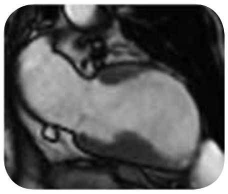

Cardiac Aneurysms, Pseudoaneurysms and Diverticula

Aneurismas, pseudoaneurismas y divertículos cardiacos

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Key words (MeSH)

Heart aneurysm
Aneurysm, false
Multidetector computed tomography
Magnetic resonance imaging

Summary

Cardiac aneurysms, pseudoaneurysms, and diverticula are dilations or outpouchings of different cardiac structures: ventricles, atria, atrial septum, coronary arteries, among others, due to different causes and of variable morphology. Advances in different diagnostic modalities have allowed greater accuracy in the morphological and functional assessment of the heart. Cardiac aneurysms, pseudoaneurysms, and diverticula are common manifestations of different conditions that can be assessed by magnetic resonance imaging and computed tomography, which are increasingly used to evaluate cardiac configuration. Cardiovascular magnetic resonance (CMR) is the technique of choice for a better cardiac anatomic evaluation. This paper aims to illustrate, through clinical cases based on our experience in CediIMed, the value of these non-invasive diagnostic modalities in the evaluation of cardiac aneurysms, pseudoaneurysms, and diverticula.

Palabras clave (DeCS)

Aneurisma cardiaco
Aneurisma falso
Tomografía computarizada multidetector
Imagen por resonancia magnética

Resumen

Los aneurismas, pseudoaneurismas y divertículos cardiacos son dilataciones o evaginaciones de estructuras de la pared cardiaca: ventrículos, aurículas, septo interauricular, arterias coronarias, entre otros, de distintas causas y de morfología variable. Los avances en las diferentes modalidades diagnósticas han permitido una mayor precisión en la evaluación morfológica y funcional del corazón. Los aneurismas, pseudoaneurismas y divertículos cardiacos son manifestaciones frecuentes de diferentes condiciones, que pueden ser evaluados mediante técnicas como la resonancia magnética (RM) y la tomografía computarizada (TC) que se usan, cada vez con mayor frecuencia, para evaluar la configuración cardiaca. La resonancia magnética cardiovascular (RMC) es la técnica de elección para una mejor valoración anatómica cardiaca. El propósito de este artículo es ilustrar mediante casos clínicos el valor de estas modalidades diagnósticas no invasivas en la evaluación de los aneurismas, pseudoaneurismas y divertículos cardiacos.

Introduction

Cardiac aneurysms are dilatations or evaginations of different structures of the cardiac wall. Cardiac diverticula and pseudoaneurysms are also saccular formations of the cardiac wall, of different cause and variable morphology (1).

Generally, echocardiography is the first diagnostic modality used to evaluate cardiac morphology; however, magnetic resonance imaging (MRI) and computed tomography (CT) are being used more frequently for this purpose (2).

Cardiovascular magnetic resonance imaging (CMR) is the technique of choice used for a better valuation of cardiac morphology, which also quantifies the biventricular function. Unlike transthoracic echocardiography, the CMR has no cardiac regions with restricted evaluation and can take the images on any plane (3,4).

Advances in multidetector computed tomography (MDCT), through the use of the electrocardiogram-based triggering (electrocardiographic "triggering"), have allowed an adequate morphological evaluation

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of the heart with better spatial and temporal resolution. A complete heart acquisition can be achieved in one apnea, which is particularly useful in patients with claustrophobia or with orthopnea (2,5). Another application of MDCT is angiotomography coronary artery, which provides intraluminal and extraluminal information; This allows to evaluate tortuous vessels or anomalous vascular anatomy (2). The purpose of this article is to illustrate with clinical cases, in 1.5 and 3 tesla MRI equipment and 64-row multislice CT scan detectors, the functionality of these diagnostic modalities does not invasive techniques in the evaluation of aneurysms, pseudoaneurysms and cardiac diverticula.

Aneurysms and pseudoaneurysms of the left ventricle

True left ventricular aneurysms (figures 1 and 2) represent areas of thinning in the myocardial wall, defined as an abnormal contour area during diastole, with dyskinesia and paradoxical bulging during systole (6). Its main cause is the infarct with transmural compromise, however its etiology includes less common causes, such as myocarditis, Chaga's disease, vasculitis and sarcoidosis (7, 8).

