



IMAGING ASSESSMENT OF INTRACRANIAL VESSELS AND BRAIN PARENCHYMA IN TAKAYASU ARTERITIS AND ITS RELATION WITH MACARONI SIGN IN CERVICAL CAROTID ARTERIES

Radiology

Dr. Gulam Rabbani	Post Graduate Trainee, Department Of Radio-Diagnosis, IPGME&R SSKM Hospital Kolkata.
Dr. Pawan Singh	Post Graduate Trainee, Department Of Radio-Diagnosis IPGME&R SSKM Hospital Kolkata.
Dr. Sumit Chakraborty*	Associate Professor Department Of Radio-Diagnosis IPGME&R SSKM Hospital Kolkata. *Corresponding Author
Dr. Arghya Chattopadhyay	Rmo Cum Clinical Tutor, Department Of Rheumatology IPGME&R SSKM Hospital, Kolkata.

ABSTRACT

Objectives - Aim of this study to evaluate the imaging findings of intracranial vascular and parenchymal involvement in Takayasu arteritis and to correlate these findings with Macaroni sign in cervical carotid arteries. **Materials and Methods:** This is a cross-sectional study with total of 19 study subjects. We have evaluated each patient by ultrasonography of cervical carotid vessels. Subsequently each patient underwent MRI brain and MRA of cerebral vessels. We have assessed correlation of Macaroni sign in cervical carotid arteries with intracranial vascular and parenchymal involvement. **Result:** our study shows Maximum number of patients (63%) belonged to the age group (25-35) years with female predominance. Neurological involvement in the form of history of stroke were present in 31.5% of cases. In our study 19 patients of Takayasu arteritis the neck vessel involvement in the form of macaroni sign, were very common approximately 63.2% of cases. In Macaroni sign the echogenicity of intima-media thickness were hyperechoic in most of the cases. The maximum thickness of the involved arterial wall was 2.7mm (mean $\pm$ SD, 1.14 $\pm$ 0.66mm). Two patients of Takayasu arteritis showed calcific plaque with significant stenosis and one patient also had the reverse flow in vertebral artery. Macaroni sign is a strong predictor for the intracranial cerebral vessels involvement in Takayasu arteritis. **Conclusion:** CCA involvement and Macaroni sign are very common as compared to cervical part of ICA in Takayasu arteritis. Takayasu arteritis is an unusual etiology for neurological brain parenchymal vascular insult. Ultrasonography (USG) is a simple, portable, bedside, non-invasive, standard real-time, quite sensitive and superior imaging method to detect the early changes in the wall of the arteries, progression of disease and indirect predictor of brain parenchymal vascular insult.

KEYWORDS

Ultrasonography, MRI, MRA, Takayasu arteritis, Macaroni sign

INTRODUCTION

Takayasu arteritis is a chronic, progressive, inflammatory, occlusive disease of the aorta and its branches commonly affects young women. The disease remains an enigma as the exact cause of the disease is still not elucidated.¹ CNS manifestation of Takayasu arteritis are TIA, subclavian steal syndrome, neurological deficit, cavernous sinus syndrome, hypertrophic pachymeningitis etc.² Prolonged course of the disease may lead to arterial stenosis, occlusion, or aneurysmal dilation. Carotid involvement of TA may result in ischaemic impairments, such as limb claudication, lightheadedness, syncope, and stroke.

Ultrasonography is a better modality of investigation than angiography for cervical vessel wall thickness of the patients of Takayasu arteritis because angiography can show the narrowing and extent of arterial involvement with more precision but cannot assess the arterial wall thickness.³ B-mode ultrasonography may depict homogeneous circumferential thickening of affected vessels, characterized by a diffuse hypoechoic or isoechoic thickening of the affected wall on longitudinal scanning, classically described as the "macaroni sign," which may represent edema, increased vascularity, or both. B-mode morphologic study has further been utilized to monitor the progression of disease.⁴

Currently, MRI is one of the methods most often used to evaluate Takayasu arteritis. It offers reproducibility and excellent luminography and lacks radiation. The soft tissue differentiation obtained with MR techniques may help distinguish the active or acute phase from the chronic phase of the disease. Significant enhancement of the arterial wall was identified in active disease,

MATERIALS AND METHODS

this study was conducted in a tertiary care hospital of eastern India in time a time span of 18 months. Our study was approved by institutional Ethics committee vide approval no. IPGME&R /IEC/2022/151 dated March 23, 2022. written informed consent was taken from every study subject at recruitment. 19 cases of Takayasu arteritis were studied

Inclusion Criteria:

- Patients: Diagnosed cases of Takayasu arteritis based on American college of rheumatology criteria 1990.
- Age: More than 18 years.
- Sex: both sexes.

