 54±15 years, M/F: 188/148) with either tinnitus or hearing loss in any ear and 22 healthy controls (mean age: 53±19 years, M/F: 8/14) without vestibulocochlear symptoms were involved as controls. Patients who had a cranial MRI with normal findings were included in the control group. A total of 712 ears in 358 patients were evaluated for this study. A total of 336 patients, 75 patients had unilateral tinnitus, 104 patients had bilateral tinnitus and 156 patients had unilateral hearing loss, 130 patients had bilateral hearing loss. Thus, the number of the patients had vestibulocochlear symptoms was 390. Demographic datas of study group was presented in Table 1. Patients with previous otologic surgery, vestibulocochlear diseases such as Meniere's disease, vestibular neuritis, vestibular acoustic neurinoma were excluded. Patients under 18 years old were not included. Demographic datas such as sex, age with symptoms of patients are obtained from the hospital information system. Ethical approval of this retrospective study was obtained (No: 050.99-180).The informed consent was waived.

Table 1. Characteristics of patients with tinnitus and hearing loss

Study Population	Age	Gender (M/F)
Patients with neuro-otological symptoms (n=336)	54 ±15	188/148
Tinnitus (n=179)	54±15	99/80
Unilateral (n=75)	55±14	43/32
Bilateral (n=104)	54±14	56/48
Hearing loss (n=211)	55±14	121/90
Unilateral (n=81)	50±16	46/35
Bilateral (n=130)	57±14	75/55
Asymptomatic (n=22)	53±19	8/14

MRI Examination and Evaluation

All examinations were performed by using an 8-channel phased head coil with 1.5 T magnetic field MRI (Signa Excite; GE Healthcare, Milwaukee, WI, USA). Three dimensional fast imaging employing steady-state acquisition (3D-FIESTA) sequence was revealed with the parameters as follows: TR; 5.9 ms, TE; 1.6ms, FOV; 20x20cm, Nex; 1, matrix size; 320x224 with 1mm slice thicknes of 88 contiguous slices. All images transferred to work station (Advantage Windows 4.1, GE Healthcare) for multiplanar reconstructions of axial 3D FIESTA images. The anatomical relationship between AICA and vestibulocochlear nerve in bilateral cerebellopontine cisterns was evaluated in axial 3D-FIESTA images with sagittal and coronal reconstructions for each ear. All MRIs were reviewed by consensus of 5 and 10 years experienced two radiologists, blinded to the patient's clinical findings and diagnosis. The patients were evaluated in three groups (tinnitus group, hearing loss group and asymptomatic group) to correlate the ipsilateral symptoms with the type of the neurovascular relationship.

MRI Classifications:

Relationship between AICA loop and vestibulocochlear nerve was assessed according to radiologically two different classifications defined by Chavda in McDermott et al and Sirikci et al.[10,11] (Table 2). According to more frequently used classification described by Chavda in McDermott et al.,[10] the vascular loops formed by the AICA are classified into three types by to entrance through the internal auditory canal (IAC). In type I, course of AICA is located to IAC

Table 2. Two different MRI-based classifications aaccording to Mcdermott et. al. and Sırıkcı et al.

Classification used by Mcdermott et al.	
Type	Explanation
M1	Course of AICA is located to IAC
M2	Vasculary loop reaches to proximal half of IAC
M3	Vasculary loop reaches to distal half of IAC
Classification used by Sırıkcı et al.	
Type	Explanation
S1	AICA compresses to vestibulocochlear nerve at a single point
S2	AICA courses parallel with the vestibulocochlear nerve
S3	AICA make a loop formation around vestibulocochlear nerve
S4	AICA makes an indentation by the vestibulocochlear nerve

AICA: Anterior inferior cerebellar artery; IAC: Internal acustic channel.

(Fig. 1a); in type II, vasculary loop reaches to proximal half of IAC (Fig. 1b); in type III,vasculary loop reaches to distal half of IAC (Fig. 1c). In other classification defined by Sırıkcı et al.[11] the classification based on relationship of the AICA loop and vestibulocochlear nerve in cerebellopontine cistern; in type I, AICA compresses the vestibulocochlear nerve at a single point (Fig. 2a); in type 2, AICA follows a parallel course to vestibulocochlear nerve (Fig. 2b); in type 3, AICA make a loop formation around vestibulocochlear nerve (Fig. 2c); in type 4, AICA makes an indentation to the vestibulocochlear nerve (Fig. 2d). Accordingly, the individuals had no vascular loop according to both A and B classifications mentioned as M0 and S0.

Statistical Analysis

For the statistical analysis, SPSS version 20.0 software (IBM Corporation, Armonk, NY, USA). was used. Results were expressed as mean±SD unless otherwise stated. Comparisons of continuous data for the groups were performed using the Student t-test or the Mann–Whitney U-test. The chi-square test was used to compare variables in different groups. All tests of significance were two sided, and differences were considered statistically significant when the P-value was <0.05.