The abnormal myocardium may be hypokinetic, akinetic or dyskinetic. True aneurysms are often dyskinetic, leading to congestive heart failure, thrombi and embolic events. Other complications associated with cardiac aneurysms are cardiac arrhythmias and sudden death, which appear by scar tissue present within an aneurysm.

The pseudoaneurysms (figure 3) represent a rupture of the wall of the left ventricle contained by an adherent thrombus or the pericardium. Its etiology may be secondary to myocardial infarction, cardiac surgery, trauma or infection (9, 10). Given it is a contained rupture, pseudoaneurysms are very unstable (11); it is of great clinical importance to differentiate them from true aneurysms, Since the pseudoaneurysms require an urgent surgical repair, while true aneurysms can be managed with drugs (12). Like true aneurysms, the pseudoaneurysms can lead to heart failure, thrombi and embolic events by the absence of contractility.

Morphologically, pseudoaneurysms (figure 3c) are characterized for having a narrow neck that connects with a large sack aneurysm; on the contrary, true cardiac aneurysms (figure 1b) have a broad neck and a smooth transition from the normal myocardium to the thinned myocardium. The ratio of the maximum diameter of the neck with the maximum internal diameter in the cavity is between 0.25-0.5 for pseudoaneurysms and between 0.9-1.0 for true aneurysms (13,14).

As for the pathological evaluations, the pseudoaneurysms show fibrous tissue and absence of myocardial cells, which are present in true aneurysms (15).

The marked pericardial enhancement is another useful finding to recognize the pseudoaneurysms. It is believed that chemical irritation secondary to the exit of blood into the pericardial space, due to myocardial rupture, explains this finding (16).

90% of cardiac aneurysms are secondary to full thickness heart attacks, most of them located in the territory of the anterior descending artery, so its location is usually in the anterior walls (figure 2), lateral and apical (figure 1) (2). On the other hand, pseudoaneurysms are located more frequently in the posterior and inferior walls, territory of the circumflex artery (figure 3) (17,18). This is believed to be due to the fact that anterior wall ruptures are generally fatal, whereas the pericardium in the posterior wall exerts a protective role in case of rupture and allows the formation of pseudoaneurysms (19).

MRI is being used more and more frequently in the evaluation of patients with myocardial infarction. MRI can identify the location of the aneurysm, helps differentiate the pericardium from the thrombus, scar and myocardium; and accurately defines the size of the infarction (20).

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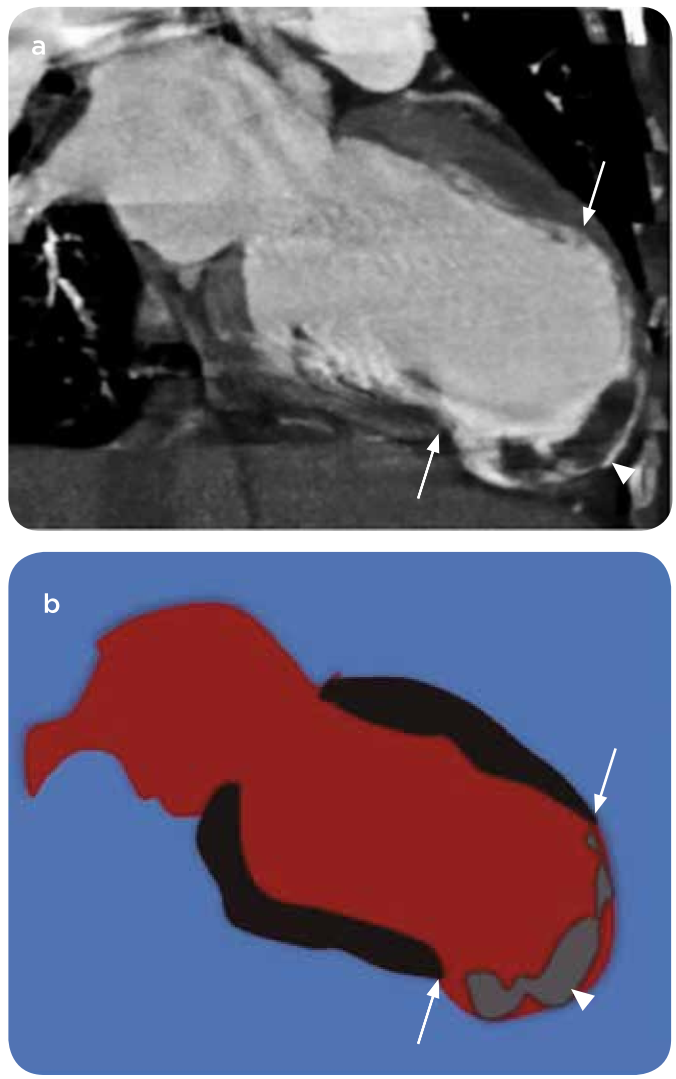

