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MRI in Left Ventricular Aneurysms: Experience of a Moroccan Cardiac MRI Center

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ABSTRACT

Left ventricular (LV) aneurysm or pseudoaneurysm are most often secondary to myocardial infarction. They predispose to heart failure, rhythm disorders and thrombus formation. Their diagnosis can be difficult, requiring a high performance imaging. The purpose of our study is to demonstrate the important role of cardiac MRI in the study of the left ventricular aneurysms. We performed a retrospective study, which collected 68 patients referred for cardiac MRI, between 2007 and 2021, and for whom the final diagnosis of left ventricular aneurysms or pseudoaneurysms was retained. We evaluated the incidence of this pathology, the underlying heart disease, the myocardial morphology, perfusion and viability, as well as those of aneurysms with search for thrombus. The mean age was 64.4 years, with a male predominance. Cardiac MRI was performed mostly to search for myocardial viability (61.8 %). The underlying heart disease was exclusively ischemic heart disease. In 58.8% of the cases, the diagnosis was that of a true aneurysm without thrombus and in 38.2% of cases with thrombus. LV pseudoaneurysm was present in only 2 patients. These aneurysms were mainly located apically (84.8%). Perfusion defect perfusion was noted in the necrotic coronary territories, with the presence of viability in 11.8% of cases. The mean of the LV end-diastolic diameter was at 66.3+/- 8.2 mm (i.e. 39 mm/m2) and the mean volumes were at 264.1± 101.5 ml (155.3 ml/m2). The mean LV ejection fraction was at 29.8 ±10%. Thus, cardiac MRI is the "gold standard" in post-infarction studies for an exhaustive study, not only for the diagnosis of LV aneurysms, but also on the complete myocardial study.

Introduction

Left ventricular aneurysm or pseudoaneurysm formation is most often secondary to myocardial infarction. In fact, aneurysms complicate 30 to 35% of MI and are responsible for 8 to 10% of complications that must be identified because of the increased morbidity and risk of rupture. The diagnosis of these entities is a real challenge.

Aneurysms and pseudoaneurysms are now diagnosed with increased frequency with the advent of recent imaging techniques. Magnetic resonance imaging (MRI) plays an important role in characterizing these entities.

The purpose of our study is to demonstrate that cardiac MRI is the only examination that allows a single and definitive comprehensive study of the presence, location, size, and nature of left ventricular aneurysms, as well as the presence of thrombus and myocardial viability.

Materials and Methods

We report a retrospective study of patients referred for cardiac MRI between 2007 and 2021, for whom the final diagnosis of LV aneurysms or pseudoaneurysms was retained. Sixty-eight patients were included in our study. All of them had received transthoracic echocardiography before being referred for cardiac MRI. The reason for performing cardiac MRI was obtained from the referral letters. For the study of the cases, we have developed an operating form containing epidemiological data, the reason for referral, the underlying coronary damage, and the data from the cardiac MRI.

Cardiac MRI allowed morphological analysis of the left ventricle with ventricular diameters and volumes, myocardial thickness, left ventricular ejection fraction, the study of myocardial perfusion and viability. The MRI has enabled the analysis of ventricular aneurysms with its location, morphology and the search for intra-cavity thrombus.

Results

The average age of our patients was 64.4 years, with a male predominance (80.9% of cases). Cardiac MRI was performed mainly to search for myocardial viability in 61.8% of cases.

Our cases were exclusively secondary to ischemic heart disease.

The data from the coronary angiography, when it was performed, show that monotruncular involvement is dominant (51.5%).The mean left ventricular end-diastolic diameters were dilated: 66.3+/- 8.2 mm (i.e. 39 mm/m2) and the mean volumes were 264.1± 101.5 ml (155.3 ml/m2). The left ventricular ejection fraction was 29.8 ± 10% on average. (Table 1).

The retained diagnosis was true AVG without thrombus in 58.8% and with thrombus in 38.2%. LV pseudoaneurysm was present in only 2 patients. These aneurysms were mainly apical: in 84.8% of cases.

