Morphology of the Left Atrial Appendage: Prevalence and Gender Difference in a Kenyan Population

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Abstract

Introduction The left atrial appendage is the site of origin of thrombi in 90% of cardioembolic stroke. Although literature reports a higher risk of cardioembolic stroke among blacks and females, it is unclear whether this is due to preponderance of specific left atrial appendage morphologies in these groups since there is paucity of data. This study describes the left atrial appendage morphology in a Black Kenyan population and assesses for existence of gender differences.

Materials and Methods Ninety one (91) human hearts (50 male and 41 female) were obtained from autopsy specimens after ethical approval. The morphological types of the left atrial appendage were determined and classified as cauliflower, Windsock, Chickenwing and cactus. Data were analyzed using Statistical Package for Social Sciences. The frequencies of the morphological types was determined and Chi square applied to check for gender differences. A p-value of < 0.05 was considered statistically significant at 95% confidence interval.

Results and Conclusion There were 27 cauliflower (29.7%), 26 Windsock (28.6%), 25 Chickenwing (27.4%) and 9 cactus (14.3%) morphological types of left atrial appendage. Cauliflower and cactus types were more prevalent in males, while Windsock and Chickenwing types were more prevalent in females ($p = 0.537$). There are no statistically significant gender differences in the left atrial appendage morphology types in this sample black Kenyan population. The higher frequency of both the risky cauliflower and the protective Chickenwing morphologies warrants assessment of left atrial appendage morphological types in management of high risk cardioembolic stroke patients in this setting.

Keywords
- left atrial appendage
- gender
- blacks

Introduction

The left atrial appendage (LAA) or left auricle is a small muscular pouch attached to the left atrium. It is constricted at its atrial junction hence demarcating it from the left atrium.[1] Its morphology varies in size, shape and the number of lobes. Based on these features, the LAA has been classified into Windsock, Chickenwing, cactus or cauliflower types.[2,3]

These morphologies may influence an individual's risk of cardioembolic stroke,[4,5] the risk being highest in cauliflower morphology and least in Chickenwing morphology.[2,4] This variation in risk arises from a difference in contractility in the morphologies since low contractility predisposes to thrombi formation.[6–8]

Cardioembolic stroke (CES) risk shows gender and racial variations. It is higher in the females and blacks compared

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with males and other races.[9,10] The highest risk of CES occurs in individuals with atrial fibrillation (AF) patients who have a 5-fold increase in risk.[11] Despite low prevalence of AF in females and blacks,[12,13] these groups are known to have a higher risk of CES in the event of AF. It is unclear whether the higher predisposition in blacks and females is due to presence of high risk morphology in these groups. This study therefore aimed to determine frequency of LAA morphological types in a Kenyan population and assess for existence of gender differences. This knowledge may further elucidate the basis of variation in CES risk.

Materials and Methods

A total of ninety one (91) human hearts, 50 male and 41 females, were obtained after exclusion of 4 hearts (3-dilated cardiomyopathy, 1- aortic valve replacement) from autopsies conducted at Chiromo, Nairobi city and Kenyatta National Hospital mortuaries following ethical approval from Kenyatta National Hospital/University of Nairobi Ethics and Research Committee (KNH-UoN/ERC). This study was done in conformation to the Declaration of Helsinki. Informed written consents were obtained from the next of kin of the deceased prior to subject inclusion. Subject confidentiality was ensured by use of case numbers instead of names throughout the study for the purposes of identification. Hearts with any obvious gross cardiomegaly, observable gross pathology for example endocarditis, observable congenital defects such as LAA agenesis and heart septal defects, history of surgery and deformed LAA were excluded with the help of expert advice from the attending pathologists. Normal heart specimens of males and females of age ranging from 18–80 years who died of non-cardiac pathology and had grossly normal anatomy of the LAA were included in this study.

