ORIGINAL ARTICLE

Anterior Inferior Cerebellar Artery (AICA) Loop Variants and Its Effect on Audio-Vestibular Symptoms Using Three-Dimensional Fast Imaging Employing Steady State Acquisition (3-D FIESTA) MRI Sequence

Saerah Iffat Zafar[1], Syeda Tatheer Fatima[2]

ABSTRACT

Objective: To assess the effect of vascular loop variant anatomy of anterior inferior cerebellar artery (AICA) types in relation to vestibulocochlear and facial nerves within cerebellopontine angle (CPA) on MRI, in patients presenting with otoneurological symptoms.

Study Design: Cross-sectional study.

Place and Duration of Study: Combined Military Hospital (CMH) Abbottabad for a period of 8 months from July 01, 2022 to February 28, 2023.

Materials and Methods: All patients with audio-vestibular symptoms (group I) pertaining to facial or vestibulocochlear nerve referred for MRI brain were included in the study. Specific MRI protocol for the assessment of cerebellopontine angle and its contents- three-dimensional fast imaging employing steady-state acquisition (3-D FIESTA)- was used to delineate the relation of AICA loop to VII and VIII cranial nerves within cerebellopontine angles and internal auditory meatus on both sides. Patients without any symptoms also underwent similar MR protocol to serve as a control group (group II). Vascular loop anatomy of AICA in CPA was recorded and its relation to patient's symptomatology, if any, was documented. Findings were compared with the control group. Social Package for Statistical Studies (SPSS) version 25.0 was used for analysis. Data type was Qualitative (categorical) and Chi square test was applied for drawing results. A p value of ≤ 0.05 was considered statistically significant with 95% confidence interval (CI).

Results: Type I was most common variant in both groups followed by Type II and Type III subsequently. No statistically significant difference was found in the AICA loop variant distribution between the symptomatic and control groups for both right ($p = 0.543$) and left ($p = 0.564$) sides with respect to patient's symptoms.

Conclusion: AICA loop within cerebellopontine angle demonstrates variant course with respect to internal auditory meatus in proximity to VII and VIII nerves; this variation has no impact on patient's otoneurological symptoms. Other factors need to be addressed and evaluated for such symptoms in the relevant patients.

Key Words: *Anterior Inferior Cerebellar Artery, Cerebellopontine, Facial, MRI, Vestibulocochlear.*

Introduction

Cerebellopontine angle (CPA) contains many vascular structures and nerves, including anterior inferior cerebellar artery (AICA) which is a branch of basilar artery predominantly arising from its lower third part. Less commonly it may originate from the distal vertebral artery.[1] It supplies lateral pons, inner ear, middle cerebellar peduncles and antero-inferior part of the inferior cerebellum as well as the 7th and 8th cranial nerves. Vascular compression through the course of nerves has been proposed to cause neurological symptoms due to direct contact and irritation of the nerves by the adjacent vessels, particularly in closed spaces like internal auditory meatus.[2] Some authors proposed this neurovascular compression to be dynamic, occurring only at times hence this could be missed on routine MRI at the time of examination.[3] AICA can form a vascular loop within the CPA in relation to internal auditory meatus (IAM) after its origin - forming a loop at the base of the meatus, entering part of it or extending more than half of its length, crossing over the vestibulocochlear and facial nerves. These loops have traditionally been graded according to Chavda classification according to which loops within the

[1]Department of Radiology
Combined Military Hospital, Abbottabad
[2]Department of Radiology
Institute of Nuclear Medicine, Oncology and Radiotherapy (INOR) Abbottabad

Correspondence:
Dr. Saerah Iffat Zafar
HOD Radiology
Combined Military Hospital, Abbottabad
E-mail: saerah_syk07@yahoo.com

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CPA not entering the IAM were classified as type I, those entering the porus acusticus and extending less than 50% of the length as type II, and extension of AICA loop beyond 50% of meatal length were labelled as type III.[4]

Three-dimensional fast imaging employing steady-state acquisition (3D-FIESTA) is an ultrafast heavily weighted T2W MRI sequence developed by General Electric (GE) HealthCare for evaluation of thin or small structures against fluid, due to high intrinsic contrast resolution and relative insensitivity to motion.[5] Hence it has been utilised in assessment of abnormalities pertaining to cranial nerves and small vessels within cisterns and inner ear structures. Some centres are using the pre and post contrast T1W images in addition to identifying small retro cochlear lesions and inflammation in investigations of otovestibular symptoms.[6] An equivalent to this MRI sequence is constructive interface in steady state (CISS) by Siemens, working on the same principle.[7]