Figure 1. 75-year-old patient with true aneurysm of the left ventricle, with previous myocardial infarction in the region of the anterior descending coronary artery. a) CMT, long axis projection of the two chambers. b) Corresponding illustration that shows true apical aneurysm with broad neck (arrows) and intracavitary thrombus (arrowhead).

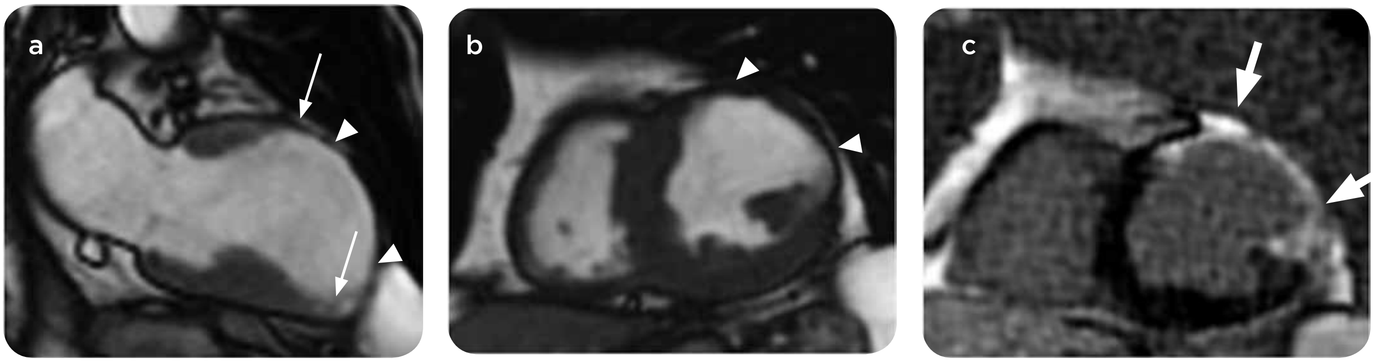

Figure 2. 68-year-old patient with a true left ventricular aneurysm, with previous myocardial infarction in the region of the anterior descending coronary artery. a) Study of CMR, long axis film sequences of the two chambers. b) Short axis. SSFP (steady-state free precession) and T1 sequence of late enhancement (viability), with reversal of the short axis recovery, where one can observe an anterolateral true aneurysm with broad neck (white arrows in a), thinning of the wall (arrow heads in a and b) and extensive transmural late enhancement (arrows on c).