During the autopsies, routine standard Y incision were made and the thoracic cage opened. The pericardium was excised longitudinally and the hearts were harvested by excising the great vessels 2 cm from the base and the inferior vena cava was excised close to the thoracic diaphragm. The left atrium and the left atrial appendage were identified. On the external surface, the length of the LAA was measured using a vernier caliper, Pittsburg™, as the longest dimension from the left atrial-LAA junction (which is constricted) to the apex. Moreover, angulation of bend was measured, in presence of a bending morphology (Windsock and Chickenwing), using a goniometer. An incision was made on the posterior wall of the left atrium extending from the roof of the left atrium to the atrio-ventricular junction (►**Fig. 1**). The two flaps were then reflected laterally so as to expose the endocardial surface of the left atrium. This allowed for internal assessment of the LAA (►**Fig. 1**). The LAA morphology type was determined by external observations of shape, measurement of length and confirmation of number of lobes which was done using a probe into the LAA. According to classification by Wang et al[3] and Di Biase et al. (2012),[4] a lobe is regarded as a visible outpouching marked by an external crease and can internally accommodate a 2 mm probe. The different morphological types were determined using the shape, overall length, degree of bend from the principal axis, and number of lobes. Chickenwing morphology $>$ 4 cm, with a dominant lobe which bend some distance from the ostium $<$ 100° (►**Fig. 2a**). Cactus morphology $<$ 4 cm with secondary lobes (►**Fig. 2b**). Windsock morphology was regarded as having length $>$ 4 cm with a dominant lobe and bend $>$ 100° (►**Fig. 2c**). It could have secondary lobes. Cauliflower morphology $<$ 4 cm with no forked lobes (►**Fig. 2d**). The shape, number of lobes and length were recorded in the data sheet.

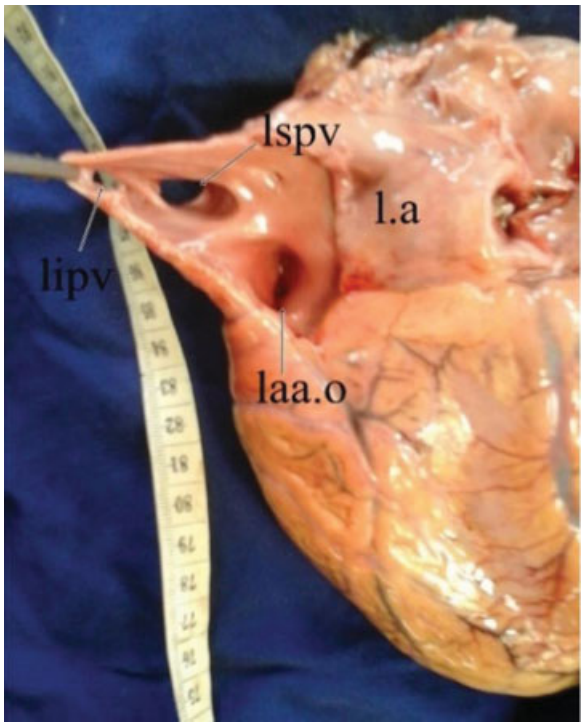

Fig. 1 Image showing method of internal assessment of the LAA assessment. L.a: left atrium (posterior wall); Laa.o: LAA ostium; lspv: left superior pulmonary vein ostium; lipv: left inferior pulmonary vein ostium.

Data were analyzed using Statistical Package for Social Sciences (SPSS) (Version 21.0, Chicago, Illinois). The frequencies of the morphological types was determined. Percentage prevalence of the morphological types based on gender was performed. Chi square was applied to check for gender differences. A p-value of $<$ 0.05 was considered statistically significant at 95% confidence interval.

Results

All the four varieties of LAA were observed in the current study (►**Fig. 3**) with the highest prevalence of cauliflower (29.7%) and least cactus (14.3%). Cauliflower, Chickenwing and Windsock morphologies were of almost similar prevalence (►**Fig. 4**).