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Regarding pseudoaneurysms, we had 2 locations: inferior (Figure 1 A, and B) and apical (Table 2).

The average size of the aneurysm necks was 48 mm, the largest diameter was 67 mm, and the transverse diameter was 71 mm. The average size of the neck of the pseudoaneurysm was 12 mm. Regarding the study of perfusion, we observed a perfusion defect in the necrotic coronary territories with the presence of myocardial viability only in 11.8% of cases.

The search for intra-cavity thrombus revealed 26 cases (38.2%) of thrombus at the aneurysm level (Figure 2 A and B). The mean diameter of these thrombi was 20.83±7.57 mm, with extremes of 13 to 35 mm for the largest diameter.

Discussion

Left ventricular (LV) aneurysms are defined by an expansion of the LV myocardium that contracts dyskinetically during systole. It has a wall consisting of necrotic myocardium that continues with the healthy myocardium.

Pseudoaneurysms (PSA) is most often secondary to a rupture of the myocardial free wall which is contained in a pericardial space limited by adhesions, and which can rupture and be the cause of a tamponade, threatening sudden death. In some cases, the pericardium contains the rupture locally, and a sac is formed, bounded by the pericardium and inflammatory tissue which is the cause of the formation of a false aneurysm.

True and false aneurysms have a different treatment with a greater risk of rupture of pseudoaneurysms, hence the importance of imminent surgical treatment.

The diagnosis of LV pseudoaneurysm is challenging. The radiological aspects that allow the differential diagnosis with true aneurysm are : the ratio of the size of the neck to the largest diameter is larger in true aneurysm whereas it is smaller in pseudoaneurysm [1]; the distribution of the aneurysm sac and the discontinuity of the myocardium at the neck of the aneurysm. These aspects are more common in the inferior wall of the LV, however, they are difficult to demonstrate by echocardiography [2]. Coronary angiography can distinguish pseudoaneurysm by the absence of coronary artery at the affected area [3]. The characteristic morphologies of the two types of aneurysms are usually well evaluated using MR imaging [4].

MRI is a non-invasive highly reliable, well-validated technique for measuring heart function and analyzing the structural anatomy of the heart .[5] It is superior to other frequently used imaging modalities [6;7], such as 2D echocardiography and SPECT imaging in evaluating anatomical defects such as LV aneurysms [6]. It has an increasing potential in the non-invasive evaluation of patients with myocardial infarction and subsequent complications.[4]

Cardiac MRI allows a complete study of the morphology of the aneurysm and the adjacent myocardium with a perfect tissue characterization not allowed by other available techniques.

If the aneurysm (true or false) requires surgical treatment, the search for myocardial viability is essential thanks to MRI.

Gadolinium injection can identify viable myocardium that can benefit from myocardial revascularization combined with aneurysm resection, which may improve LV systolic function, or on the contrary, demonstrate a nonviable transmural myocardial infarction, without any interest in revascularization.[8]

It is very important to distinguish aneurysms from pseudoaneurysms, for which surgical management is imperative. For this purpose, cardiac MRI has made it possible to highlight some characteristics that allow us to differentiate them. Regarding aneurysms, their location is most often apical, with a connection angle of the aneurysmal wall to the healthy myocardium which is progressive in a soft slope, and a wide neck. The cine sequence shows their dyskinetic character. The MRI viability sequence 10 min after injection of gadolinium shows transmural contrast of the aneurysmal sac corresponding to myocardial fibrosis.

As for pseudoaneurysms, their wall is composed of epicardium and pericardium only and their risk of secondary rupture is much more frequent. They are preferentially located in the inferior and inferolateral wall of the left ventricle. They have acute connection angles to the adjacent myocardium with a narrow neck. The ratio of neck diameter to maximum neocavity diameter is significantly lower in pseudoaneurysm. Enhancement after gadolinium injection is intense and diffuse at the level of adjacent pericardial structures.[9.10]

There is no consensus for the cut-off of the aneurysm neck/diameter ratios. In the literature, Ballard et al, through their series, compared 17 cases of left ventricular aneurysms with 18 cases of pseudoaneurysms, measuring neck diameters and the aneurysms width and depth. The ratio of neck to sac width and depth diameter was lower in pseudoaneurysms compared with aneurysms with a significant p value.[11]

