Original Article

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ANATOMY OF THE LEFT ATRIAL APPENDAGE IN PATIENTS UNDERGOING CT CORONARY ANGIOGRAPHY FOR EVALUATION OF CORONARY ATHEROSCLEROSIS

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ABSTRACT

Objective: Thromboembolic phenomenon is directly related to atrial fibrillation, a phenomenon being increasingly diagnosed, and LAA has been postulated to be the major cause of its occurrence. Various morphologies of LAA have been discussed with increasing incidence of thrombus formation in certain varieties. In Pakistani population, we are describing the morphology of left atrial appendage for the first time.

Study Design: Prospective descriptive observational study.

Place and duration of study: Department of cardiac CT, Armed Forces Institute of Cardiology and National Institute of heart Diseases from 20th October 2015 to 29th February 2016.

Materials and Methods: We conducted an analysis of LAA morphologies on patients undergoing a CT coronary angiogram for evaluation of coronary atherosclerosis and were found to have normal coronaries.

Results: 100 patients were evaluated. The most frequently found shape was windsock, followed by chicken wing, cauliflower and then swan neck.

Conclusion: We have found similar forms of LAA as those reported in the international data. However the size of LAA was smaller than that reported in other studies, possibly because our study was conducted upon relatively normal population.

Keywords: Windsock, Chicken wing, Cauliflower, Swan neck, Computed, Tomography Coronary Angiography, Left atrial appendage.

INTRODUCTION

There is well known risk of thromboembolic phenomenon in patients with atrial fibrillation (AF), mostly from a thrombus arising from the left atrial appendage (LAA)[1-4]. Atrial fibrillation (AF) is the commonest arrhythmia occurring in approximately 0.4% to 1% of the general population, which later increases with age to >10% in those >80 years of age, as a result there is need to evaluate the LAA morphology in detail[5]. Furthermore, many procedures including mitral valve repair, electrophysiological studies with radiofrequency or cryo ablation and lately addition of LAA occlusion device result in the instrumentation of LAA, either intentionally or unintentionally, necessitating the complete assessment of LAA anatomy. Transesophageal echocardiography (TEE) has been the modality of choice for the evaluation of LAA, but certain cases have shown poor imaging resulting in difficulty in the analysis[6]. Recent advancement in Cardiac MRI and Multi-Slice CT (MSCT), on the other hand, have lead to a volumetric analysis of the heart including the LAA, which leads to the accurate evaluation of the LAA lobes and shapes that has shown to be the primary source of thrombus formation[7-9].

MSCT also allows us to evaluate the relationship of LAA to various structures including pulmonary veins which has been found to be of clinical significance in various studies[10].

We have studied the anatomy of LAA in otherwise normal patients and are reporting our findings of normal LAA anatomy in the Pakistani population.

MATERIAL AND METHODS

Patients undergoing MSCT coronary angiography for the evaluation for coronary atherosclerosis were included in the study,

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these patients had normal coronaries upon evaluation and their left ventricular ejection fraction upon 2D echocardiogram was also normal. Patients having underlying coronary atherosclerosis, valvular or congenital heart disease, LV systolic or diastolic dysfunction, or rhythmic abnormalities such as atrial fibrillation were excluded.

Table-1: LAA Measurements using double oblique sagittal MSCT reconstructions (N=100).

		Mean ± Std. Deviation	Minimum	Maximum
LAA Ostium	Minimum diameter (cm)	1.46 ± 0.38	0.79	2.92
	Maximum diameter (cm)	2.38 ± 0.49	1.45	3.80
	Perimeter of Ostium (cm)	6.1409 ± 1.06262	3.93	9.39
	Area of Ostium (cm2)	2.8162 ± 1.00746	0.87	6.65
LAA 10mm deep to ostium	Minimum diameter (cm)	1.5761 ± 1.75277	0.52	15.50
	Maximum diameter (cm)	2.0982 ±2.07829	0.94	17.50
	Perimeter of Ostium (cm)	5.1376 ±1.04247	2.45	8.06
	Area of Ostium (cm2)	2.1317 ± .82550	0.69	5.53

Table-2: Miscellaneous measurements LAA using Single oblique coronal reconstruction.

	Mean ± Std. Deviation
Angulation of LAA	62.02 ± 15.86113
Length of LAA	3.2103 ± 0 .55075
Length of LAA from Ostium to First Bend	1.7397 ± 0.44809
Distance Septum to LAA Ostium	3.9440 ± 0.54403

Table-3: Comparison of LAA diameters and LAA Length using t-test between different age groups.

		N	Mean ± SD	*p*-value
Maximum diameter (cm)	Age ≤ 49	55	2.29 ± 0.49	0.239
	Age ≥ 50	45	2.41 ± 0.48	
Minimum diameter (cm)	Age ≤ 49	55	1.38 ± 0.37	0.027
	Age ≥ 50	45	1.55 ± 0.36	
Perimeter of Ostium (cm)	Age ≤ 49	55	6.03 ± 1.14	0.268
	Age ≥ 50	45	6.27 ± 0.94	
Area of Ostium (cm2)	Age ≤ 49	55	2.68 ± 1.20	0.148
	Age ≥ 50	45	2.97 ± 0.67	
Length of LAA	Age ≤ 49	55	3.15 ± 0.55	0.293
	Age ≥ 50	45	3.27 ± 0.54	

MSCT Data Analysis

LAA Morphology

LAA morphology was evaluated by reconstructing images and were divided into four categories