Many studies have been conducted to identify the relationship between loop variants of AICA in the CPA with the otological symptoms of tinnitus, vertigo, hearing loss or symptoms related to facial nerve such as hemispasm, with the help of these relatively new sequences. This relation was proposed due to close relation of AICA with the VII and VIII cranial nerves in the CPA raising the possibility of neurovascular compression. For this purpose, classification system of Chavda has been utilised as proposed by McDermott *et al.*,[4] in patients with such symptoms. There have been conflicting conclusions regarding the importance of this neurovascular relation. Despite repeated research, no significant effect of AICA anatomical type was identified with the patients' symptomatology.[8,9,10] The aim of this study was to identify the role of AICA loop variations in causing audio-vestibular and facial nerve symptoms secondary to neurovascular compression of the nerves traversing the internal auditory meatus by comparing the distribution of AICA loop variants between patients with and without vestibulocochlear symptoms. So far, no such study has been conducted in this region; it will help neurosurgeons to properly evaluate and diagnose the root cause of patients with symptoms related to ear by appropriate investigation.

Materials and Methods

This was a cross-sectional study carried out in Combined Military Hospital (CMH) Abbottabad for a period of 8 months from July 01, 2022 to February 28, 2023. Prior permission was obtained from Ethical Review Board (ERB) of the institution (ETH-63 dated 16 July 2022). A total of 58 patients were included in the study. Random sampling was used for patients and control group selection. Inclusion criteria included patients of all ages and both genders referred to Radiology Department CMH Abbottabad for MRI brain for assessment of otovestibular symptoms like tinnitus, hearing loss, vertigo and facial sensory or motor abnormalities. The patients who were found to have an organic lesion as a cause of these symptoms or those who were unable to undergo MRI examination by virtue of age, technical limitations or claustrophobia were excluded from the study. In addition, all patients undergoing MRI brain without these symptoms formed a number specific control group, matched for age and gender. A total of 58 patients were included in the study distributed into group I (having otovestibular/facial nerve symptoms, n = 29) and group II undergoing MR brain for other reasons (control, n = 29). Both groups were matched for age and gender (Table I). Data was collected by the author with assistance from the co-author. Non-enhanced MRI brain was done on 1.5 Tesla GE machine including three-dimensional fast imaging employing steady-state acquisition (3D-FIESTA) to determine the location of anterior inferior cerebellar artery with respect to vestibulocochlear and facial nerves in cerebellopontine angle. AICA loop anatomy in the CPA and its relation to facial and vestibulocochlear nerves was ascertained for each patient on either side. Images were interpreted by consultant radiologist. Data was fed into Social Package for Statistical Studies (SPSS) v 25.0 and significance of variant anatomy to the symptoms of patients was determined. Similar MRI sequence was carried out in asymptomatic patients undergoing MRI brain as a control group. Chi square test was applied for assessment of relation between AICA loop variant and symptoms related to VII/VIII nerves. In analyses where at least one case had an expected frequency of less than five, Fisher's exact test was applied. A p value of ≤ 0.05 was considered statistically significant with 95% confidence interval (CI).

Results

Most of the group I patients (n = 22, 75.8%) demonstrated symptoms related to the vestibulocochlear nerve (vertigo, dizziness, and tinnitus), with vertigo being the most frequent complaint (n = 20, 71.4%). Isolated tinnitus was reported in seven patients -out of these, five had bilateral symptoms while two had reported tinnitus in the left ear only; two patients had both tinnitus and dizziness. Facial nerve symptoms (hemispasm and palsy were reported in two (6.8%) patients. The frequencies of AICA loop types for the right and left ears are illustrated in Table II. There was no statistically significant difference in the distribution of the AICA loop types between the symptomatic and asymptomatic groups for both right (p = 0.543) and left (p = 0.564) CP angles.

