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Pictorial Essay

CT imaging for left atrial appendage closure: A review and pictorial essay

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ABSTRACT

Cardioembolic stroke is an important complication of atrial fibrillation. The thrombus responsible for this arises from the left atrial appendage (LAA) in >90% of cases, providing the rationale for device-based LAA closure as a means of thromboprophylaxis. Although oral anticoagulant therapy remains the mainstay for reducing the risk of stroke in patients with atrial fibrillation, an increasing number of patients, particularly those ineligible for conventional pharmacotherapy, are being offered percutaneous left atrial appendage closure. Cardiovascular CT can provide important information to assess the suitability of patients for LAA interventions and guide device selection and approach. The high spatial resolution and multiplanar capability of contemporary contrast-enhanced gated multidetector cardiovascular CT render it an ideal modality for noninvasively evaluating patients before intervention and assessing patients after intervention both for complications and procedural outcome.

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1. Background

Atrial fibrillation (AF) is the most common sustained cardiac arrhythmia and is a frequent cause of cardioembolic stroke, particularly in the elderly.[1] Although anticoagulation with warfarin, and more recently with novel orally active direct thrombin or factor X_a inhibitors, remains the principal strategy for stroke prevention in these patients; a substantial number have either relative or absolute contraindications to oral anticoagulants or experience significant bleeding complications. In patients with nonvalvular AF, 90% of the thrombi responsible for stroke are thought to originate in the left atrial appendage (LAA).[2,3] This provides a strong rationale for percutaneous device–based closure

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of the LAA as an alternative to oral anticoagulation. Such procedures may be undertaken independently or at the same time as ablation procedures to treat the underlying AF.

The high spatial resolution and noninvasive multiplanar capability of contemporary contrast-enhanced electrocardiography-gated cardiovascular multidetector CT render it an important modality for evaluating patients being considered for such procedures and for assessing patients for procedural success and complications after intervention. This review describes the relevant protocols, clinical anatomy, and procedural factors pertinent to the cardiothoracic imager and provides a pragmatic approach to the use of CT to guide and assess the success of percutaneous LAA occlusion.

2. Clinical and radiologic anatomy

The LAA usually arises as a finger-like projection from the left atrium and forms part of the left border of the heart, superior to the left ventricle and inferior to the main pulmonary trunk (Fig. 1).

The tip or apex of the LAA can vary in position but usually points anteriorly and superiorly coming into close apposition with the proximal left anterior descending coronary artery, the proximal circumflex artery, and the pulmonary trunk.[4] It may point inferiorly and posteriorly or behind the aorta into the transverse pericardial sinus. A number of different shapes have been described, but for device deployment purposes, the LAA can be considered as multilobed with an obvious bend (chicken wing morphology; Fig. 2A), single lobed without a bend (windsock morphology; Fig. 2B), multilobed without an obvious bend or dominant lobe (cauliflower; Fig. 2C), or multilobed without an obvious bend but with a dominant lobe (cactus; Fig. 2D).[5] Different morphologies may be associated with different risks of thromboembolism, with the chicken wing morphology thought to confer the lowest risk.[6]

Although the endocardial surface of the LAA os is generally smooth, the interior of the appendage is covered with pectinate muscles which may cause apparent filling defects or pseudothrombus on CT and can also mimic the appearances of thrombus on transesophageal echocardiography (TEE). The wall of the LAA in between these pectinate muscles is often paper thin, rendering it at risk of perforation during catheter manipulation and device deployment.[7]

The LAA os may be either circular or elliptical and is separated from the origins of the pulmonary veins by the left lateral ridge (Fig. 3). The relation of the ellipsoid type to the left lateral rim of the atrium can make measurements of os dimensions challenging, particularly with echocardiographic techniques that lack the endocardial definition offered by CT. The spatial configuration of the LAA os in relation to the left superior pulmonary vein (LSPV) is also of paramount importance given the potential for devices to impair pulmonary venous return or interfere with future ablation procedures. This can particularly be an issue in the two-thirds of patients in whom the LAA and LSPV orifices are found in close proximity at the same level.[5] Deployed devices may interfere with access to the LSPV for subsequent ablation procedures. In a fifth of cases, it is superior to the LSPV, and in the remainder, inferior.[5] Other surrounding structures that

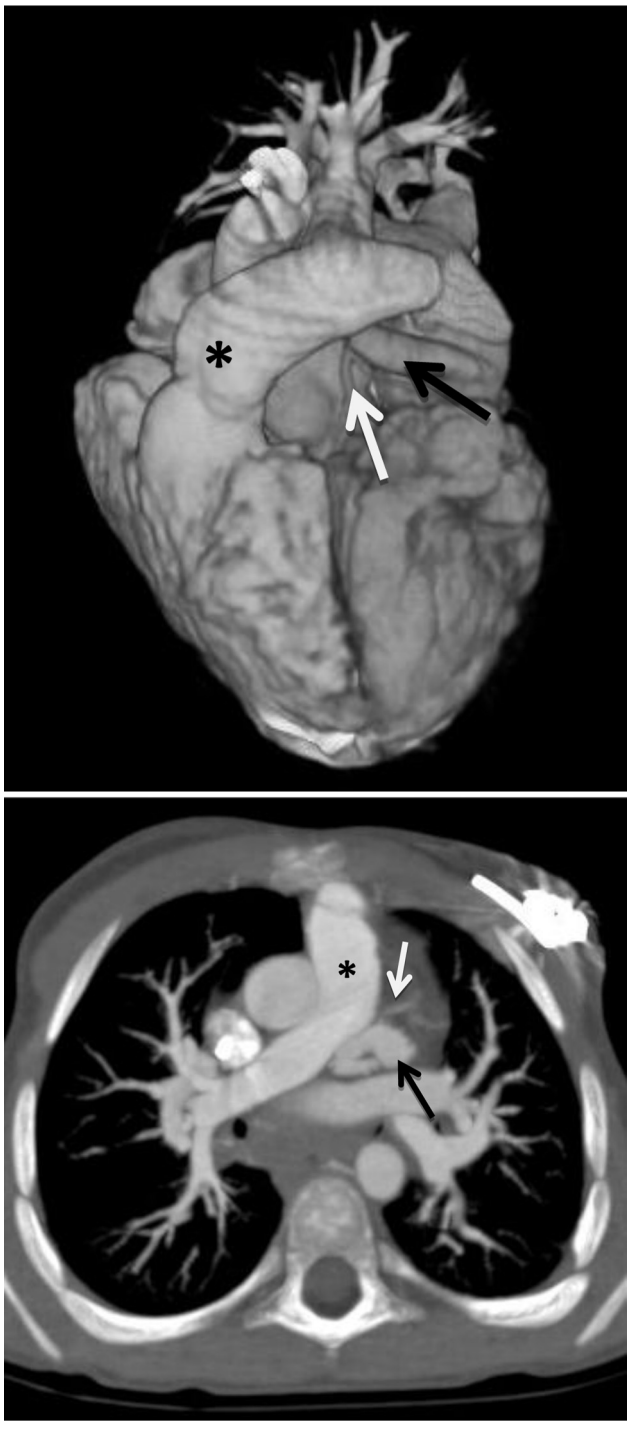

Fig. 1 – Volume-rendered (*top*) and axial images (*bottom*) illustrating the location and anatomy of the left atrial appendage (LAA) and its apex. In this example, the LAA (*black arrow*) apex lies behind the main pulmonary trunk (*asterisk*), the so-called "retro-PA" configuration, and is related to the left anterior descending coronary artery (*white arrow*).

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