Results

There was no statistically significant difference between patients and control groups in terms of the mean age (54±15 vs. 53±19; p=0.65) Patients with bilateral hearing loss were significanlty older compared to patients with unilateral hearing loss (57±14 vs. 50±16; P=0.001) Frequencies of AICA loop formation according to different two MRI-based classification in ears with tinnitus, hearing loss and control

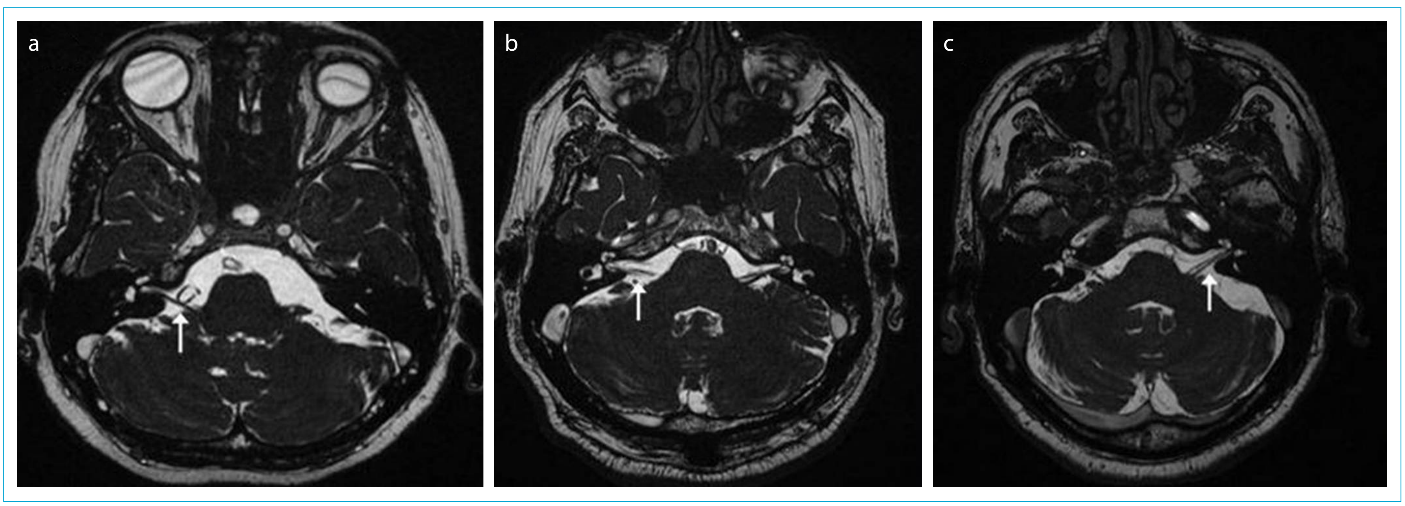

Figure 1. Examples of cases evaluated according to the classification used by McDermott et al. Axial 3D-FIESTA MR images show the following: Course of AICA is located to internal auditory canal (arrow) (Type I) **(a)**; vascular loop reaches to proximal half of IAC (arrow) (Type II) **(b)**; and vasculary loop reaches to distal half of IAC (arrow) (Type III) **(c)**.

