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Case Report

Left atrial anomalous bands associated with arrhythmia detected by computed tomography during coronary CT angiography: a case series

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Abstract: False tendons are fibrous cord-like malformations within the cardiac chambers, with only approximately 2% occurring in the left atrium. In this study, we analyzed the clinical and imaging characteristics of multiple cases of left atrial false tendons (LAFTs) to provide additional clinical insights into this uncommon anatomical variant. A total of 10 representative LAFTs cases identified between September 2015 and June 2022 were included in this analysis. All patients were diagnosed using coronary computed tomographic angiography (CCTA). A retrospective analysis was performed using data retrieved from the Radiology Information System (RIS) and Picture Archiving and Communication System (PACS). Clinical history and electrocardiographic data were reviewed, and Xelis software was used for three-dimensional reconstruction to evaluate the morphology, anatomical position, and length of the LAFTs. Among the patients, eight exhibited arrhythmias: five had coarse, short longitudinal muscle bundles associated with atrial premature beats, while three had delicate longitudinal bundles accompanied by nonspecific T-wave abnormalities. The remaining two patients showed no specific symptoms or arrhythmic findings. Imaging analysis revealed that longitudinal and transverse muscle bundles measured approximately 2.5-3.0 cm and 3.5-4.4 cm in length, respectively, with attachments commonly located between the anterior and posterior walls of the left atrium or between the interatrial septum (near the fossa ovalis) and the lateral wall. A potential correlation between LAFTs and electrocardiographic abnormalities was observed. These findings suggest that LAFTs may be considered in the differential diagnosis when evaluating patients with unexplained arrhythmias undergoing CCTA.

Keywords: Left atrial anomalous band, cardiac arrhythmias, computed tomography angiography, case series

Background

False tendons (FTs) are fibrous or fibromuscular structures located within the cardiac chambers, primarily found in the atria and the left ventricle, but typically absent in the right ventricle [1]. They often involve connections between the papillary muscles and the mitral valve leaflets in the left ventricle. FTs have also been referred to as fibromuscular bands, ectopic tendons, or accessory papillary muscles due to their variable morphology and attachment sites. False tendons are predominantly found in the left ventricle, with reported prevalence ranging from 0.5% to 74%, depending on the diagnostic method and study population [2]. Their presence is typically considered a standard anatomical variant; however, in some cases, they have been associated with arrhythmias, conduction abnormalities, or altered intracardiac flow dynamics. Several studies have suggested that left ventricular false tendons may be associated with premature contractions, abnormal cardiac repolarization, heart murmurs, and other clinical phenomena. However, there is limited clinical reporting on the correlation between left atrial false tendons (LAFTs) and these phenomena [3-6]. Most patients with left atrial false tendons (LAFTs) are clinically asymptomatic, and their presence is often detected incidentally. Nonetheless, some studies have suggested potential associations between LAFTs and conditions such as mitral regurgitation, atrial fibrillation, and conduction disturbances [7-9]. Therefore, research on LAFTs may offer valuable insights into the

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broader spectrum of cardiac false tendons. In this study, we analyzed 10 cases of LAFTs by integrating clinical presentations with imaging findings, aiming to enhance the current understanding of their morphological features and potential clinical relevance.

Case presentation

Clinical information

This study collected data from 10 confirmed cases of LAFTs diagnosed and treated at our hospital from September 2015 to June 2022, depending on the different manifestations of their cardiac symptoms. The age range of the patients was 43 to 75 years old. Among them, 6 cases reported chest discomfort, 8 cases had hypertension, 5 cases presented with angina pectoris, 4 cases experienced exertional dyspnea, and 6 cases reported palpitations. Auscultation revealed systolic and diastolic murmurs in 9 cases. The final diagnosis of the patients was based on coronary computed tomographic angiography (CCTA).