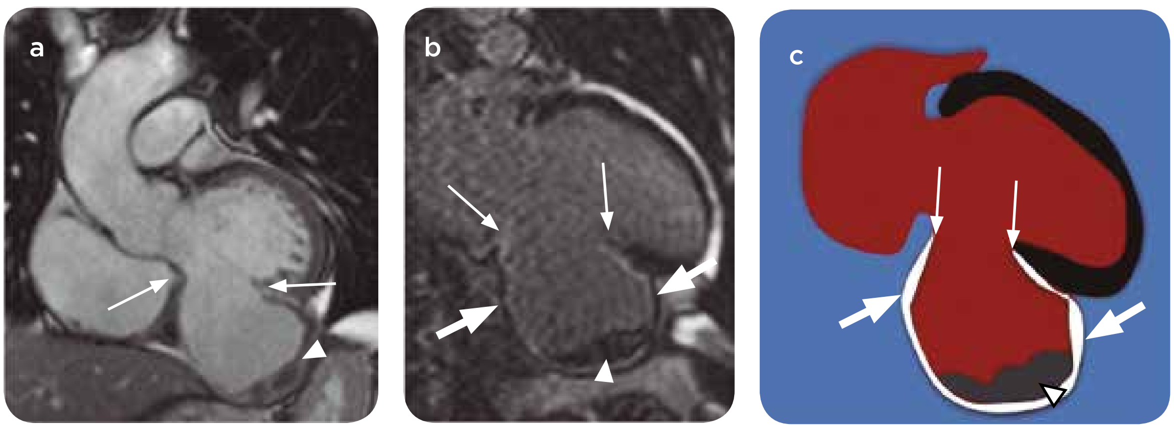

Figure 3. 63-year-old patient with left ventricular pseudoaneurysm and previous myocardial infarction in the vascular region of the right coronary artery. a) CMR, short axis film sequences. b) Sequence with late T1 enhancement information (viability) with investment of long axis recovery for the two cameras. c) Illustration demonstrating pseudoaneurysm of the basal inferior wall of the left ventricle with narrow neck (white arrows), diffuse late enhancement of the pseudoaneurysm wall (arrows) and intracavitary thrombus (arrow heads).

Aneurysms and congenital diverticuli of the left ventricle

These are rare congenital abnormalities, with a prevalence of 0.04% in series of echocardiography and 0.76% in series of angiography (21,22). In these there is a localized protrusion of the endocardium and myocardium. Most patients are asymptomatic; nevertheless, an increased incidence of embolic events and cardiac arrhythmias has been reported (22).

In general, cardiac diverticula are considered to be of the type muscular and have adequate contractility, whereas congenital aneurysms (figure 4) are fibrous, with late enhancement of their walls in the viability sequences and present with dyskinesia or akinesia on its walls (23). Most are small, with a diameter of less than 1.5 cm (24).

Aneurysms of the left ventricle

They are much less common than in the left ventricle, since the latter is the most frequently affected by ischemia (25). An incidence of 0.08% following an infarction has been reported (26). Other causes include trauma, Fallot's surgery (figure 5) and arrhythmogenic cardiomyopathy of the right ventricle (figure 6). Aneurysms of the right ventricle present more frequently towards the apex and in the tract of entry and exit (triangle of dysplasia).

In arrhythmogenic dysplasia of the right ventricle there is a progressive loss of ventricular myocytes, which, when replaced by fatty and fibrous tissue, lead to dilation, dysfunction and susceptibility to arrhythmias. CMR is the imaging modality of choice; in it one can observe right ventricular systolic dysfunction and regional abnormality in the ventricular wall motility, which is a focal (aneurysmal) dyskinesic segment (figure 6) (27).

Among the complications associated with the surgical correction of the tetralogy of Fallot, the following have been described: the interventricular septal defect, obstruction and formation of aneurysms in the outflow tract of the right ventricle (Figure 5). Aneurysms of the outflow tract of the right ventricle usually appear in the first postoperative year and are associated with the use of a redundant patch in the correction of the interventricular defect or distal obstruction resulting in an increased systolic load on the right ventricle (28).