Exclusion Criteria:

- Patients of less than 18 years
- Patients with general contraindication of MRI examination (The cardiac implantable electronic device such as pacemakers, defibrillators, cardiac desynchronizing therapy, metallic intraocular foreign bodies, implantable neurostimulator system, cochlear implants, swan - ganz catheter, dental implants, claustrophobia etc.

Detailed history was taken with special emphasis upon following points;

- Age
- Sex
- Inflammatory markers
- Duration of the disease
- History of hypertension
- History of diabetes mellitus
- History of smoking
- History of present or previous stroke

Study Tool:

- Informed consent form.
- Case record form.
- MRI machine Signa HDXT 3TMR-GE healthcare manufacturer.
- SIGNA 3T HDXT with head coil
- LOGIQ P9, GE, USG machine with broadband multifrequency, and electronic focusing by General Electrics (GE) with linear (3-12 MHz) linear transducer having electronic focusing.

Study Variable:

- MR-imaging characteristics of brain parenchymal involvement (acute subacute and chronic infarct in the territory of cerebral vessels) and cerebral blood vessel involvement in the form of

narrowing, occlusion and hypoplasia.

- USG colour doppler imaging features of bilateral common carotid arteries, internal carotid arteries and vertebral arteries in the form of circumferential wall thickening, echogenicity, narrowing, stenosis, thrombosis or plaque.

Parameters to be Studied:

1. USG findings:-
2. MRA findings :-
3. MRI findings :-

Statistical Analysis

Collected data were entered into a Microsoft Excel spreadsheet and then analyzed by the IBM SPSS statistics software (version 25.0; SPSS Inc). Data has been summarized frequency and percentages for categorical variables. Chi square test & fishers exact test were performed for the categorical variables to examine the significance of the association. A value of $p < 0.05$ was considered significant.

RESULT AND DISCUSSION

The present study was carried out on 19 patients of Takayasu arteritis. In our study maximum patients (63%) belonged to the age group of 25-35 years and the majority of the patients were female with male to female ratio of 4:15. Takayasu arteritis commonly affects the young and middle aged women of Asian descent.⁷

Comorbidities like diabetes mellitus was present in 3 patients (15.8%) and 8 patients (42.1%) were hypertensive. Hypertension has been a predominant feature in most of the studies from India. It commonly results from the involvement of renal arteries (involved in 90% cases in different series). Kumar A reported that for young patients with renovascular hypertension, the predominant cause was Takayasu arteritis (69.4%). Bilateral involvement of the renal arteries is common in patients with TA (60%).⁸

In our study group of 19 patients of Takayasu arteritis neurological involvement in the form of history of stroke were present in 31.5% of cases. Each patients had varying presentations of stroke with Takayasu arteritis along with other neurological symptoms. Four of the 7 patients presented with ischemic stroke, one with hemorrhagic stroke, one with TIAs, and one with syncope attack. It is important to consider Takayasu arteritis as an unusual etiology of stroke especially in young adults.⁹

In 12 of 19 patients of Takayasu arteritis on B-mode ultrasonography clearly shows characteristic segmental, circumferential, diffusely thickened intima-media complex arterial wall of either one or both sides of the common carotid arteries as a Macaroni sign. Maeda conducted a study on Takayasu arteritis patients and found that 19 out of 23 patients showed characteristic circumferential arterial wall thickening of either one or both sides of the common carotid arteries as a macaroni-like, diffusely thickened intima-media complex on B-mode ultrasonography. Conversely, contrast angiography demonstrated carotid lesions in only 13 of 23 patients. These results clearly show that B-mode ultrasonography is quite sensitive and superior in the detection of the characteristic thick intima-media complex of the common carotid artery in patients with Takayasu's arteritis.

In our study of 12 patients of Takayasu arteritis with macaroni sign, CCA in 9 patients showed hyperechoic and in 3 patients showed isoechoic intima medial thickness echogenicity. The wall thicknesses of the rest of the patients were hypoechoic intima-media complex.