Cauliflower was the most prevalent morphology in males compared with females who had Chickenwing as the most prevalent morphology. Cactus morphology was the least prevalent in both the male and female group. Gender

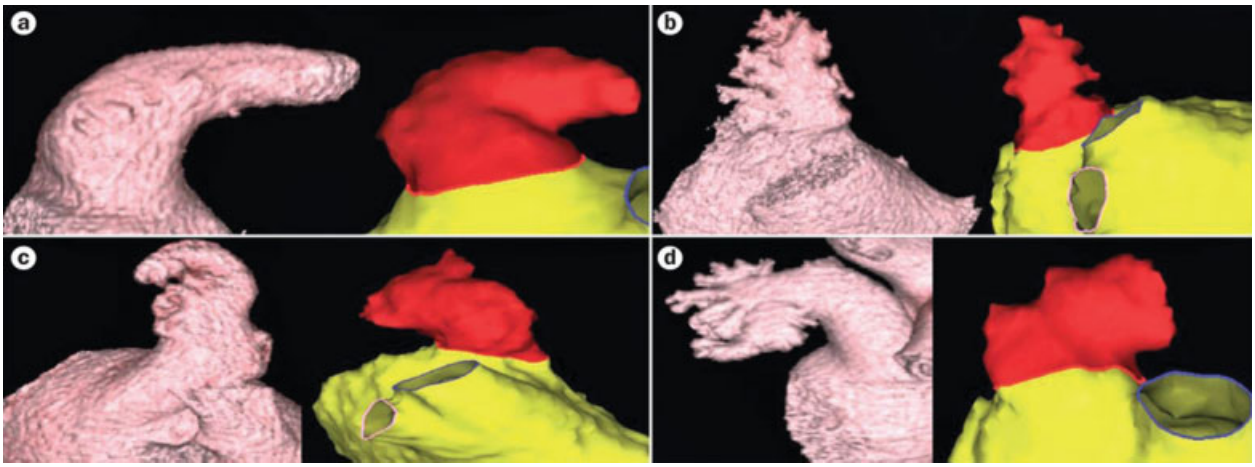

Fig. 2 Image showing LAA morphology types. (a) Chickenwing; (b) cactus; (c) Windsock; (d) cauliflower. Classification by Di Biase et al. (2012).[4]

difference in the morphologies was however not statistically significant ($p = 0.537$) (►**Table 1**).

Discussion

Cauliflower, Chickenwing and Windsock morphologies were more frequent and present in almost similar prevalence while cactus morphology was the least frequent. The similar proportions of the LAA morphologies in this study is contrary to other studies which report a wider variability in the proportions (►**Table 2**). On account of the similar proportions observed, it is conceivable that each individual from this study population had a relatively equal probability of having any of the four morphological types as opposed to other populations which had various preponderance of specific morphologies. It is however unclear whether such a pattern of similar proportion is characteristic of black populations since there was no literature among black populations for comparison.

Cauliflower morphology was the most prevalent morphology in this study and is higher than existing data from other populations (►**Table 2**). Although almost similar proportions of cauliflower have been recorded recorded among American,[3] Turkish [14] and Finish populations,[5] cauliflower was not the most prevalent morphological type among these populations. In contrast, Cauliflower morphology was least frequent among Italians.[4] This morphology is associated with the highest risk of cardioembolic stroke in the event of atrial fibrillation [AF].[2] Infact, it is thought to have, as high as, an 8-fold risk compared with Chickenwing morphology which is noted as the least risky morphology.[4] Despite the high frequency of cauliflower (29.7%), existing similar proportions of non-cauliflower morphologies suggest that the frequency of LAA morphology might only partially explain high CES risk in this black population. Additional studies assessing multiple risk factors among black CES patients are required to completely understand the basis of CES predisposition in blacks.

Chickenwing morphology was common in this study population (27.4%) and this was only comparable to findings by a study by Di Biase et al. [4] who currently report the highest prevalence in literature. Other studies report Chickenwing as the least prevalent morphology.[5,6,14] Chickenwing morphology is suggested to be the least risky morphological type with regards to CES in the event of AF.[4] Although higher risk of CES is seen among Blacks when compared with other races,[10] the high prevalence of the least risky morphology in this black population and low prevalence reported among non-black populations is paradoxical. It is therefore plausible that other factors might be implicated in influencing cardioembolic stroke risk variation between these races. Moreover, despite the advantage of lower risk of CES in Chickenwing morphology, the bending morphology confers a procedural challenge during insertion of LAA occlusion devises and has higher periprocedural risk of complication during AF catheter ablation.[15,16] The high prevalence of Chickenwing morphology in our population should be taken into consideration during surgical management of CES risks.