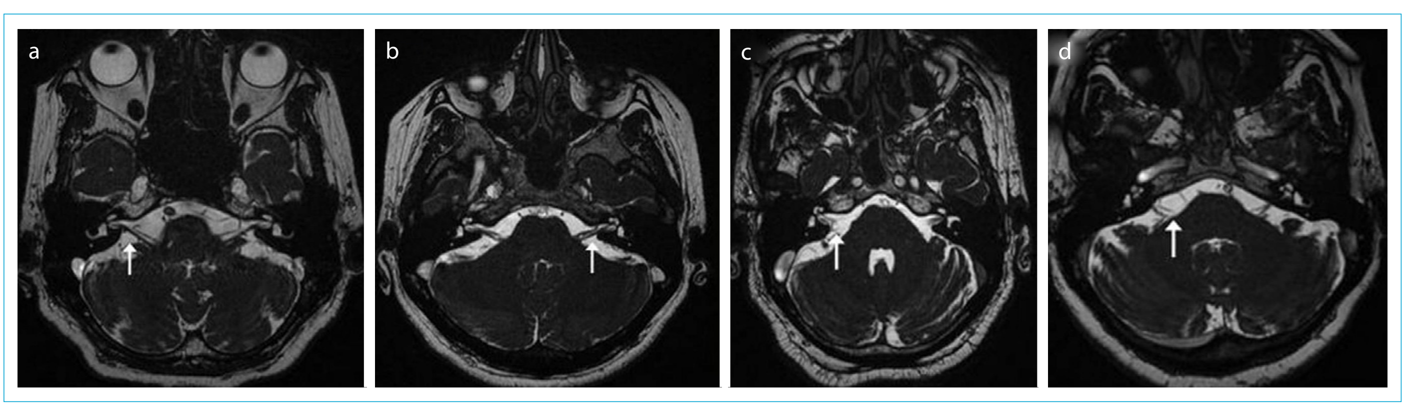

Figure 2. Examples of cases evaluated according to the classification used by Sirikci et al. Axial 3D-FIESTA MR images show the following: AICA compresses to vestibulocochlear nerve at a single point (arrow) (Type I) **(a)**; AICA courses parallel with the vestibulocochlear nerve (arrow) (Type II) **(b)**; AICA make a loop formation around vestibulocochlear nerve (arrow) (Type III) **(c)** and AICA makes an indentation by the vestibulocochlear nerve (arrow) (Type IV) **(d)**.

group were presented in Table 3. No vascular loop in study according to both MRI classifications (M0 and S0) was the most common traits in both the presence of tinnitus and hearing loss (52 % of tinnitus M0, 51% of tinnitus S0and 50% of hearing loss M0, 50% of hearing loss S0). M1 and S1 type AICA loop formation were the most common type of vascular loop patterns in patients without symptom. When the ears with and without tinnitus were compared in terms of vascular loop findings according to two MRI-based classification, no significant difference was found (classification by Chavda in McDermott et al; p=0.19, classification by Sirikci et al; p=0.29) (Table 4). Similarly, when ears with and without hearing loss were compared in terms of vascular loop findings according to two MRI-based classification, no significant difference was found (classification by Chavda in McDermott et al; p=0.63, classification by Sirikci et al; p=0.65) (Table 5).

Discussion

Vascular loops formed by AICA are frequently observed in MRI studies.[2,12] Controversy exists about the hypothesis of "anterior inferior cerebellar artery syndrome" that the neuroolologic symptoms may occur due to compression of vestibulocochlear nerve by AICA because these vascular loops are commonly found in many asymptomatic individuals. The pathophysiology of this compression syndrome is not well-understood and many different theories have been suggested. Progressive pulsatile compression by AICA may lead to demyelination of the vestibulocochlear nerve at the root entry zone which is the junction between central and peripheral nervous tissues.[13] In cases of trigeminal neuralgia, compression of the nerve is located at a specific area, however the compression of vestibulocochlear nerve may occur at any location in cerebellopontine angle.[1] Atherosclerosis and arachnoid adhesions may exacerbate the

Table 3. Distrubition of tinnitus according to both two MRI-based classifications

Vascular Loop	Tinnitus (number of ears = 283)	Hearing loss (number of ears = 341)	Asymptomatic (number of ears = 44)
Classification by Chavda in Mcdermott et. al.			
M0	146 (52%)	171 (50%)	10 (23%)
M1	89 (31%)	103 (30%)	21 (48%)
M2	41 (14%)	52 (15%)	12 (27%)
M3	7 (3%)	15 (5%)	1 (2%)
Classification by Sırıkcı et. al.			
S0	144 (51%)	169 (50%)	10 (23%)
S1	110 (39%)	136 (40%)	26 (59%)
S2	7 (2.5%)	9 (2.5%)	4 (9%)
S3	10 (3.5%)	18 (5%)	4 (9%)
S4	12 (4%)	9 (2.5%)	0 (%)

Table 4. Comprarison of symptom frequencies according to both two MRI-based classifications

Vascular Loop	Tinnitus (number of ears = 283)	No Tinnitus (number of ears =433)	p
Classification by Chavda in Mcdermott et. al.			0.19
M0	146 (52%)	199 (46%)	
M1	89 (31%)	144 (33%)	
M2	41 (14%)	67 (16%)	
M3	7 (3%)	23 (5%)	
Classification by Sırıkcı et. al.			0.29
S0	144 (51%)	198 (46%)	
S1	110 (39%)	186 (43%)	
S2	7 (2.5%)	15 (3.5%)	
S3	10 (3.5%)	23 (5%)	
S4	12 (4%)	11 (2.5%)	

Results are presented as mean±SD; p: p value of Chi-square test and considered statistically significant when <0.05.

