Original Article

The Association of Vascular Loops of Anterior Inferior Cerebellar Artery and Vestibulocochlear Symptoms

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Abstract

Aim: The association of vascular loops of anterior inferior cerebellar artery (AICA) with vestibulocochlear symptoms including hear loss, tinnitus, and vertigo is controversial. We aimed to investigate the relationship between vestibulocochlear symptoms and AICA vascular loop syndrome on magnetic resonance imaging (MRI). **Materials and Methods:** The patients underwent a posterior fossa MRI examination were reviewed regarding the presence of hear loss, tinnitus, and vertigo by an experienced ear-nose-throat specialists' physical examinations. The incidences of these lesions in the patients with and without AICA vascular loop syndromes were compared. Furthermore, the correlation between the AICA vascular loop syndrome subtypes (grade 1–3) and the incidence of the symptoms were analyzed. **Results:** A total of 502 patients (1004 ears) were included in this study. Vascular loops were demonstrated in 150 ears (14.9%). Subtype 1 was observed in 97 (9.7%), subtype 2 in 40 (4.0%) and subtype 3 in 13 (1.3%) ears. The incidences of tinnitus, hear loss, and tinnitus + hear loss were statistically significantly higher in the patients with vascular loops than without vascular loops (p: 0.000042, p: 0.0446906, p: 0.028106, respectively). However, there was not a significant correlation between the incidence of the symptoms and the grade of the vascular loop formation (p>0.05). Vertigo incidence was very similar among the patients with no, with one-sided and with both-sided AICA vascular loops (41.5%, 39.8% and 46.2%, respectively) with no statistical difference (p>0.05). **Conclusion:** The AICA vascular loop is associated with either tinnitus or hear loss but there is no correlation with the degree of the vascular loops. There is no relationship between AICA vascular loops and vertigo.

Keywords: *Anterior inferior cerebellar artery vascular loop, hear loss, tinnitus, vertigo, vestibulocochlear symptoms*

Introduction

Tinnitus, hearing loss, and vertigo are the most common vestibulocochlear symptoms. The incidence of tinnitus was found to be 22%, hearing loss 9%, and vertigo 42% in general population which increase with age.[1-3]

The contrast-enhanced magnetic resonance imaging (MRI) of the posterior fossa is essential for the detailed examination of posterior fossa, internal acoustic canal, and cerebellopontine angle (CPA) structures which can be associated with vestibulocochlear symptoms.[4] Although otological symptoms including tinnitus, hearing loss, and vertigo reported to occur secondary to malignant (acoustic schwannoma, etc.,) and vascular conditions (vascular loop syndromes,) in CPA and internal acoustic canal, these symptoms can be seen also in asymptomatic individuals.[5]

Vascular compression loop syndrome was first described by McKenzie but the association of this syndrome with otological syndromes is still controversial.[6,7] In this study, we aimed to examine the possible association of Vascular loops of the anterior inferior cerebellar artery (AICA) and vestibulocochlear symptoms including tinnitus, hearing loss and vertigo.

Materials and Methods

Patients

The data of the patients who underwent an MRI of posterior fossa 1 week within the admission of the otorhinolaryngology department because of various complaints between January 2016 and January 2018 were collected from the hospital and clinic database. Demographic features, results of physical examination regarding having vestibulocochlear findings, and radiological images were obtained. This retrospective

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study was approved by a university ethics committee on September 18, 2018 with a number of 2018-18/155.

Magnetic resonance imaging

MRI examinations were performed using a 1.5 Tesla MRI system (GE Signa Excite) with an 8-channel neurovascular head coil. The imaging protocol of posterior fossa consisted of axial T2-weighted images (TR/TE, 4000/100 ms; NEX, 4; section thickness, 5 mm; intersection spacing, 1.5 mm; matrix size, 256 × 160), axial T1-weighted images before and after the administration of intravenous contrast material (TR/TE, 540/8 ms; NEX, 4; section thickness, 5 mm; intersection spacing, 1.5 mm; matrix size, 288 × 192) and 3D-FIESTA images (TR/TE, 4/1.28 ms; flip angle, 60°, FOV, 19; matrix size, 352 × 224; section thickness, 1 mm).

All the images were transferred to a workstation and interpreted by a radiologist with 10 years' experience on neuroradiology who was blinded to the otological examination results of the patients.

