References


Prominent crista terminalis and Eustachian ridge in the right atrium: Two dimensional (2D) and three dimensional (3D) imaging

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Abstract The crista terminalis and Eustachian ridge are normal anatomical structures within the right atrium that are not normally looked for or visualised in the standard views obtained while performing a transthoracic echocardiogram (TTE). In this case report, the prominent terminal ridge (a normal anatomical variant) appeared as a "mass" in the right atrium that needed to be differentiated from a pathological cardiac mass. Identification of physiological structures in the right atrium on TTE using additional 3D imaging can avoid unnecessary additional tests that are both more invasive and expensive such as transesophageal echocardiography or MRIs.

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Case presentation

A 49-year-old female who volunteered as a healthy control for a research study presented for a transthoracic echocardiogram (TTE). There was no history of heart disease, nor any cardiovascular risk factors for cardiac involvement (i.e. hypertension, diabetes mellitus or hypercholesterolemia), as determined by a questionnaire. The subject denied chest pain, dyspnea on exertion or palpitations. During the TTE an echogenic structure was noted in the right atrium protruding laterally from the lower third of the interatrial septum (Fig. 1).

The atrium was imaged in the standard apical 4 chamber view. When the standard view was modified with the ventricle foreshortened, an
echo-dense structure became apparent in the right atrium. This structure was located in the posterior wall of the right atrium and was continuous with the superior border of the coronary sinus (Fig. 2). In the subcostal view (Fig. 3), this could be seen to extend to the inferior border of the inferior vena cava. The linear structure could be seen on multiple windows and appeared to be continuous with the posterior right atrial wall. There was no turbulent flow within the right atrium to suggest obstruction on colour Doppler. The structure was relatively immobile with the absence of the incoherent motion characteristic of a chiari network.1,2 A real time 3D full volume echocardiographic image was obtained and viewed off line using multiple slice planes. On 3D echocardiography, the structure was clearly defined as a thick and tapering linear structure in the posterior wall of the right atrium (Figs. 4 and 5). The linear ridge was non-obstructive and consistent with a fat filled ridge as described by Sanchez-Quintana and colleagues on anatomical dissections (Fig. 6).3

Discussion

In a recent report, normal right atrial structures were identified in 59% of 149 patients using magnetic resonance imaging.2 These structures included the Eustachian valve, Thebesian valve, persistent sinus venosus, crista terminalis and the chiari network.2,4–7 Most of these normal anatomic structures in the right atrium are not visualised on standard views obtained from TTE.

The crista terminalis is located at the junction of the trabeculated right atrial appendage and the smooth muscle of the right atrium.5,6 It is usually seen from the epicardial surface as a fat filled groove and overlies the sinus node. The crista terminalis is described by Ho and colleagues (2002) as a ”twisted C”. The crista terminalis originates from the atrial septal wall medially, passes anterior to the orifice of the superior vena cava,
descends posteriorly and laterally, and then turns anteriorly to skirt the right side of the orifice of the inferior vena cava (Fig. 6). The Eustachian ridge separates the orifice of the inferior vena cava from the coronary sinus and the tubercle of Lower and is continuous with the crista terminalis. On TTE, the crista terminalis is seen as an echo dense linear ridge in the posterior right atrial wall, extending laterally from the atrial septum.

The crista terminalis is an important anatomical structure, shown to be the site of origin of right atrial tachyarrhythmias referred to as “cristal tachycardias”. The subject in this report had no history of palpitations. Intracardiac echocardiography (ICE) has been utilised during invasive electrophysiological studies to provide detailed identification of endocardial structures within the right atrium including the crista terminalis.9

Findings in this study on 3D echocardiography are consistent with the identification of endocardial structures using ICE.9

3D echocardiography has been used to identify and better visualise complex anatomical structures in congenital heart disease.10,11 In the present subject, 3D echocardiography was useful in visualising the structure in question in relation to the other anatomical landmarks, and to further appreciate its size and position from varying angles and planes.10,11 Due to advances in ultrasound imaging including harmonic imaging and 3D full volume analysis, cardiac structures can be visualised particularly in subjects with a lean physique, and good acoustic windows.11 In fact in our laboratory, since this volunteer was imaged, prominent crista terminalis and Eustachian ridges have been identified more frequently. Identification from 2D echocardiography can be done in subjects with good

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**Figure 4**  Left: 2D image of the right atrium. Right: 3D image of the same plane showing the muscular ridge extending from the coronary sinus along the back wall. ER — Eustachian ridge, CT — crista terminalis, CS — coronary sinus, and TA — tricuspid annulus.

**Figure 5**  Left: 2D image of the right atrium subcostal view. Right: 3D image of the same plane. IVC — inferior vena cava, HV — hepatic vein, ER — Eustachian ridge, CT — crista terminalis, and SVC — superior vena cava.
In conclusion, we have identified a prominent crista terminalis as a normal variant that could be differentiated from a ‘pathological’ cardiac mass using 2D and 3D echocardiography. Anatomical structures in the right atrium can be more readily visualised with current imaging techniques. A similar finding on TTE does not require further investigation with a TOE or MRI.

References