Table 5. Comprarison of symptom frequencies according to both two MRI-based classifications

Vascular Loop	Hearing loss (number of ears = 341)	No hearing loss (number of ears = 375)	p
Classification by Chavda in Mcdermott et. al.			0.63
M0	171 (50%)	174 (46%)	
M1	103 (30%)	130 (35%)	
M2	52 (15%)	56 (15%)	
M3	15 (5%)	15 (4%)	
Classification by Sırıkcı et. al.			0.65
S0	169 (50%)	173 (46.1%)	
S1	136 (40%)	160 (42.7%)	
S2	9 (2.5%)	13 (3.5%)	
S3	18 (5%)	15 (4%)	
S4	9 (2.5%)	14 (3.7%)	

Results are presented as mean±SD. p; p value of Chi-square test and considered statistically significant when <0.05.

strength of compression.[14] Alternatively, it has been hypothesized that the compression of AICA may lead to reduced blood flow to the vestibule and cochlea.[15] Resultant demyelination may lead to formation of false synapses.[16] Compression by the AICA may not be enough to cause vestibulocochlear symptoms, contribution of edema and axonal damage caused by vestibular neuritis is also suggested to be needed for the development of symptoms.[17]

The prevalence of relationship between AICA and vestibulocochlear nerve has been investigated in a postmortem study performed on general population and the prevalence of compression of vestibulocochlear nerve by AICA has been reported to be 12%.[18] This prevalence was found to be 14–34% in MRI studies.[11,12] In an MRI study, the incidence of the contact between AICA and vestibulocochlear nerve was 25% in symptomatic patients and 21% asymptomatic patients.[8,19]

In a large meta-analysis by Chadha et al.,[3] 5 studies with a total number of 673 patients were included. In this study, patients with unilateral hearing loss were found to be twice more likely to have a vascular loop formation in contact with vestibulocochlear nerve in symptomatic side. Furthermore, patients with pulsatile tinnitus were significantly more likely to have vascular loop formation in contact with vestibulocochlear nerve than those with non-pulsatile tinnitus.[3] Other studies also showed significant associations between radiologic demonstration of vascular loops in the IAC and pulsatile tinnitus and hearing loss which was treated by microvascular decompression of vestibulocochlear nerve.[6,20-22]

In recent years, parallel to the development of technology in radiologic diagnostic techniques, it becomes more important to diagnose and classify the variations of neurovascular structures. The association of the neuro-otologic symptoms and the loop formation of AICA compressing the vestibulocochlear nerve has been investigated in several MRI studies by 3D-FIESTA sequence.[10,11,23-26] In the most widely accepted classification system, three types of compression have been defined according to the extension of vestibulocochlear nerve into internal acoustic channel. In this study by McDermott et al., a significant association was shown between type II and type III loop formation of AICA and hearing loss.[10] In the the other classification system by Sirikci et al, compression patterns were classified into 4 groups according to compression grade of the vestibulocochlear nerve. However, in several other studies using this MRI classification system, statistically significant relationships between vascular compression of vestibulocochlear nerve and neuro-otologic symptoms could not be found.[1,8,9,14,22,25,26] Sirikci et al. investigated the relationship between compression of vascular loop formation of AICA and otologic symptoms according to other MRI-based classification and reported that there was no relationship between the type of the AICA loop and the symptoms such as tinnitus, vertigo, hearing loss.[11] In parallel to these studies, we also showed that there was no relationship between vestibulocochlear symptoms and the type of the AICA loop based on the classifications proposed by both Mc Dermott et al. and Sirikci et al.[10,11]

Our study have some limitations. One of the important one is, the control group consisted of a small number of cases in our study. The second important limitation is, the presence of pulsatile tinnitus, vertigo, and progressive symptoms was not questioned. Cases with both tinnitus and hearing loss were not evaluated in a separate group. The compression of the vestibulocochlear nerve was evaluated from different aspect in both two classifications. Naturally, it is impossible to compare these classifications as one-to-one. However, the distribution of hearing loss caused by the compression of nerves differs in each anatomical location. This pressure can be evaluated by hearing test and if there is correlation, correlation between MRI print point and hearing test can be searched. Possible effects of vascular compression of vestibulocochlear nerve revealed by MRI and related symptoms should be investigated in further prospective randomized studies with the correlation of hearing test.

In conclusion, relationship between vestibulocochlear nerve and vascular loop formed by AICA on MRI were not found to be associated with vestibulocochlear symptoms. Both MRI-based vascular loop classifications were not associated with symptoms. Although 3D-FIESTA MRI can detect anatomic relationships between vestibulocochlear nerve and vascular structures in detail, treatment decisions for vascular compression syndrome should not be based on radiologic findings alone. Reporting the neurovascular relationship can be helpful to classify the anatomic variations.

Disclosures

Ethics Committee Approval: Çanakkale Onsekiz Mart University, No: 050.99-180, 29.05.2013.

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Conflict of Interest: None declared.

Authorship Contributions: Concept – S.O.; Design – S.O.; Supervision – F.U.; Materials – S.O.; Data collection &/or processing – S.O.; Analysis and/or interpretation – S.O.; Literature search – S.O.; Writing – S.O.; Critical review – S.O.

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