CT scan parameters

All patients underwent CCTA using a Siemens Dual-Source CT (Somatom Definition Flash). Patients were positioned supine, and scanning was performed head-to-foot, covering the range from 10 mm below the tracheal prominence to the level of the cardiac diaphragm. Before the scan, all patients received strict breath-holding training at least twice. After being positioned on the scanning table, each patient was administered one sublingual tablet of 0.5 mg nitroglycerin. Standard electrocardiographic monitoring electrodes were attached to the anterior chest wall, and a double-barreled high-pressure injector (UIRICH, Germany, model: Missouri-XD2001) was connected to a vein puncture in the right antecubital fossa. The main diagnostic criteria for premature atrial contractions (PACs) are changes observed in the electrocardiogram (ECG) [10-12], including the following: (1) Premature appearance of ectopic atrial P' waves, with a different shape compared to sinus P waves in the same lead; (2) Following the atrial P' wave, there is often a supraventricular QRS-T wave with a P'R interval ≥0.12 s; (3) The coupling interval of consecutive premature contractions is mostly fixed; (4) If a QRS complex does not follow the premature atrial P' wave, it is termed non-conducted premature atrial contractions (PACs); (5) Compensation often needs to be completed.

To minimize interference from superior vena cava artifacts, the bolus-tracking trigger plane was adjusted slightly to the left of the ascending aorta. Patients first underwent a breath-hold chest positioning scan and a non-contrast calcium scoring scan. Subsequently, 20 ml of normal saline was pre-injected to ensure the patency of the catheter, followed by 50 ml of iodixanol (350 mg I/ml, trade name: Optiray) and another 50 ml of normal saline at a flow rate of 5 ml/s. The DS_CorAdSeq sequence scan was then performed with the following parameters: detector collimation width of 0.6 mm, Z-axis flying focal spot technology for data acquisition, reconstruction slice thickness of 0.75 mm, gantry rotation time of 0.28 s, temporal resolution of 75 ms per single-sector reconstruction, tube voltage of 120 kV, tube current of 344 mAs per rotation, and automatic current modulation using CARE Dose 4D. The optimal scan phase was set between 35% and 75% of the R-R interval. Post-processing was conducted using INFINITE Xelis software, including multiplanar reconstruction (MPR), virtual reality (VR), and CT virtual endoscopy.

CTA scanning

CCTA scans revealed that among all included patients, there were 5 cases each of transverse and longitudinal LAFTs. The longitudinal muscle bundles ranged from 2.5 to 3.0 cm, attaching between the anterior and posterior walls of the left atrium, exhibiting a relatively coarse and short morphology. The transverse muscle bundles ranged from 3.5 to 4.4 cm, attaching between the posterior part of the interatrial septum fossa ovalis and the left lateral wall, exhibiting a relatively thin and elongated morphology. Among the patients, eight had associated arrhythmias, with 5 having coarse, short longitudinal muscle bundles, all accompanied by atrial premature beats. In 3 cases with delicate, longitudinal muscle bundles, all exhibited nonspecific T-wave abnormalities. Additionally, 2 cases showed no specific clinical discomfort or manifestations of arrhythmia. More details are shown in **Table 1** and Supplementary Table 1.

Table 1. The basic information of the including patients

No.	Gender	Age (years)	Diagnostic methods	Symptomatic	Arrhythmia (yes/no)	Atrial premature beats (yes/no)	T-wave abnormalities (yes/no)	Muscle bundle (H/V)	Length (cm)	Location
1	Male	55	DSCT	Chest pain	yes	yes	no	V	2.6	Front wall - back wall
2	Female	43	DSCT	ECG abnormality	yes	yes	no	V	2.6	Front wall - back wall
3	Female	64	DSCT	Chest pain (2 h)	yes	yes	no	V	3.0	Front wall - back wall
4	Female	75	DSCT	Chest pain	yes	yes	no	V	2.5	Front wall - back wall
5	Female	64	DSCT	Precordial discomfort (2 m)	yes	yes	no	V	2.9	Front wall - back wall
6	Female	59	DSCT	Palpitations, chest tightness (>1 d)	yes	no	yes	H	4.4	Fossa ovalis - left wall
7	Male	67	DSCT	Repeated episodes of chest and back pain (1 m)	yes	no	yes	H	4.2	Fossa ovalis - left wall
8	Female	58	DSCT	Chest discomfort (>1 d)	yes	no	yes	H	3.9	Fossa ovalis - left wall
9	Male	61	DSCT	Palpitations, chest tightness (2 d)	no	no	no	H	3.5	Fossa ovalis - left wall
10	Male	70	DSCT	intermittent palpitations (5 d)	no	no	no	H	3.6	Fossa ovalis - left wall

DSCT, dual-source dual-energy CT imaging; ECG, Electrocardiographic abnormality; H, Horizontal; V, Vertical.