The prevalence of Windsock morphology was high (28.6%), only second to cauliflower morphology in our study population. Windsock morphology was also the most common morphology type in other studies.[3,5,14] Cactus morphology on the other hand shows a large interpopulational variability in literature (►**Table 2**). It was the least common in the present study in accord with findings in an American population [3] but differing greatly with the Japanese who found it as the most prevalent morphology.[6]

The current study also showed that males and females did not differ significantly in the prevalence of LAA morphological types. Females are known to have higher risk of CES compared with males in the event of AF.[9,17] This absence of gender difference in in the prevalence of high risk LAA morphology types therefore suggests a possibility of other factors underlying the difference in CES risk. For example, various hematological differences between males and females with atrial fibrillation have been suggested to play a role in the variation in CES risk. These include a higher concentration of prothrombotic factors such as tissue plasminogen activator, Von willebrand factor in females compared with males.[9] Further studies are therefore warranted to elucidate the basis of gender variation in risk of CES.

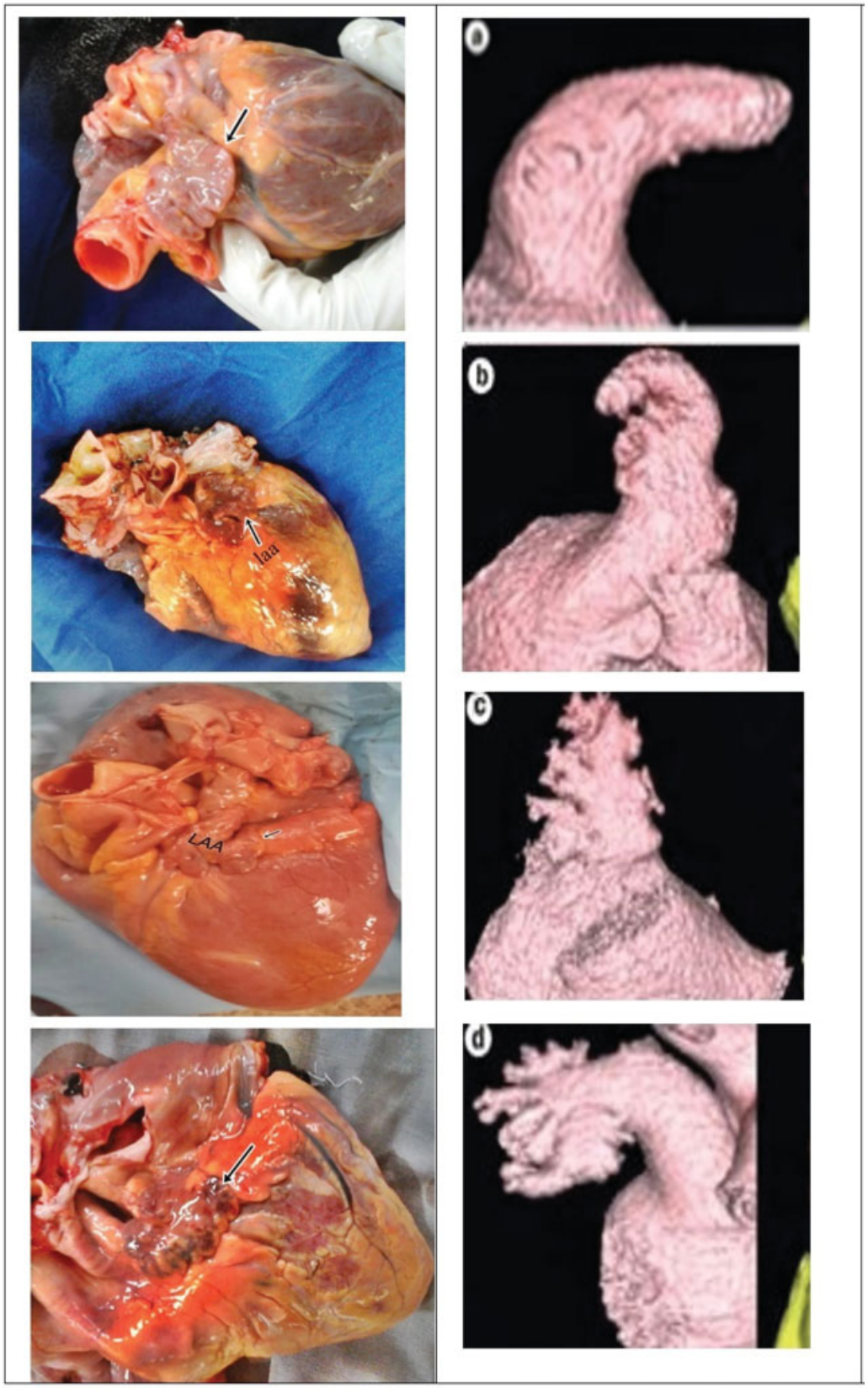

Fig. 3 (a) chickening; (b) Windsock; (c) Cactus; (d) Cauliflower (arrow pointing to LAA, LAA- left atrial appendage). Comparison CT images based on classification of Di Biase et al. (2012).[4]