Anterior inferior cerebellar artery vascular loop compression syndrome

The AICA supplies the ventral-inferior parts of cerebellum and lateral lower portions of pons which originates from the lateral wall of the caudal third of the basilar artery. After AICA usually arises from the basilar artery as a single trunk, it courses laterally and posteriorly [Figure 1], frequently bifurcating into the superior and inferior trunk at the pontomedullary junction close to where the facial and vestibulocochlear nerves exit the brain stem and enter to internal auditory canal.[8]

AICA vascular loop refers to an anatomic variation in that AICA locates close to 7–8 cranial nerves in CPA or internal auditory canal. The classification of the vascular loop of AICA is based on the anatomical location of AICA as in type 1 AICA lies in the CPA but does not enter to internal auditory canal [Figure 2], in type 2 enters the CPA and extends less than half of length of internal auditory canal [Figure 3] and in type 3 enters the CPA and extends more than half of the length of internal auditory canal [Figures 4 and 5].[9]

Assessment of hearing loss

Audiological evaluation hearing test examinations were made by an ear–nose–throat specialist with the assistance of an audiometrist. A resonance A R37A audiometer (Italy) device was used to perform the audiometric evaluation with a pure-tone audiometer inside a sound-proof cabin. Pure-tone thresholds were examined at 0.25, 0.5, 1, 2, 3, 4, and 8 kHz.[10] The patients with a value >15 were accepted as with hearing loss.

Assessment of tinnitus

The patients completed the tinnitus handicap inventory questionnaire during the first examination. When the score in this questionnaire, 0–16 it was defined as slight tinnitus, 18–36 mild tinnitus, 38–56 moderate, tinnitus, and 58–76

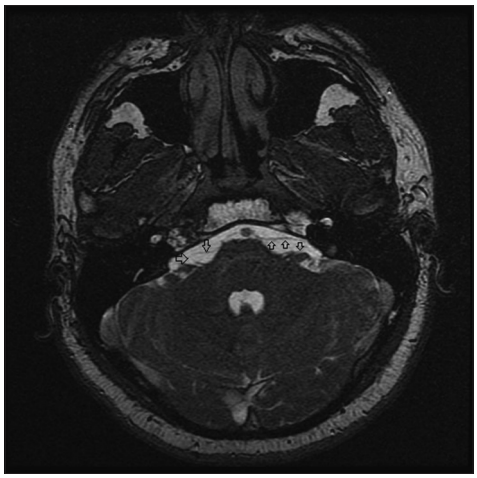

Figure 1: Normal location of bilateral anterior inferior cerebellar artery (arrows) as they are far from internal auditory canals

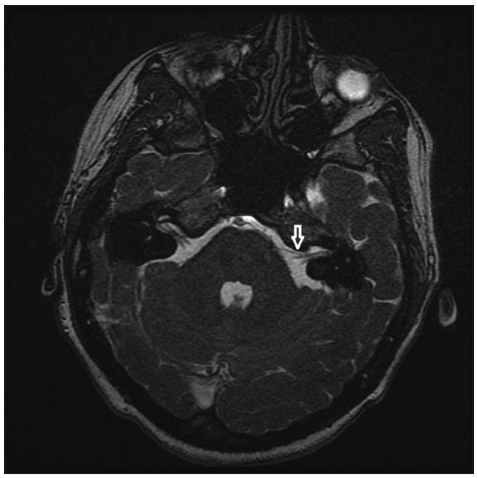

Figure 2: Type 1 anterior inferior cerebellar artery (AICA) loop syndrome in left side as the AICA lying close to the internal auditory canal but is not entering (arrow)

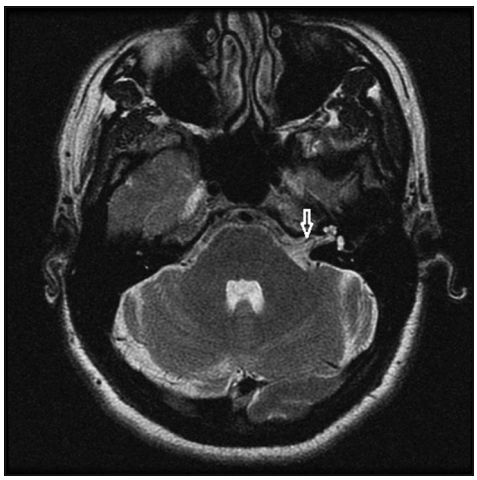

Figure 3: Type 2 anterior inferior cerebellar artery (AICA) vascular loop syndrome in left side as the AICA is entering less than half of internal auditory canal (arrow)