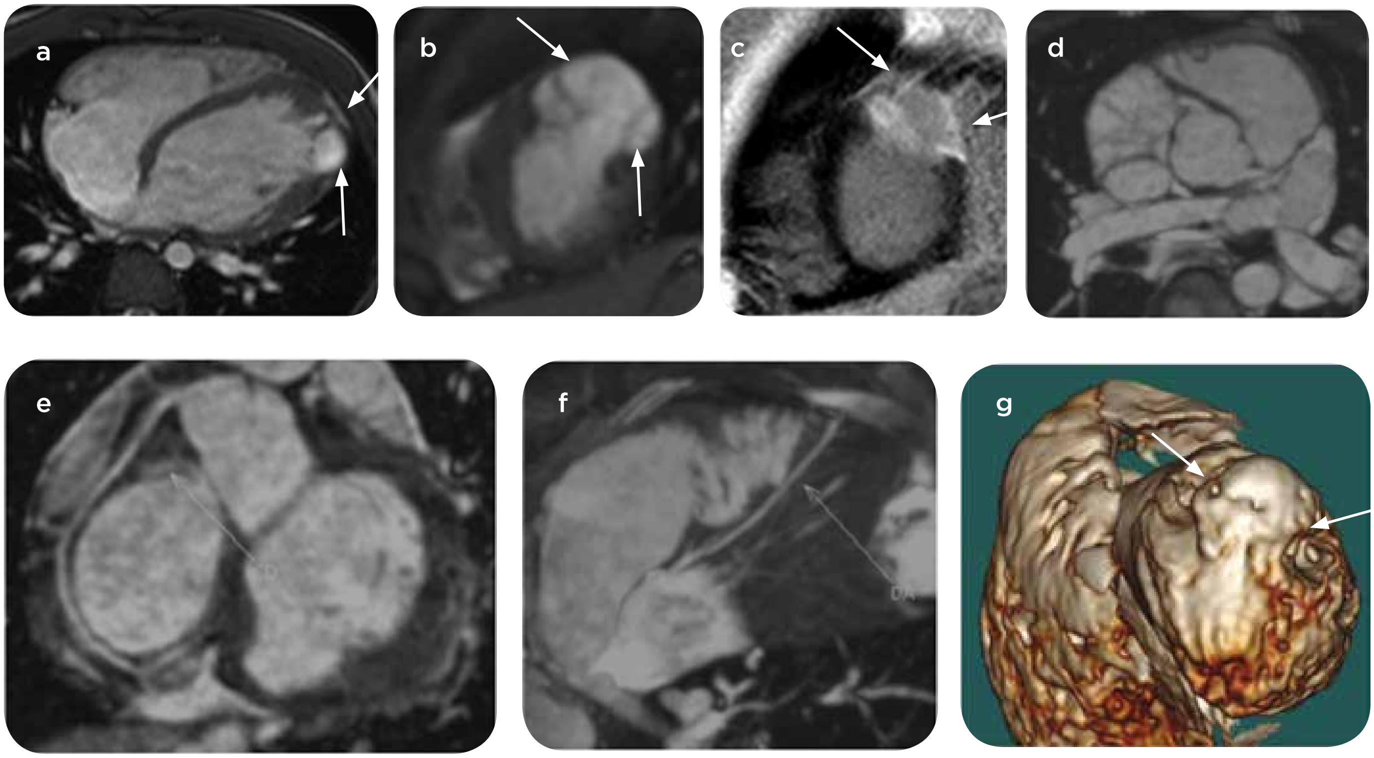

Figure 4. 12-year-old patient with anterolateral congenital aneurysm of the left ventricle. a) CMR, film sequences long axis for the four cameras. b) Short axis in systole. c) T1 sequence of late enhancement (viability), with inversion of the short axis recovery. d) Reconstructions curves of coronary sequence 3D MR SSFP at the origin of coronary arteries. e) Right coronary. f) Left coronary. g) 3D with volumetric demonstration of the ventricles. Sacral reinforcement image in anterolateral systole (dyskinesia) of the left ventricle (arrows), with thinning of its walls and diffuse late enhancement of its wall (fibrosis) in the viability image (arrows in c). d) In the CMR sequence: normal origin of the coronary arteries of the corresponding Valsalva sinuses. e and f) No coronary artery pathway abnormalities suggestive of congenital anomalies of the coronary arteries are demonstrated. Neither alterations of the caliber or aneurysms of the coronary ones that suggest Kawasaki disease.