In 19 patients of Takayasu arteritis most of them approximately 63.2% showed segmental or diffuse circumferential wall thickening of neck vessels CCA on ultrasonography. The maximum thickness of the involved arterial wall was 2.7mm (mean $\pm$ SD, 1.14 $\pm$ 0.66mm). The thickness of the intima-media complex and outer diameter of the vessel are the important marker of the disease activity. Prominent wall thickening with maintained outer diameter of the neck vessels are indicative of active lesion. Thinner arterial wall and smaller vessel diameter are related to fibrotic changes of the involved vessels in later stage of disease.

CCA in 2 patients showed calcific plaque with Macaroni sign and significant stenosis and one patient showed the reverse flow in vertebral artery on ultrasonography.

In our study we found that the chances of involvement of common carotid arteries in the form of diffuse circumferential thickening with stenosis were very high approximately 91% in those patients who were positive for Macaroni sign. In our study finding is nearly similar to the previous study. USG finding may be beneficial for appropriate follow-up and diagnostic workup. Circumferential thickening/Macaroni sign in CCA may be an indicator for the progression of disease.

In our study we did not get the strong association between Macaroni sign and stenosis in cervical part of internal carotid arteries by ultrasonography. There is only 26% chance of involvement of ICA in Macaroni sign positive Takayasu arteritis patient but when we include the neck vessels including both either common carotid arteries or cervical part of internal carotid arteries we found the strong association between Macaroni sign and involvement of neck vessels approximately 91.7% on ultrasonography. Findings of our study indicate that in Takayasu arteritis the involvement of common carotid artery is more than the cervical part of internal carotid artery on ultrasonography.

In our study we found that 31.6% patients of Takayasu arteritis patient had the history of stroke but when we performed the Fisher's Exact Test, we were not able to find the statistically significant result between Macaroni sign and brain parenchymal vascular insult. We also did not get the statistically significant result between the involvement of neck vessels on ultrasonography and cerebral vascular insult on MRI. However we note that all patients with history of stroke had involvement of cerebral vessels on MRA.

In our small series of 19 patients of Takayasu arteritis, intracranial cerebral vascular involvements were present in 68.4% cases. We performed the Fisher's Exact Test to explore the relation between Macaroni sign and intracranial cerebral vascular involvement we found the strong association between Macaroni sign in neck vessels on ultrasonography and intracranial cerebral vessels involvement on MRA. In Macaroni sign positive Takayasu arteritis patient the involvement of cerebral vessels were 84.6%. In Takayasu patient study the presence of intracranial vasculitis, although generally thought to be rare in this disease, has been increasingly recognized in Takayasu arteritis patients¹⁰ with neurologic symptoms. The frequency of intracranial involvement varies considerably in individual studies (from 4.9% to 41.9%), likely as a result of study design, reporting bias, patient selection, and the type of imaging modality performed. The examination of intracranial vessels in patients with Takayasu arteritis may be helpful for primary or secondary prevention strategies for neurological course of the disease and Macaroni sign in cervical carotid arteries shows the predilection of involvement of intracranial cerebral vascular involvement in Takayasu arteritis patient.

In our study we note that the intracranial part of ICA were involved in 57.9% of Takayasu patients and its involvement becomes very much significant approximately 90.9% in those cases in which the neck vessels were involved.

CONCLUSION

From our study we can conclude:-

- Takayasu arteritis is more common in young population predominantly in females and presents with the symptoms related to end organ ischemia.
- Takayasu arteritis is a common cause of renovascular hypertension.
- It is important to consider Takayasu arteritis is an unusual etiology for the neurological brain parenchymal vascular insult although we did not get the statistically significant result between neck vessel involvement and brain parenchymal vascular insult.
- Takayasu arteritis involves both extra- and intra cranial arteries providing blood to the brain.
- CCA involvement and Macaroni sign are very common as compared to cervical part of ICA in Takayasu arteritis.
- Ultrasonography (USG) is a simple, portable, bedside, non-invasive, standard real-time, quite sensitive and superior imaging method to detect the early changes in the wall of the arteries and progression of disease.
- MRA and Ultrasonography (USG) finding suggest that the Macaroni sign and neck vessel involvement on ultrasonography are an indirect predictor for the intracranial cerebral vessel involvement on MRA in Takayasu arteritis.
- Ultrasonography (USG) and neuroimaging like MRA and MRI in

Takayasu arteritis patient at base line may provide complete assessment of the extent of the disease and provide an opportunity for monitoring the disease progression and to prevent the serious neurovascular complication.