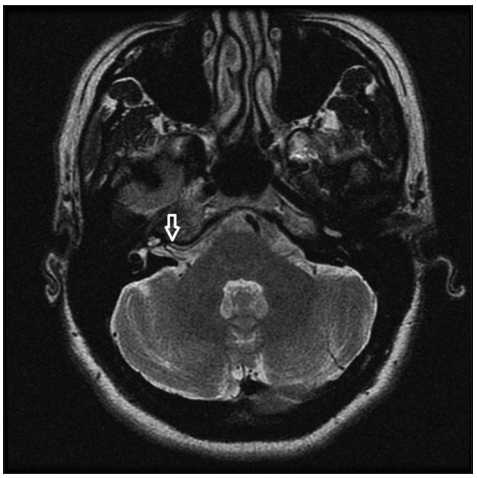

Figure 4: Type 3 anterior inferior cerebellar artery (AICA) vascular loop syndrome in right side as the AICA is entering more than half of internal auditory canal (arrow)

severe tinnitus. The patients with a score >1 were accepted as with tinnitus.[11]

Assessment of vertigo

The patients who had no identified cause including cardiovascular, hematological, metabolic and endocrine disorders, admitted with complaints of dizziness and imbalance were accepted as having vertigo.

Groups

Patients were classified into 4 groups as group N (with no AICA vascular loop syndrome), group 1 (patients with type 1 AICA vascular loop syndrome), group 2 (patients with type 2 AICA vascular loop syndrome), and group 3 (patients with type 3 AICA vascular loop syndrome) and group 4 (patients with all types [group 1 + 2 + 3] of AICA vascular loop syndrome). For all these 5 groups, the presence of only tinnitus, only hearing loss, and tinnitus + hear loss in the same ear were analyzed and compared with each other. Also in the groups, a comparison of the presence of otological symptoms was performed between males and females.

In addition, patients were classified into three other groups according to the side location of AICA vascular loop syndrome as group N (the patients with no AICA vascular loop compression syndrome in any ear), group S (the patients with AICA loop vascular loop syndrome in only one ear) and group D (the patients with AICA vascular loop syndrome in both ears). The frequency of presence of vertigo was compared between these three groups. In each group, comparison of the presence of vertigo was performed also between males and females.

Statistical analysis

Categorical variables were presented as frequency (n) and percentage (%); numerical variables were expressed as mean ± standard deviation, minimum and maximum. A Chi-square test was used for the comparison of

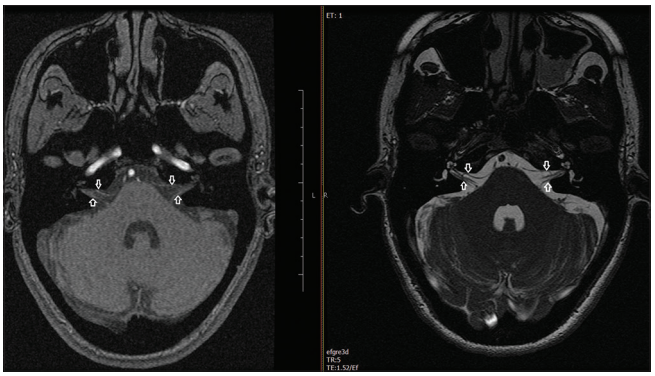

Figure 5: Type 2 (left side) and type 3 (right side) anterior inferior cerebellar artery vascular loops (arrows)

categorical variables. A $P < 0.05$ was considered statistically significant. All the statistical analyses were made by an SPSS 20 software program (IBM Corporation, Armonk, NY, USA).

Results

Among 596 patients, 29 ones with previous intracranial or ear surgery anamnesis, 21 with posterior fossa or internal auditory canal lesions, 3 with inner ear anatomical variations were excluded from the study. Detailed medical records of 41 patients were not available. Finally, a total of 502 patients (1004 ears) were included in this study.

Male/female ratio was 1.02 (253/249) and the mean age was 43.4 ± 19.1 (18–79) years. The mean age of the groups was similar with no significant differences.

The control group was consisted of 854 ears (429 males and 425 females), group 1 of 97 ears (38 males and 59 females), group 2 of 40 ears (24 males and 16 females), group 3 of 13 ears (7 males and 6 females), and group 4 of 150 ears (69 males and 81 females) [Table 1].