Table I: Gender and Age for symptomatic and control Groups (n = 58)

		Group I	Group II	Total
Gender n %	Male	15 (41.7%)	15 (41.7%)	30
	Female	14 (48.3%)	14 (48.3%)	28
Age (Years)		44.97 ± 16.46	47.76 ± 16.90	46.36 ± 16.60

Table II: AICA Loop Type Distribution for both Groups (n = 58)

AICA Loops		Group I	Group II	Total	p value
Right	Type I	24 (82.8%)	25 (86.2%)	49 (84.5%)	0.543
	Type II	3 (10.3%)	4 (13.8%)	7 (12.1%)	
	Type III	2 (6.9%)	0 (0%)	2 (3.4%)	
Left	Type I	23 (79.3%)	24 (82.8%)	47 (81%)	0.564
	Type II	4 (13.85)	5 (17.2%)	9 (15.5%)	
	Type III	2 (6.9%)	0 (0%)	2 (3.4%)	

* The p value ≤ 0.05 was considered statistically significant

Discussion

Our study revealed AICA loop distribution to be similar in both symptomatic and non-symptomatic patients (control group). Type I remained the most common variant in both groups at 81.5 % in symptomatic patients, and 84.5% in the control group; no difference in rest of the variants was noted (p value = 0.5), signifying no role of these vascular loop variants in causation of audio-vestibular symptomatology.

AICA arises as a branch of basilar artery in 98% of normal population. Like majority of vessels, it can have a variant course - traversing the CPA at the origin of IAC close to the meatus (19%– 40%), at the meatus (33%–56%), or entering within the IAC (25%–27%)[11] - Figures 1-3. At this juncture it lies in close proximity to the VII and VIII nerves.[12] Superomedially, midbrain borders the CPA, which is the exit point of some important nerves including trigeminal, facial and vestibulocochlear nerves. Eighth nerve travels lateral to the abducens and facial nerve after its exit from the brain; after a short anterolateral course, it accompanies facial and intermediate nerve to enter the auditory canal before dividing into cochlear and vestibular branches.[13]

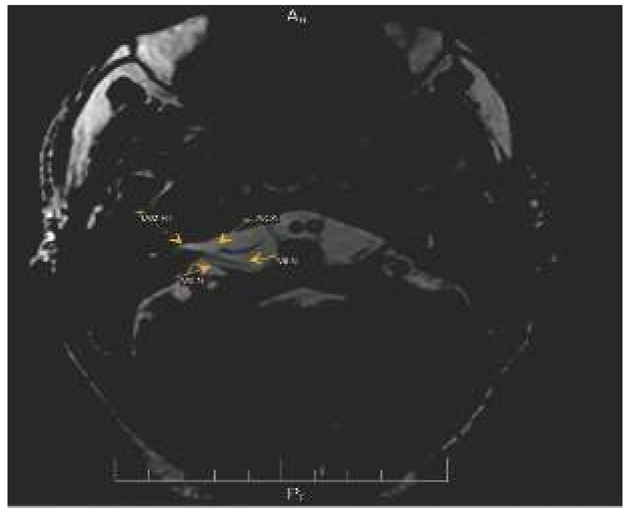

Fig 1: MRI 3-D axial FIESTA sequence outlining AICA in the CSF of right cerebellopontine angle. The vessel is seen crossing over the VII/VIII nerve at the level of porus acusticus without entering the internal auditory meatus (type I variant).

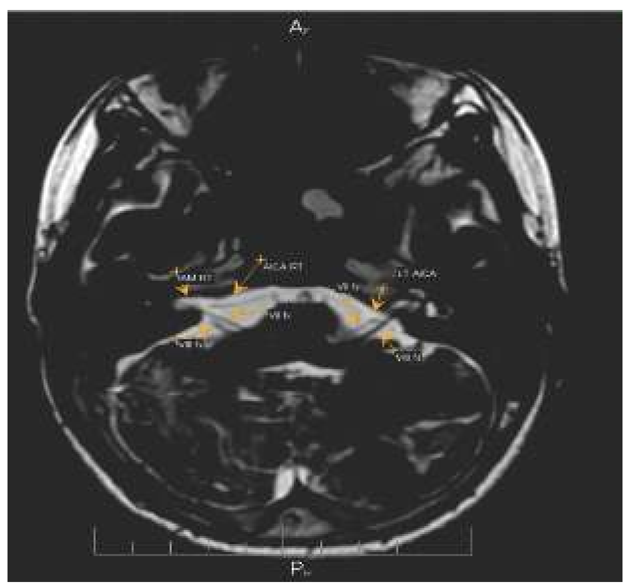

Fig 2: MRI 3-D FIESTA sequence axial view showing right AICA entering the IAM for less than 25% of its length (type II variant); left sided AICA loop is type I