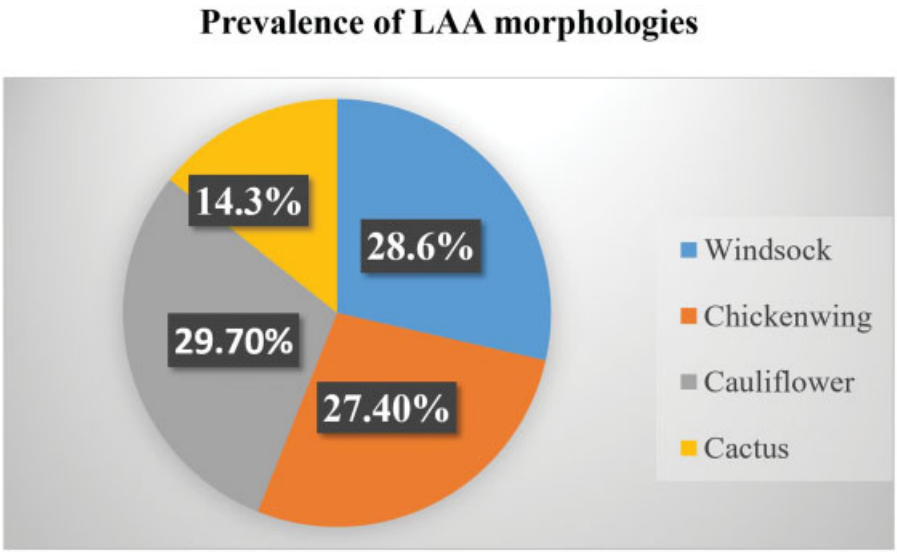

Fig. 4 Chart showing prevalence of LAA morphologies.

Table 1 Table showing sex difference in the prevalence of LAA morphology types. Percentage prevalence is shown for both sexes. Chi square analysis was done for sex differences in the proportions of the LAA types

shapes	males/50	females/ 41	(x/ 91)% male	(x/ 91)% female
Windsock	14	12	15.38462	13.18681
Chickenwing	12	13	13.18681	14.28571
Cactus	8	5	8.791209	5.494505
cauliflower	16	11	17.58242	12.08791

Table 2 Prevalence of LAA morphology types in various populations

	Population	Chickenwing	Windsock	Cauliflower	Cactus
Present Study	**KENYAN**	**27.4%**	**28.6%**	**29.7%**	**14.3%**
Di Biase et al. (2012)[4]	Italian	**48%**	19%	3%	30%
Wang et al. (2010)[3]	American	18.3%	46.7%	29.1%	5.9%
Korhonen et al. (2015)[5]	Finish	**10%**	**67.5%**	25%	20%
Fukushima et al. (2016)[6]	Japanese	12%	32.3%	16.7%	38.5%
Ucerler et al. (2013)[14]	Turkish	12%	38%	26%	24%

Conclusion

There are no statistically significant gender differences in the LAA morphology types in this sample black Kenyan population. The Cauliflower, Chickenwing and Windsock morphologies were more frequent and present in almost similar prevalence. Cactus morphology was the least frequent. High frequency of both the risky cauliflower morphology and protective Chickenwing morphology warrants assessment of LAA morphological types in management of high risk CES patients in this setting.