In our series, the diagnosis of aneurysm was made by echocardiography in 13 cases (19.1%), which underlines the importance of cardiac MRI, which is a more complete method of evaluation in ischemic heart disease. Apical location is the most frequent in our series, less well explored by transthoracic echocardiography (TTE), hence the particular contribution of cardiac MRI in this indication. Myocardial viability was found only in 9 patients, who could thus benefit from a combined aneurysm cure and surgical revascularization. There were only 2 cases of pseudoaneurysms, one apical and one inferior. 26 cases (38.2%) of intraventricular thrombi were found, 24 of which were unrecognized by TTE, hence the importance of MRI to adjust the therapeutic attitude for anticoagulation.

Conclusion

Cardiac MRI in post-infarction is the gold standard for an exhaustive study, providing the diagnosis of left ventricular aneurysms, the study of myocardial viability, the search for thrombus and the evaluation of ventricular function with a low intra and inter-observer variability.

Table 1: Morphological analysis of the left ventricle on MRI

	Measurements (mean ± standard deviation)	Minimum	Maximum
LVEDD(mm)	66,3±8,2	50	85
LVEDD indexed(mm/m^2)	38,8±4,8	29,4	50
LVSD (mm)	51,7±10,4	34	74
LVEDV(ml)	264,1±101,5	97	516
LVEDV indexed(ml/m^2)	155,2±59,7	57	303,5
LVESV(ml)	192,1±93	41	408
LVEF(%)	29,8±10	13	54

Table 2.Final diagnosis based on cardiac MRI

Final diagnosis based on cardiac MRI	Number of patients N=68	%
True left ventricular aneurysm	40	58,8
Left ventricular pseudoaneurysm of inferior location	1	1,5
Left ventricular pseudoaneurysm of apical location	1	1,5
True left ventricular aneurysm with thrombus	26	38,2

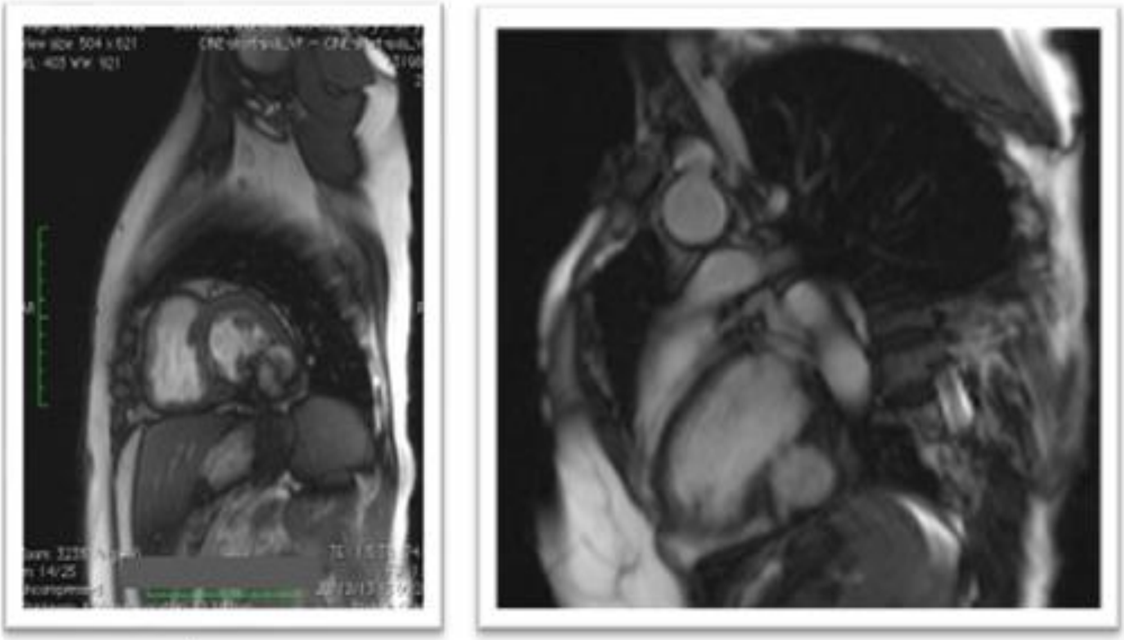

Figure 1. A, B. MRI images of a patient admitted for an infero-basal infarction. Presence of a pseudo aneurysm secondary to a rupture of the inferior wall with a small neck of 12 mm and a significant blood stasis.