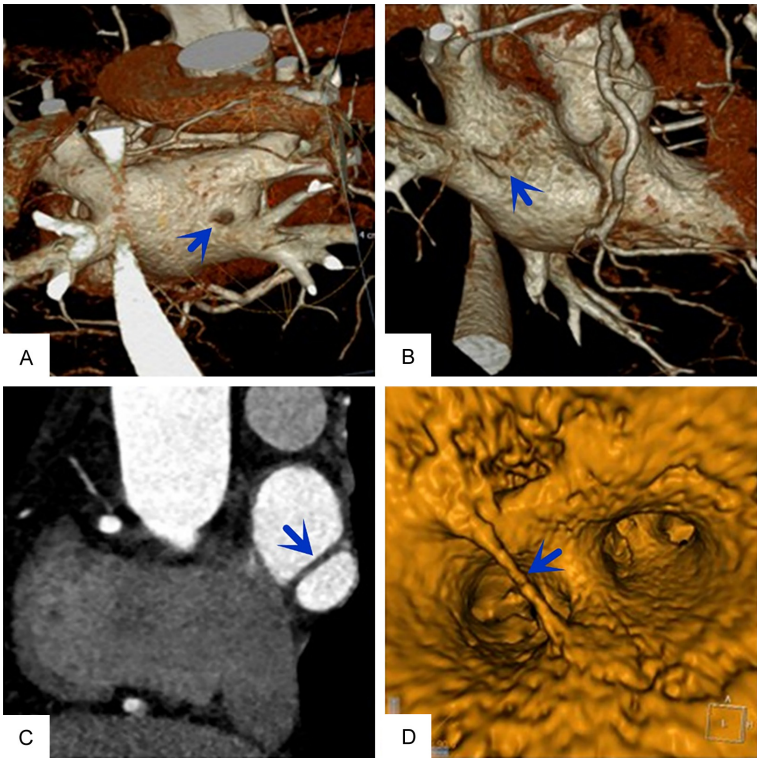

Figure 1. Longitudinal left atrial false tendon in a female patient. The results of three-dimensional reconstruction show an abnormal stripe-like shadow in the left atrium, suggesting a false tendon (blue arrow). A. A coarse longitudinal muscular bundle (~3.0 cm) extends from the posterior to the anterior wall of the left atrium. B. A slender longitudinal tendon-like structure (~2.8 cm) extends from the interatrial septum to the left atrial lateral wall. C. A transverse muscular bundle (~4.0 cm) spans from the posterior to the lateral wall of the left atrium. D. A thin fibrous strand (~2.5 cm) extends from the superior to the posterior wall of the left atrium.

Typical cases

Longitudinal left atrial false tendon: A 54-year-old female patient presented to the cardiology outpatient department of our hospital complaining of chest discomfort for one week. The patient had a history of hypertension for seven years with irregular medication. Laboratory tests revealed no significant abnormalities in the routine blood work. Coronary angiography indicated generally normal coronary arteries. Three-dimensional reconstruction (VR, maximal intensity projection) revealed an abnormal stripe-like shadow in the left atrium (**Figure 1**), and the electrocardiogram showed premature atrial beats.

Transverse left atrial false tendon: A 48-year-old female patient complained of exertional dyspnea and palpitations for one month, worsening over the last week. Auscultation revealed systolic and diastolic murmurs at the apex of the lungs. Chest X-ray showed a mild increase in the cardiothoracic ratio to 0.55 (usually 0.50). Coronary CTA three-dimensional reconstruction revealed a stripe-like shadow between the walls of the left atrium (**Figure 2**). The electrocardiogram showed sinus rhythm and nonspecific ST-T segment changes. Echocardiography revealed left ventricular dilation, with a left atrium (LA) size of 4.3 cm (normal range for females: 1.9-3.3 cm), left ventricular diameter (LVD) of 6.7 cm (normal range for females: 3.5-5.0 cm), and left ventricular end-systolic diameter (LVESD) of 4.6 cm (normal range for females: 2.0-3.5 cm). The left ventricular ejection fraction (LVEF) was 52%, slightly below the normal range (usually ≥60%). The thickness of the interventricular septum (IVS) was 1.4 cm (normal range: 0.6-1.2 cm), and the posterior wall (PW) thickness was 1.2 cm (normal range: 0.8-1.1 cm).