Windsock – one dominant lobe

Chicken wing – single acute bend in the dominant lobe

Cauliflower – small length of LAA with a distal breadth much bigger than the proximal breadth

Swan neck – LAA has another bend leading to its folding back to the origin

LAA Ostium And Neck Dimensions

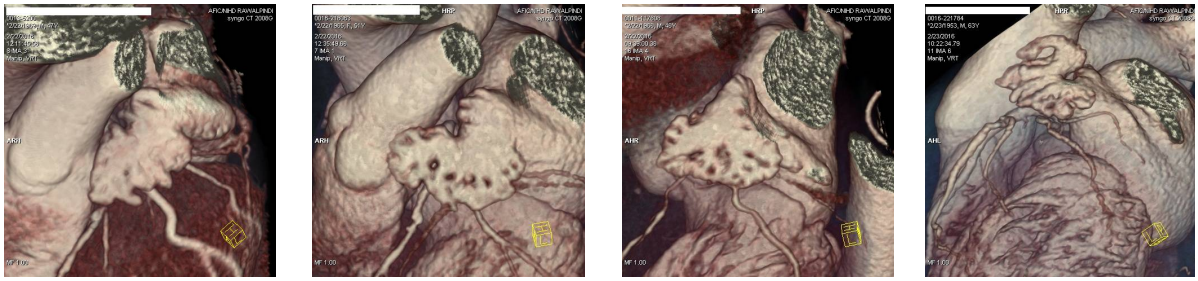
Orthogonal axial and single oblique coronal views were used to reconstruct an oblique sagittal view, which was used to measure the maximum and minimum diameter along with perimeter and osteal area. The same view was pushed 10 mm into the LAA for similar measurements along the neck of LAA.

LAA Length, Angulation and distance of ostium to the first bend of LAA

Orthogonal axial view was used to reconstruct the oblique coronal view and above mentioned measurements were carried out.

Distance of LAA ostium to the foramen ovale

Orthogonal axial and single oblique views were used to reconstruct a single oblique coronal view and the distance was measured.



A B C D

Figure-1: Morphologies of LAA. Windsock (A), Chicken wing (B), Cauliflower (C) or Swan neck (D).

Figure-2: Orthogonal axial (A) and oblique coronal views (B) double oblique sagittal view (C & D).

Figure-3. Measurement of distance of LAA ostium to foramen ovale.

RESULTS

In our study population of 100 patients there were 89 men with a mean age of 48 ± 12 years and 11 women with a mean age of 49 ± 9 years. Windsock morphology was seen in 37 patients (37%), followed by chicken wing in 30 patients (30%) then cauliflower in 22 patients (20%) followed by swan neck shaped morphology in 11 patients (11%)

DISCUSSION

LAA is formed during the third week of gestation, which is actually a lengthened protrusion of the left atrium towards the anterior or inferior right side. It is the commonest site for thrombus in patients with atrial fibrillation and the reasons why left atrial appendage is so commonly involved and not the other structures have been hypothesized well, but not understood completely[1].

This study has been designed to show the variability of LAA in normal Pakistani population and as LAA is known to undergo changes in the presence of disease our findings can serve as a reference in future. It was found that the windsock morphology has the highest frequency followed by the chicken wing, cauliflower and swan neck morphology. It has been shown in other studies that the chicken wing morphology is associated with the least number of strokes and cauliflower is associated with the highest number of strokes with age playing the role of an independent risk factor[4,7,11,12]. It was also concluded after taking chicken wing as a reference point, windsock had 4.5 times more likelihood of having an ischemic stroke/ TIA, and cauliflower had 9 times more chances of having an ischemic

stroke/ TIA. We infer from our findings that an aggressive management of atrial fibrillation will be required via anticoagulation in our population because of a very high frequency of windsock and cauliflower morphology in our study. However, certain studies also showed that no specific difference in incidence of stroke in patients occurred with different anatomic variation in shape[10].

Size of left atrial appendage has also correlated well with increased thromboembolic risk[11]. It has also been found that the LAA size is also associated with risk of stroke in patients without any other risk factors in those patients and were labeled cryptogenic in the past[12,13].

Our study also shows that the minimum diameter of LAA also increases with age having an increase of 0.36 cm in patients more than 50yrs old which was statistically significant. In various studies this finding has shown to be associated with an increased risk of stroke. The LAA size increases with advancing age and atrial fibrillation[14]. It is probably because of the changes in muscle mass due to age and a further decrease in systolic and diastolic variability due to atrial fibrillation which further promotes the thrombogensis. Therefore our study infers that age plays its role in \CHA2DS2-VASc scoring system likely because of this phenomenon. This phenomenon needs to be further studied and correlated in patients with atrial fibrillation and in patients who have undergone stroke without any obvious cause and to elucidate it as an independent risk for cardiac thrombo-embolism.

In our study it was found that the average length of the LAA was 3.2103 ± 0 .55075 cm and the average angulation was 62.02 ± 15.86113 degrees which is inconsistent with findings in other studies[15]. This could be because our study population was otherwise relatively normal. Whether or not this difference gives our population an advantage in decreasing the chances of a cardioembolic stroke/ TIA needs to be evaluated in detail. The main limitation of our study was our inability to conduct parallel transesophageal studies upon our patients and the comparison of our relatively normal patients with those having atrial fibrillation in international studies.

In conclusion, the morphology of LAA in our population is not much different from that reported in international literature, although the size of LAA was comparatively small and this being first of its kind study conducted in Pakistan will act as a reference point for the pre procedure analysis of our patients in future.

CONFLICT OF INTEREST

This study has no conflict of interest to declare by any author.

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