Variables	Frequency	Percentage
Numbers 19		
Age (years)	Median =29	63% (25-35)years
Sex		
Male	4	21.1%
Female	15	78.9%
History of diabetes mellitus	3	15.8%
History of hypertension	8	42.1%
History of stroke	6	31.5%
Macaroni sign	12	63.1%
Carotid intima-media thickness (mean $\pm$ SD.)	(1.14 $\pm$ 0.66mm)	
Echogenicity of CIMT		
Hyperechoic	9 (47%)	
Hypoechoic	7 (37%)	
Isoechoic	3 (16%)	

Table-: Table showing association of macaroni sign with ICA stenosis by USG in Takayasu arteritis

			ICA Stenosis on USG		Total
			Absent	Present	
Macaroni sign	Absent	Count	6a	1a	7
		Expected Count	4.8	2.2	7.0
		% within Macaroni sign	85.7%	14.3%	100.0%
		% within ICA Stenosis on USG	46.2%	16.7%	36.8%
		% of Total	31.6%	5.3%	36.8%
	Present	Count	7a	5a	12
		Expected Count	8.2	3.8	12.0
		% within Macaroni sign	58.3%	41.7%	100.0%
		% within ICA Stenosis on USG	53.8%	83.3%	63.2%
		% of Total	36.8%	26.3%	63.2%
Total		Count	13	6	19
		Expected Count	13.0	6.0	19.0
		% within Macaroni sign	68.4%	31.6%	100.0%
		% within ICA Stenosis on USG	100.0%	100.0%	100.0%
		% of Total	68.4%	31.6%	100.0%
Fisher's Exact Test					
	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2- sided)	Exact Sig. (1- sided)
Continuity Correctionb	.529	1	.467		
Likelihood Ratio	1.657	1	.198		
Fisher's Exact Test				.333	.238
Linear-by-Linear Association	1.453	1	.228		
N of Valid Cases	19				

Table-: Table showing association between macaroni sign and Brain parenchymal vascular insult in Takayasu arteritis

			Brain parenchymal vascular insult		Total
			Absent	Present	
Macaroni sign	Absent	Count	5a	2a	7
		Expected Count	4.8	2.2	7.0
		% within Macaroni sign	71.4%	28.6%	100.0%
		% within Brain vas insult	38.5%	33.3%	36.8%
		% of Total	26.3%	10.5%	36.8%
	Present	Count	8a	4a	12
		Expected Count	8.2	3.8	12.0
		% within Macaroni sign	66.7%	33.3%	100.0%
		% within Brain vas insult	61.5%	66.7%	63.2%
		% of Total	42.1%	21.1%	63.2%

Total	Count	13	6	19
	Expected Count	13.0	6.0	19.0
	% within Macaroni sign	68.4%	31.6%	100.0%
	% within Brain vas insult	100.0%	100.0%	100.0%
	% of Total	68.4%	31.6%	100.0%

Fisher's Exact Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2- sided)	Exact Sig. (1- sided)
Continuity Correctionb	.000	1	1.000		
Likelihood Ratio	.047	1	.829		
Fisher's Exact Test				1.000	.622
Linear-by-Linear Association	.044	1	.834		
N of Valid Cases	19				

Table-: Table showing association between macaroni sign and intracranial vessels (ICA, MCA, ACA, PCA & its branches) involvement in Takayasu arteritis

			Intracranial vessels involvement on MRA		Total
			Absent	Present	
Macaroni sign on USG	Absent	Count	5a	2b	7
		Expected Count	2.2	4.8	7.0
		% within Macaroni sign on USG	71.4%	28.6%	100.0%
		% within Intracranial vessels involvement on MRA	83.3%	15.4%	36.8%
		% of Total	26.3%	10.5%	36.8%
	Present	Count	1a	11b	12
		Expected Count	3.8	8.2	12.0
		% within Macaroni sign on USG	8.3%	91.7%	100.0%
		% within Intracranial vessels involvement on MRA	16.7%	84.6%	63.2%
		% of Total	5.3%	57.9%	63.2%
Total		Count	6	13	19
		Expected Count	6.0	13.0	19.0
		% within Macaroni sign on USG	31.6%	68.4%	100.0%
		% within Intracranial vessels involvement on MRA	100.0%	100.0%	100.0%
		% of Total	31.6%	68.4%	100.0%
Fisher's Exact Tests					
	Value	Df	Asymptotic Significance (2-sided)	Exact Sig. (2- sided)	Exact Sig. (1- sided)
Continuity Correctionb	5.487	1	.019		
Likelihood Ratio	8.439	1	.004		
Fisher's Exact Test				.010	.010
Linear-by-Linear Association	7.717	1	.005		
N of Valid Cases	19				

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