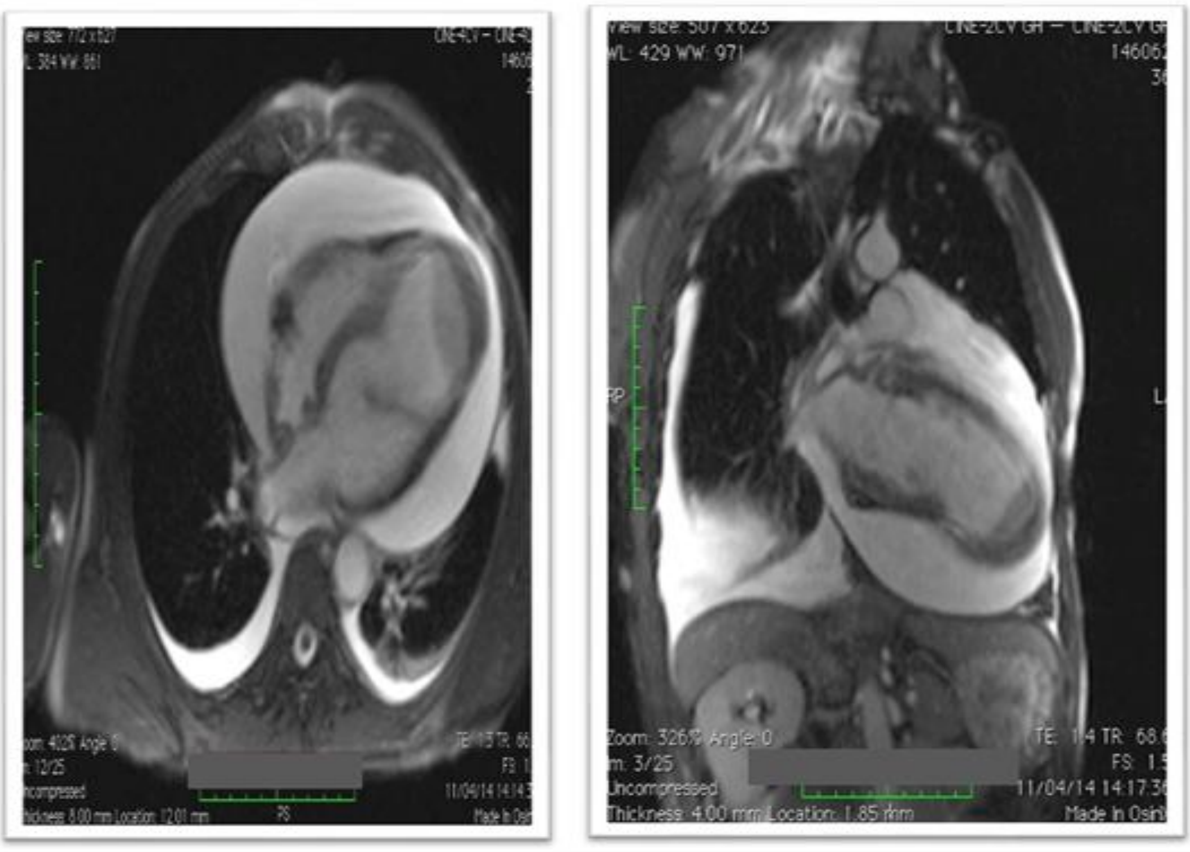

Figure 2. A and B. 4-chamber and 2-chamber sections showing an apical aneurysm with thrombus and a parietal rupture complicated by tamponade.

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