Only tinnitus frequency was statistically significantly higher in group 1 (30.9% 30/97) than in group N (14.5% 124/854) (p:0.000032). The difference between group 2 (27.5% 11/40) and group N (14.5% 124/854) was significant (p:0.025034). The difference between group 3 (7.7% 1/13) and group N (14.5% 124/854) was nonsignificant (p:0.486718). The difference between group 4 (28.0% 42/150) and group N (14.5% 124/854) was significant (p:0.000042). The difference between group 1 and 2 (p:0.69037), 1 and 3 (p:0.080345, and 2 and 3 (p:0.138211) were all nonsignificant [Table 1]. Only hear loss frequency was nonsignificantly higher in group 1 (17.5% 17/97) than group N (12.6% 108/854) (p:0.177721). The difference between group 2 (20.0% 8/40) and group N (12.6% 108/854), between group 3 (33.3% 3/10) and group N (12.6% 108/854), between group 2 (20.0% 8/40) and group 1 (17.5% 17/97), between group 3 (33.3% 3/10) and group 1 (17.5% 17/97), and between group 3 (33.3% 3/10) and group 2 (20.0%

Table 1: Groups and the incidences of tinnitus, hear loss and tinnitus+hear loss

	Group N (Grade 0)			Group 1 (grade 1)			Group 2 (grade 2)			Group 3 (grade 3)			Group 4 (group 1+2 + 3)			Total		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
No finding	303 (49.4)	310 (50.6)	613 (61.1)	17 (35.4)	31 (64.6)	48 (4.8)	9 (47.4)	10 (52.6)	19 (1.9)	4 (50.0)	4 (50.0)	8 (0.8)	30 (40.0)	45 (60.0)	75 (7.5)	333 (48.4)	355 (51.6)	688 (68.5)
Tinnitus	64 (54.6)	60 (48.4)	124 (12.4)	16 (53.3)	14 (46.7)	30 (3.0)	7 (63.6)	4 (36.4)	11 (1.1)	0	1 (100)	1 (0.1)	23 (54.8)	19 (45.2)	42 (4.2)	87 (52.4)	79 (47.6)	166 (16.5)
Hear loss	59 (54.6)	49 (45.4)	108 (1.1)	5 (29.4)	12 (70.6)	17 (1.7)	6 (75.0)	2 (25.0)	8 (0.8)	2 (66.7)	1 (33.3)	3 (0.3)	13 (46.4)	15 (53.6)	28 (2.8)	72 (52.9)	64 (47.1)	136 (13.5)
Tinnitus + hear loss	3 (33.3)	6 (66.7)	9 (9.0)	0	2 (100.0)	2 (0.2)	2 (100.0)	0	2 (0.2)	1 (100.0)	0	1 (0.1)	3 (60.0)	2 (40.0)	5 (5.0)	6 (42.9)	8 (57.1)	14 (1.4)
Total	429 (50.2)	425 (49.8)	854 (85.1)	38 (39.2)	59 (60.8)	97 (9.7)	24 (60.0)	16 (40.0)	40 (4.0)	7 (53.8)	6 (46.2)	13 (1.3)	69 (46.0)	81 (54.0)	150 (14.9)	498 (49.6)	506 (50.4)	1004 (100.0)

8/40) were all nonsignificant (*p*:0.176142, *p*:0.263948, *p*:0.733173, *p*:0.626042, *p*:0.812154, respectively). However, the frequency of only hearing loss was statistically significantly higher in group 4 (18.7% 28/150) than group N (12.6% 108/854) (*p*:0.046906) [Table 1].

Tinnitus + hear loss frequency of group N (1.1% 9/854) was statistically lower than group 2 (5.0% 2/40) (*p*: 0.026918) ,group 4 (3.0% 5/150) (*p*: 0.028106) and group 3 (7.7% 1/13) (*p*: 0.026096). The difference between group N and group 1 (2.1%) was nonsignificant (*p*:0.378948). The difference between group 1 and 2, group 1 and 3, and group 2 and 3 was all nonsignificant (*p*:0.35025, *p*:0.214829, *p*:0.71558, respectively) [Table 1].

Vertigo was recorded in 41.5% (160/386) of the patients with group N (no involvement in ears), 39.8% (35/88) of in group S (single ear involvement) and 46.2% (13/28) in group D (Double ear involvement). The difference of the vertigo frequency between group N and group S (*p*:0.77283), group N and group D (*p*:0.60683) and group S and group D (*p*:0.533389) was all non-significant [Table 2].

