

Original Investigation Reports

IMAGGEN AR-RMC registry: use of cardiac magnetic resonance in Argentina.

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Comité de Imágenes Cardíacas TC y RMR.

ARTICLE INFORMATION

Received on February 18, 2024.

Accepted after review on April 3, 2025.

www.revistafac.org.ar

There are no conflicts of interest to disclose.

Keywords:

Cardiac magnetic resonance, registry, Argentina, cardiomyopathy, gadolinium.

ABSTRACT

Introduction: cardiac magnetic resonance imaging (CMR) is a fundamental tool in the diagnosis of cardiovascular diseases. The Argentine Registry of Cardiac Magnetic Resonance (IMAGGEN AR-RMC) was designed to obtain information on the use of CMR.

Materials and Methods: A prospective registry of patients undergoing CMR was carried out.

Results: 1006 CMR were included. The most frequent indications were non-ischemic cardiomyopathy (55.7%), ischemic heart disease (14.6%). Macrocytic gadolinium was used in 61.9% of the studies, with an increase from 54.3% in the period 2018-2020 to 83.5% in the period 2021-2022 ($p < 0.001$); 89.7% of the studies had an impact on patient management. The complication rate was 0.5%.

Conclusions: Non-ischemic cardiomyopathy was the main indication. Macrocytic gadolinium utilization increased during registration. CMR was a safe study with an impact on patient management.

INTRODUCTION

In spite of research studies giving rise to magnetic resonance imaging being close to 70 years old, it was during the 1970s that the development of this technique quickened, because of fundamental studies that allowed the definitive placement of this technique as a diagnostic tool in medical practice.^{1,2,3,4} In the last 20 years, cardiac MRI has emerged as a tool for diagnosis, prognosis and management of CAD, pericardial disease, cardiomyopathies, cardiac masses and tumors, and congenital heart diseases, among others.^{5,6,7,8,9}

In spite of having several international registries showing the reality of cardiac MRI, there is no wide-ranging information available about the reality in Argentina, in terms of cardiac MRI indication in medical practice, or about the use of different sequences, techniques or contrast agents used in MRI laboratories in our country.^{10,11,12}

For this reason, we developed from the Committee of Cardiac CT and MRI of the Argentine Federation of Cardiology, a registry (IMAGGEN AR-RMC) that would enable data gathering about the reality of MRI in our country, pro-

viding an informative and conceptual framework to prepare strategies for the improvement and dissemination of this auxiliary method.

MATERIALS AND METHODS

A prospective, cross-sectional registry was designed, along with the medical centers of the country that wished to participate. The patients signed an informed consent and were included consecutively. Data were uploaded to a digital platform anonymously. Information was divided into two periods of time: the 2018-2020 term and the 2021-2022 term, to evaluate the variation in the use of macrocytic contrast agents over time.

Statistical analysis

Continuous variables are presented as mean and standard deviation and median and interquartile range according to them being of Gaussian distribution or not, respectively. Categorical variables are expressed as frequencies and percentages. Student's t-test or Wilcoxon test was per-

formed as it corresponded for quantitative variable comparison. Quantitative variables were compared with Chi-square test or Fisher's exact test, according to the case. A p value <0.05 was considered a statistically significant value.

RESULTS

There were 1006 MRI tests included, from January 2018 to October 2022, in 15 centers from 9 provinces of Argentina. In *Table 1*, we show the percentages corresponding to each of them, with 70.6% of them having been made in the province of Santa Fe. The 1.5 Tesla MRI device was used in 80.2%, and the 3 Tesla was used in the remaining 19.8%. In this sample, the most frequent brand was General Electric, in 61.6% of cases. The median of age was 47 (27-61) years. The most frequent cause for requesting MRI was non-ischemic cardiomyopathy, within which, the most frequent indications were dilated cardiomyopathy (18.9%) and hypertrophic cardiomyopathy (17.8%). In 14.6% of cases, the request was related to ischemic heart disease (*Figure 1*). In 96.9%, the tests were requested with contrast agents. The MRI sequences made in the tests are shown in *Table 2*, with cine (91.7%) and late enhancement (85.6%) being the most used ones.

In 38.1% of tests with contrast agents, linear gadolinium was used. Viewgam® was the most used contrast agent in this group (90.7%), macrocyclic gadolinium in 61.9%, and Gadovist® was the one most used in the latter group (59.7%). During the 2018-2020 period, the percentage of use of macrocyclic contrast agents was 54.3%, and during the 2021-2022 period, 83.5% ($p<0.001$) (*Figure 2*). The median gadolinium dose was 15 ml in the 2018-2020 period, and 14.8 ml in the 2021.2022 period ($p=0.89$).

The test reports were made by cardiologists in 97.2% of cases, in 2.4% they were made jointly with radiologists, and in 0.4% they were made only by radiologists. After the report, it was considered that in 89.7% of cases the report was conclusive with an impact on the management of patients, in 9.8% there was no impact, and in 0.5% the report was not conclusive and/or diagnostic. The rate of complications was very low, presenting in 5 patients (0.5%): two patients with heart failure worsening, one patient with vomits, one patient with a mild allergic reaction, and another one with unspecific discomfort. None of them required suspending the procedure.