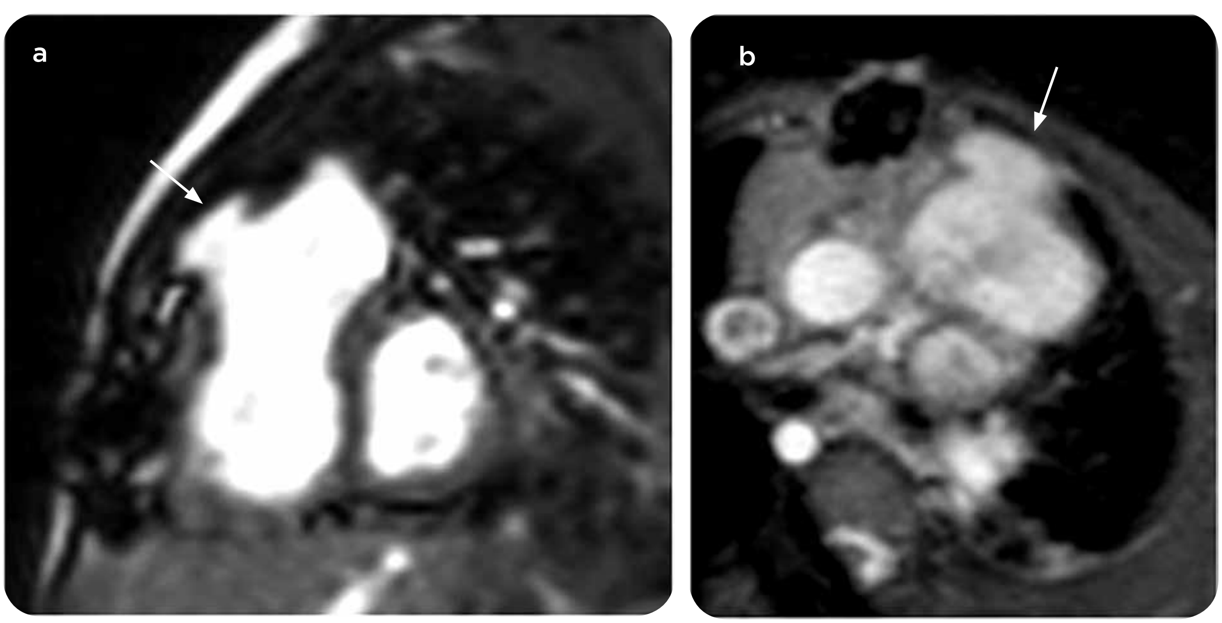

Figure 5. 32-year-old patient with arrhythmogenic right ventricular dysplasia, anterior aneurysm of the outflow tract, associated with dyskinesia, dilation of the right ventricle and compromise of its function (ejection fraction 36%). CMR, axial SSFP (steady-state free precession) film sequence demonstrating right ventricular outflow tract aneurysm (arrows).

Accesory auriculum and diverticuli of the left atrium

They represent small sacculations projected from the wall of the left atrium. Most are small, with a swelling size between 2 and 6 mm.

They are an anatomical variant with little clinical significance; nevertheless, it has not been defined with certainty if they can be a source of thromboembolism or associated with an ectopic focus of atrial fibrillation (29-32).

They are often found in patients who have undergone triggered cardiac tomography, with a prevalence of 10%-23% (33,34).

The morphological characteristics (figure 7) that help differentiate an accessory auriculum from a diverticulum are a narrow ostium and a body of irregular contours by the presence of pectin muscles in the accessory auriculum, while the diverticulum has the shape of a sac of smooth walls with a wide ostium. The most frequent location of the left atrial diverticulum is supero-anterior, while the auriculum is most frequently located in the inferolateral wall (34).

Aneurysm of the interatrial septum

Defined as a deviation of the major septum, 10-15 mm from the midline, which may compromise the entire septum or be confined to the oval fossa.

It has a prevalence ranging from 0.2% -10% according to the diagnostic method, the study population and the diagnostic criteria (35, 36). It can be found with MRI or with triggered tomography with adequate precision, which allows to detect, also, oval foramen (37) (figure 8); it is important to recognize it as it can be mistaken for an atrial mass (38-40).

There is an association between the interatrial septum aneurysms (figure 8) and permeable oval foramen and paradoxic embolic events (41).

Aneurysm of the coronary arteries

A coronary artery aneurysm is defined as an increase in the diameter of the artery, greater or equal to 50% compared to the adjacent segment; and is defined as giant aneurysm when their diameter is greater than 4 cm (42). Coronary ectasia is diffuse dilation of the coronary artery with an increase in its diameter of less than 50% (43).

The vessel most commonly affected is the right coronary artery (40%), followed by the anterior descending (32%) and the left circumflex (23%) (1).

The main cause of coronary artery aneurysms in adults Is atherosclerosis; it is three to four times more common in men with an average age of 65 years (44,45). In children, the main cause Is Kawasaki disease (figure 9). Other causes of aneurysms in coronary arteries include trauma, iatrogenic, arteritis, infections, connective tissue diseases, among others.

Kawasaki disease (figure 9) involves small and medium caliber arteries (particularly coronary); mainly affects children under 5 years of age. In 15% to 25% of untreated patients, aneurysms or ectasias develop, which can lead to sudden death or myocardial ischemic events. Most coronary aneurysms (50%-67%) are resolved with spontaneous regression (46,47).

Angiography was considered the main diagnostic method in the evaluation of coronary aneurysms. CT has a sensitivity of 100% to detect aneurysms and 87.5%-100% to detect significant stenosis (48, 49). This, although not invasive, submits the patient to ionizing radiation for which MRI has been proposed as an alternative imaging modality.