Discussion

AICA usually arises from the lateral wall of the proximal segment of basilar artery (98%) at the level of CPA or from rarely vertebral artery (2%) as a single (92%) or duplicate (8%) branch.[12] AICA gives three branches as an internal auditory branch (passes into internal acoustic meatus), lateral branch (supplies superior/inferior semilunar lobules), and medial branch (supplies biventral lobule).[13]

Vertigo or tinnitus not only results from inner ear or cranial nerve lesions but also from vascular compression syndromes in the pontocerebellar angle. Various vascular compression syndromes may lead to hemifacial spasm, trigeminal neuralgia, and glossopharyngeal neuralgia.[14,15] Compression or close neighborhood of the vestibulocochlear nerve by vascular structures is associated with vertigo and hearing loss. The pathomechanism of this condition is suggested as edema and gliosis followed by demyelination, fibrosis, and subsequently axonal degeneration of the nerve by chronic compression.[16,17] Besides AICA, PICA, and petrosal arteries may lead to vascular compression syndromes.[18,19]

Contrast-enhanced temporal MRI is an excellent modality to discriminate inflammatory processes such as labyrinthitis or mastoiditis and neoplastic conditions such as acoustic schwannoma and meningioma. Furthermore, it provides the best view to detect and grade the vascular loop syndrome in pontocerebellar angle and internal acoustic canal. MRI is superior to computed tomography as it can differentiate soft tissues from fluids and also shows inner ear structures very clear in especially patients with sensorineural hearing loss.[20,21] Fast spin echo T2-weighted images have been widely used for the examination of posterior fossa and CPA, currently CISS sequence is very useful for evaluating

Table 2: Groups and the incidences of vertigo

	Group N (normal) no involvement of ear			Group S (single) involvement of one ear			Group D (double) involvement of two ear			Total		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
Vertigo (−)	117 (51.8)	109 (48.2)	226 (45.0)	29 (54.7)	24 (45.3)	53 (10.6)	7 (46.7)	8 (53.3)	15 (29.9)	153 (52.0)	141 (48.0)	294 (58.6)
Vertigo (+)	79 (49.4)	81 (50.6)	160 (31.9)	13 (37.1)	22 (62.9)	35 (7.0)	4 (30.8)	9 (69.2)	13 (2.6)	96 (46.2)	112 (53.8)	208 (41.4)
Total	196 (508)	190 (49.2)	386 (76.9)	42 (47.7)	46 (52.3)	88 (17.5)	11 (39.3)	17 (60.7)	28 (5.6)	249 (49.6)	253 (50.4)	502 (100.0)

the course of cranial nerves and the association of vascular structures with them in the internal acoustic canal and CPA.[22]

In literature, there are some inconsistent data about the association between vestibulocochlear symptoms and AICA vascular loop syndrome.[7] Various studies did not show a marked association[10,23-27] between AICA compression syndrome and tinnitus while some reported significant[28-32] results. In our study, we found statistically significantly higher tinnitus rates among the patients with AICA vascular loop syndrome (group 4) than ones without AICA vascular loop syndrome (group N) (*P*: 0.000042). However, we did not detect any correlation between the grade of AICA loop syndrome and tinnitus rate as the difference between group 3 (type 3) and the control group was nonsignificant while the difference was higher when compared group 1 and controls. Furthermore, differences between all AICA syndrome groups (group 1–4) were nonsignificant.

Similarly, the data about the association of hear loss and AICA vascular loop syndrome are very inconsistent. Most of the studies did not report a significant[24,25,32-34] association between hear loss and AICA loop syndrome since a few studies suggested significant results.[28,35] We also found statistically significant higher hear loss rates in the patients with AICA vascular loops than in controls. This rate was highest in group 3 followed by group 2, group 1, group N, but the differences between these groups were nonsignificant. As the result, we detected a significant difference on hear loss rate between patients with and without AICA vascular loops but not a significant correlation with the AICA vascular loop grades.

In literature, we did not find any study about the association between AICA vascular loop syndrome and the presence of either hear loss and tinnitus in the same side. We found statistically significant higher rates of either hear loss + tinnitus in the same ear in the patients with AICA loop syndrome when compared with ones without AICA loop syndrome. In all groups with AICA vascular loops (groups 2, 3, and 4) except from group 1, the rates of hear loss + tinnitus were statistically significantly higher than controls.

Almost all previous studies did not suggest a significant association[23,24,27,32] between AICA vascular loop syndrome and vertigo while only one study[31] reported a significant relationship. In our study, the vertigo incidence in controls was slightly higher than the patient with AICA in only one ear and slightly lower than with AICA in both ears. Hence, there was no significant association between vertigo incidence and AICA loop syndrome in this study.

The major limitations of this study are retrospective design and relatively small sample size. We also could not evaluate the patients regarding hemifacial spasm, nystagmus, and otalgia.

Conclusion

We found that individuals with AICA loop syndrome have significantly higher incidence of only tinnitus, only hearing loss and either tinnitus + hear loss while the incidence of these symptoms does not correlate with the degree of the vascular loop formation. However, there was not such association between vertigo and AICA loop syndromes.

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Conflicts of interest

There are no conflicts of interest.

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