Discussion and conclusion

Left atrial false tendons (LAFTs), also known as left atrial anomalous bands (LAABs), are fibrous band-like structures composed of myocardial fibers that contain Purkinje fibers capable of conducting cardiac electrical signals. Due to their conductive properties, LAFTs are believed to play a potential role in the formation and propagation of arrhythmias. Previous studies have reported associations between left atrial anomalous bands and congenital cardiac structural abnormalities such as Chiari's network and patent foramen ovale, suggesting a possible embryological basis for their development [13, 14]. In addition, another study has indicated a significant correlation between supraventricular arrhythmias and cardiac false tendons [8]. In our study, two included cases exhibited similar diagnostic characteristics - both presented with LAFTs accompanied by arrhyth-

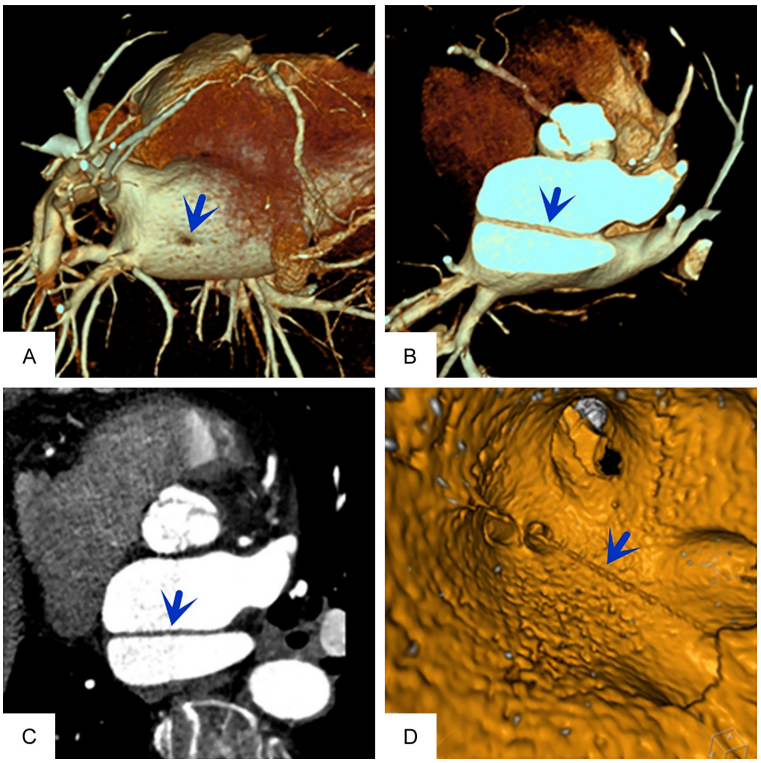

Figure 2. Transverse left atrial false tendon in a female patient. Coronary Computed Tomographic Angiography (CTA) three-dimensional reconstruction reveals a stripe-like shadow between the left atrium's walls, suggesting a false tendon (blue arrow). A. A thick longitudinal muscular bundle (~3.2 cm) extends from the posterior to the anterior wall of the left atrium. B. A fine fibrous strand (~2.6 cm) stretches from the fossa ovalis to the lateral wall of the left atrium. C. A transverse muscular bundle (~3.8 cm) connects the posterior and lateral walls of the left atrium. D. A delicate linear structure (~2.4 cm) runs from the superior wall to the posterior wall of the left atrium.

mias - further supporting the clinical relevance of the findings reported in the literature.

False tendons most commonly occur in the left ventricle [15, 16], with the most frequent locations being the left and right atria [2, 17]. In a study by Yamashita et al. involving 1,100 patients with anomalous bands, the incidence in the left atrium was only 2% [18]. The most common site in the left atrium is the endocardium near the fossa ovalis. Based on the different orientations of LAFTs, they are classified into longitudinal types parallel to the atrial septum and transverse types perpendicular to the interventricular septum. There are also case reports, such as one by Baran et al. [3], showing a patient with LAFTs involving the mitral valve. During cardiac diastole, as the atrial volume decreases and blood is pumped into the left ventricle, the relaxed anomalous band moves along with the motion of the mitral valve, thus not restricting the complete opening of the mitral valve. In 2016, Koutsogiannis et al. [6] reported a rare case of an intracardiac false tendon between the left atrial appendage and the posterior wall of the left ventricle in a 15-year-old adolescent. However, this patient did not exhibit any clinical symptoms.