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References

1 Standring S. Gray's anatomy: the anatomical basis of clinical practice. 40th ed. Edinburgh: Churchill Livingstone; 2008:1019–1020
2 Kimura T, Takatsuki S, Inagawa K, et al. Anatomical characteristics of the left atrial appendage in cardiogenic stroke with low CHADS2 scores. Heart Rhythm 2013;10(06):921–925
3 Wang Y, Di Biase L, Horton RP, Nguyen T, Morhanty P, Natale A. Left atrial appendage studied by computed tomography to help planning for appendage closure device placement. J Cardiovasc Electrophysiol 2010;21(09):973–982
4 Di Biase L, Santangeli P, Anselmino M, et al. Does the left atrial appendage morphology correlate with the risk of stroke in patients with atrial fibrillation? Results from a multicenter study. J Am Coll Cardiol 2012;60(06):531–538

5 Korhonen M, Muuronen A, Arponen O, et al. Left atrial appendage morphology in patients with suspected cardiogenic stroke without known atrial fibrillation. PLoS One 2015;10(03):e0118822
6 Fukushima K, Fukushima N, Kato K, et al. Correlation between left atrial appendage morphology and flow velocity in patients with paroxysmal atrial fibrillation. Eur Heart J Cardiovasc Imaging 2016;17(01):59–66
7 Makino N, Nishino M, Ishiyama A, et al. Left atrial appendage morphologic pattern determined by computed tomography is a novel predictor of high risk patient for embolism with atrial fibrillation. J Am Coll Cardiol 2013;61(Suppl 10):E272 Doi: 10.1016/S0735-1097(13)60272-7
8 Yamamoto M, Seo Y, Kawamatsu N, et al. Complex left atrial appendage morphology and left atrial appendage thrombus formation in patients with atrial fibrillation. Circ Cardiovasc Imaging 2014;7(02):337–343
9 Fang MC, Singer DE, Chang Y, et al. Gender differences in the risk of ischemic stroke and peripheral embolism in atrial fibrillation: the AnTicoagulation and Risk factors In Atrial fibrillation (ATRIA) study. Circulation 2005;112(12):1687–1691
10 White H, Boden-Albala B, Wang C, et al. Ischemic stroke subtype incidence among whites, blacks, and Hispanics: the Northern Manhattan Study. Circulation 2005;111(10):1327–1331
11 Blackshear JL, Odell JA. Appendage obliteration to reduce stroke in cardiac surgical patients with atrial fibrillation. Ann Thorac Surg 1996;61(02):755–759
12 Chugh SS, Havmoeller R, Narayanan K, et al. Worldwide epidemiology of atrial fibrillation: a Global Burden of Disease 2010 Study. Circulation 2014;129(08):837–847
13 Hernandez MB, Asher CR, Hernandez AV, Novaro GM. African american race and prevalence of atrial fibrillation:a meta-analysis. Cardiol Res Pract 2012;2012:275624
14 Üçerler H, İkiz ZA, Özgür T. Human left atrial appendage anatomy and overview of its clinical significance. Anadolu Kardiyol Derg 2013;13(06):566–572
15 De Backer O, Arnous S, Ihlemann N, et al. Percutaneous left atrial appendage occlusion for stroke prevention in atrial fibrillation: an update. Open Heart 2014;1(01):e000020
16 Kosiuk J, Nedios S, Kornej J, et al. Impact of left atrial appendage morphology on peri-interventional thromboembolic risk during catheter ablation of atrial fibrillation. Heart Rhythm 2014;11(09):1522–1527
17 Appelros P, Stegmayr B, Terént A. Sex differences in stroke epidemiology: a systematic review. Stroke 2009;40(04):1082–1090