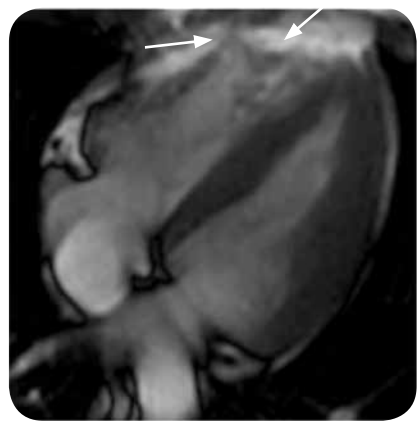

Figure 6. 32-year-old patient with arrhythmogenic dysplasia of the right ventricle, anterior aneurysm of the outflow tract, associated with dyskinesia, dilation of the right ventricle and compromise of its function (ejection fraction 36%). CMR, SSFP (steady-state free precession) sequence, aneurysm of the right ventricular outflow tract (arrows).

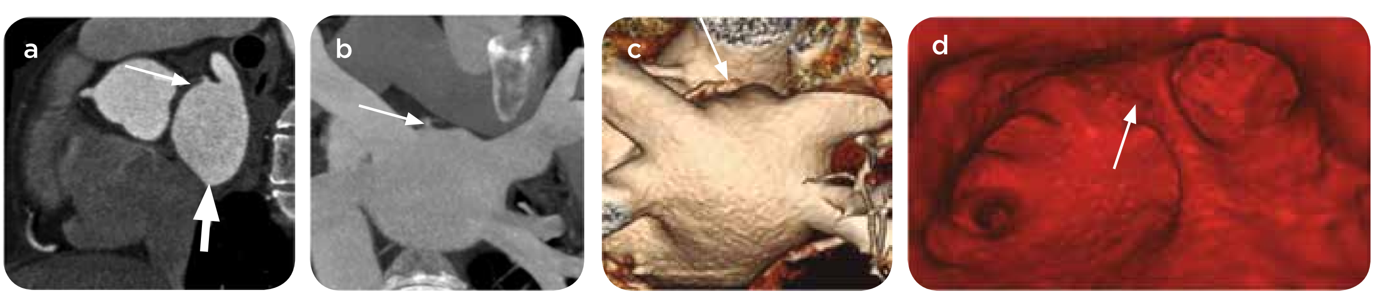

Figure 7. 45-year-old patient with paroxysmal atrial fibrillation, with diverticulum and accessory auriculum of the left atrium as incidental findings in a triggered cardio CT study for mapping of pulmonary and left atrial veins. Multiplanar reconstructions: a) sagittal, b) coronal; Three-dimensional reconstructions: c) epicardial and d) endocardial left atrium. The accessory auriculum (arrows) of the upper left atrial wall, with narrow neck and irregular contours are identified by the pectine muscles and diverticulum in the lower, broad-walled, smaller, smooth-walled wall (white arrow).

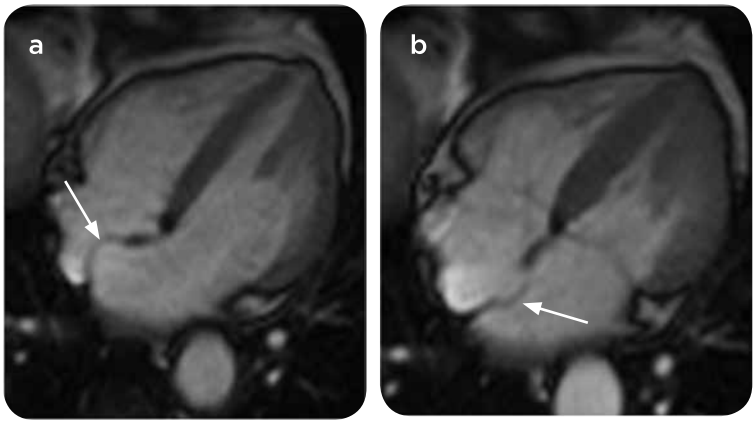

Figure 8. 40-year-old patient with interatrial septum aneurysm. a and b) CMR, steady-state free precession (SSFP) film sequences, long axis for four cameras. They demonstrate aneurysm of the interatrial septum (arrows), with great motility of the septum that changes the direction of the aneurysm in diastole a) and systole b).