The primary methods for detecting atrial structural anomalies are echocardiography and CT. Echocardiography is used for routine observation of the morphological and functional aspects of the heart, providing some assistance in identifying intracardiac abnormal structures. However, echocardiography may have limitations in displaying detailed coronary information, and there is a possibility of missed diagnosis when the probe angle is parallel to the abnormal intracardiac structures.

CCTA examinations, utilizing post-processing techniques such as multiplanar reconstruction, maximal intensity projection, and volume rendering, allow for cardiac reconstruction from any angle and three-dimensional visualization of normal and abnormal anatomical structures. This helps overcome the limitations in detail provided by echocardiography. With the application of dual-source CT, conditions like arrhythmias and tachycardia are no longer contraindications for cardiac CTA. In the future, as cardiac CTA becomes more widely used in clinical practice, more patients with intracardiac false tendons associated with arrhythmias will likely be identified. Therefore, this technology is expected to have a significant impact on the clinical decisions of cardiac surgeons.

This study has several limitations. First, due to the rarity of left atrial false tendons (LAFTs),

only ten cases were included over a seven-year period, resulting in a relatively small sample size that may limit the generalizability of our findings. Second, as a retrospective study based solely on coronary CT angiography data, functional assessments such as intracardiac electrophysiological mapping or echocardiographic flow analysis were not performed, which restricts our ability to determine the physiological or arrhythmogenic significance of LAFTs. Third, although electrocardiographic abnormalities were observed in several patients, the causal relationship between these findings and the presence of LAFTs remains speculative and requires further prospective studies. Lastly, this was a single-center study, and multi-center data or extended follow-up would be necessary to validate our conclusions and explore potential clinical implications more robustly.

In summary, this study provides detailed morphological and clinical insights into left atrial false tendons (LAFTs), a rare anatomical variant often overlooked in routine cardiac assessments. Through coronary CT angiography and three-dimensional reconstruction, we identified various types of LAFTs differing in location, orientation, and structure. The tendons were predominantly longitudinal or transverse, with attachment points involving the anterior, posterior, lateral, and superior walls of the left atrium. The observed heterogeneity in tendon morphology and length (ranging from 2.4 to 4.4 cm) suggests the presence of individualized anatomical patterns. Notably, several cases exhibited electrocardiographic abnormalities, suggesting a potential association between LAFTs and atrial arrhythmias. Our findings highlight the diagnostic value of CCTA in identifying LAFTs and underscore the need to consider their presence in patients with unexplained arrhythmias. Further large-scale, multi-center, and prospective studies are needed to clarify the clinical significance and electrophysiological impact of these structures.

Disclosure of conflict of interest

None.

Abbreviations

FT, False tendon; RIS, Radiology information system; PACS, Picture archiving and communication system; CTA, Computed tomographic angiography; VR, Virtual reality; LAAB, Left atrial anomalous band; LA, left atrium.

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Supplementary Table 1. Detailed information on included patients

No.	Chief complaints	Past medical history	ECHO findings
1	Chest distress	Hypertension	Left atrial enlargement, ventricular septal hypertrophy.
2	Physical examination reveals an abnormal electrocardiogram	Generally healthy	No abnormalities observed in cardiac structure and blood flow.
3	Intermittent chest tightness for 2 hours	Hysterectomy	Mild mitral valve regurgitation.
4	Chest distress	Diabetes	Mild tricuspid valve regurgitation.
5	Discomfort in the precordial area for 2 months	Generally healthy	No abnormalities observed in cardiac structure and blood flow.
6	Palpitations and chest discomfort for more than one day	Thyroid surgery	Decreased left ventricular diastolic function.
7	Recurrent chest and back pain for over one month	Hypertension	Left ventricular enlargement, increased thickness of the interventricular septum.
8	Discomfort in the chest for over one day	Generally healthy	No abnormalities observed in cardiac structure and blood flow.
9	Palpitations and chest tightness for 2 days	Gout	Mild to moderate mitral valve regurgitation.
10	Intermittent palpitations for 5 days	Diabetes, hypertension	Left ventricular enlargement, mild pulmonary artery hypertension.