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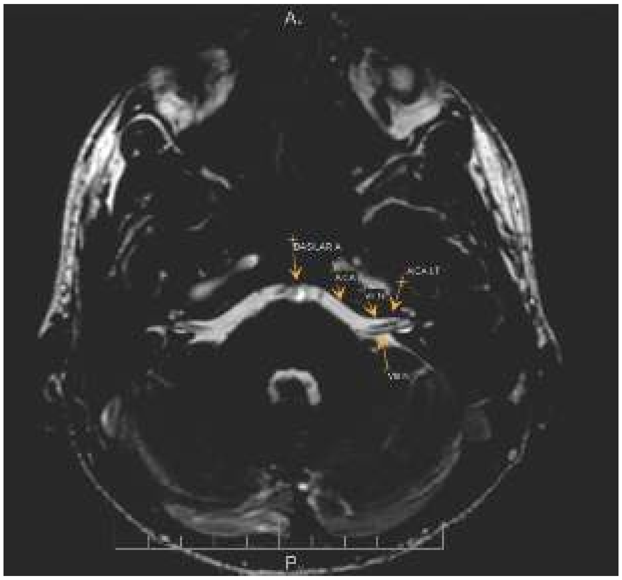

Fig 3: MRI 3D-FIESTA sequence demonstrating type III variant of AICA (on the left) as it passes into the IAM for more than 50% of its length, crossing over VII/VIII nerves

Neurovascular compression as a cause of audio-vestibular symptoms due to irritation of the nerves has long been debated without a definitive conclusion. With the advent of newer MRI sequences with thin sections, assessment of these nerves and vessels along with points of contact has been made easy. One of the researches carried out in Turkey showed no significant vascular conflict between AICA loop variants and the 8th nerve course within the CPA and auditory canal in patients having cochleo-vestibular symptoms.[14] Studies performed in Netherlands and Egypt concurred these findings as they could not establish a diagnostic value to any specific type of AICA causing compression upon the nerve to cause a neurovascular conflict.[15,16] A research carried out to determine the relation between contact of these nerves with AICA loops showed that it was similar in symptomatic and control patients (25% and 21.4%, respectively).[17] No regional study has been conducted in Pakistan so far; in our study, we concluded that no significant relation existed between audio-vestibular symptoms and vascular loop variants within the CPA and IAC, as both the cases and control group demonstrated variation in the AICA anatomy. However, a study with a large number of subjects (n=2622) concluded that loop characteristics of AICA loop in this region as a significant predictor in evaluation of sensorineural symptoms for guidance regarding its treatment.[18] Ezerarslan *et al.,* [19] showed sudden sensorineural hearing loss was significantly associated with a sub-type of AICA loop variant. Moreover, these patients were less responsive to steroid therapy. These findings led to switching of the management in these patients from oral therapy to microvascular decompression with improved results. Since the treatment required for a neurovascular conflict is microvascular decompression hence it becomes imperative that an authentic diagnosis is made before undertaking this invasive procedure. So far, based on the existing classification, no study has managed to cement the hypothesis of an AICA loop being a cause of audio-vestibular symptoms definitively. Hence routine MRI for identification of AICA variant anatomy, despite being a non-invasive modality, is not recommended by most authors as concluded by a review paper comparing the results of 12 studies.[20]

Despite multiple research world-wide, to our knowledge this is the first study in Pakistan to investigate possible relation between AICA anatomic variants to 7th and 8th nerve course in CPA for assessment of otovestibular and facial symptoms. The limitations of this study were that symptomatic evaluation was not performed clinically on all patients, and the sample size was small.

Conclusion

Anterior inferior cerebellar artery within cerebellopontine angle demonstrates variant course with respect to internal auditory meatus in proximity to VII and VIII nerves; this variation has no impact on patient's otoneurological symptoms.

Conflict of interest

There is no conflict of interest to declare by the authors.

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CONFLICT OF INTEREST
Authors declared no conflicts of Interest.
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DATA SHARING STATMENT
The data that support the findings of this study are available from the corresponding author upon request.