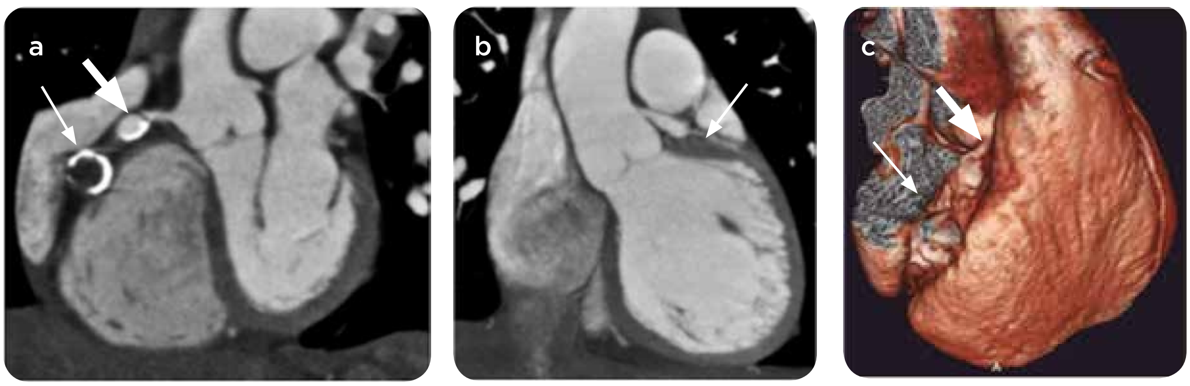

Figure 9. 8-year-old patient with Kawasaki disease and aneurysms of the right coronary and common trunk arteries of the left coronary artery. a) Curved reconstructions of the right coronary artery, b) of the common trunk of the left coronary artery and c) three-dimensional epicardial reconstruction of coronary angiotomography study. Two right coronary artery aneurysms are identified: one proximal without thrombus (white arrows) and a second more thrombosed distal aneurysm (white arrows in a and c). A smaller non-thrombosed fusiform aneurysm is also seen from the common trunk of the left coronary artery (white arrow in b).

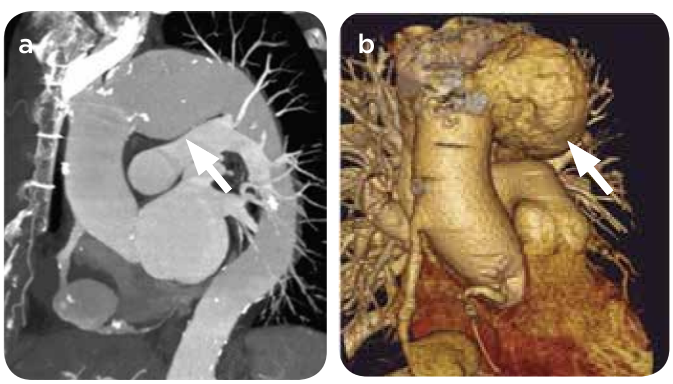

Figure 10. 75-year-old patient with a history of coronary bypass surgery 6 years ago, with a partially thrombosed giant aneurysm of a saphenous vein bridge at the right coronary circulation, associated with an aortic arch aneurysm. a) Reconstruction curve, and b) three-dimensional epicardial study of coronary angiotomography. Large size aneurysm is identified (arrows), partially thrombosed, not broken, of the middle segment of saphenous bridge to the right coronary circulation and aneurysm of the aortic arch (dotted white arrows).

Aneurysm of saphenous bypass

As in the rest of the vessels, an aneurysm of the saphenous bridges is defined as a dilation with a diameter greater than 50% compared to the diameter of the proximal or distal vessel (1).

They are classified as true or false. The real ones compromise the three layers of the vessel, are typically fusiform and occur 5 or more years after surgery due to the progression of the atherosclerosis. Pseudoaneurysms do not have an endothelial layer, are usually saccular and appear proximal or distal to the anastomosis, due to the disruption of a vessel wall contained by a hematoma.

Computed tomography (CT) and MRI demonstrates its morphological characteristics (figure 10) and differentiates it from expansive mediastinal lesions, which is the aspect it can take on a chest x-ray.

Most remain asymptomatic regardless of their size, or present acute symptoms due to the following complications: spontaneous rupture, ischemia, embolic events or formation of fistulas (50).

Conclusion

Advances in the different diagnostic modalities have allowed greater precision in the morphological and functional evaluation of the heart. Aneurysms, pseudoaneurysms and cardiac diverticula are frequent manifestations of different conditions, which can be evaluated by means of MDCT and CMR, so it is important top have an adequate knowledge of their morphological characteristics for its adequate characterization.

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