DISCUSSION

This study shows a wide information about the reality of using cardiac MRI in Argentina, including 9 provinces and 15 centers. This registry presented a greater use of 3T MRI scanners than in the European cardiac MRI registry, being 19.8% in our registry, and 5.9% in the European one; however, it is less than in the recently published study by the Society for Cardiovascular Magnetic Resonance, where it was 26%.^{11,12} In this registry, the indication by ischemic cause represented almost 15%, with a very low use of stress MRI, a methodology that presents, since 2021, a I B

TABLE 1.

General characteristics of the population

Variable	Datum
Age (mean (SD)) (years)	47 (27-61)
Male gender n (%)	627 (62.3)
Weight (kg mean (SD))	75 (66-88)
Height (cm mean (SD))	168 (160-174)
HTN n (%)	222 (22.1)
Smoking n (%)	73 (7.3)
Diabetes n (%)	50 (5.0)
Dyslipidemia n (%)	98 (9.7)
History of ischemic heart disease n (%)	140 (13.9)
Chronic kidney disease n (%)	10 (1.0)
Province	
Buenos Aires n (%)	73 (7.3)
Chaco n (%)	2 (0.2)
Córdoba n (%)	75 (7.5)
Corrientes n (%)	132 (13.1)
Entre Ríos n (%)	10 (1.0)
La Rioja n (%)	1 (0.1)
Misiones n (%)	2 (0.2)
San Luis n (%)	1 (0.1)
Santa Fe n (%)	710 (70.6)
MRI scanner brand	
General Electric n (%)	620 (61.6)
Philips n (%)	375 (37.3)
Siemens n (%)	11 (1.1)
Contrast agent use n (%)	975 (96.9)
Contrast agent dose	15 (10-20)
Macrocyclic contrast agent n (%)	594 (61.9)
Tesla number	
1.5 T n (%)	807 (80.2)
3 T n (%)	199 (19.8)
Complications	5 (0.5)
Cardiac MRI indication	
Stress test (dipyridamole or adenosine) n (%)	6 (0.6)
Feasibility n (%)	123 (12.2)
Post-infarction complications n (%)	18 (1.8)
Nonischemic cardiomyopathy n (%)	561 (55.7)
Nonischemic dilated cardiomyopathy n (%)	191 (18.9)
Hypertrophic n (%)	180 (17.8)
Arrhythmogenic RV cardiomyopathy n (%)	51 (5.1)
Restrictive n (%)	18 (1.7)
Infiltrative n (%)	31 (3.8)
Noncompaction cardiomyopathy n (%)	60 (5.9)
Takotsubo n (%)	30 (2.9)
Myocarditis n (%)	64 (6.4)
Valve disease n (%)	71 (7.1)
Pericardial disease n (%)	19 (1.9)
Congenital heart disease n (%)	144 (14.3)

level of indication for evaluating precordial pain, and with a marked difference with international registries, showing this methodology being underused in our country.⁵ The most frequent indication in this registry was nonischemic cardiomyopathy, similarly to other international registries.^{10,11,12}

The pharmacological characteristics of the different extracellular gadolinium chelate complexes are very similar. The main difference between the molecules lies in their structure and ion charge, conditioning their capacity to modify tissue signaling. The stability of gadolinium chelates relates to their structure, that could be linear or macrocyclic. Macrocyclic complexes bind the gadolinium ion more strongly than those of linear structure, preventing the release of free gadolinium, remaining trapped within the macrocyclic structure after injection.¹³ The most feared adverse effect with gadolinium infusion is nephrogenic systemic fibrosis, a rare but highly lethal entity. The recorded cases of nephrogenic systemic fibrosis were reported with linear gadolinium agents.¹⁴ On the other hand, patients subjected to several injections (4-5 injections or more) of gadolinium contrast agents have been observed to present a signal increase in some brain areas (dentate nucleus and globus pallidus) due to T1 shortening, displaying gadolinium deposits in the brain. Linear gadolinium contrast agents seem to persist for a longer time than macrocyclic ones, that only show a transient increase in the brain and seem to experiment an early clearance; it is for this reason that macrocyclic gadolinium agents are advised.^{15,16,17} In this registry, the global use of macrocyclic contrast agents was 61.9%, with a statistically significant increase from the 2018-2020 period to the 2021-2022 period, from 54.3% to 83.5%, respectively ($p < 0.001$).

In this study, no severe adverse reactions were observed, and the incidence of mild reactions was higher than those reported previously: 0.5% vs 0.11%.¹⁸

Limitations

The percentage of patients admitted to the participating centers was not uniform, which, in some way, may generate a bias in the global information.

CONCLUSION

The IMAGEN AR-RMC registry is wide, showing the reality of cardiac MRI in Argentina. Cardiac MRI is a safe test, with an impact on the management of patients. Non-ischemic cardiomyopathies was the main indication for cardiac MRI, with a significant increase being observed in the use of macrocyclic gadolinium agents through the registry.

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TABLE 2.

Cardiac MRI sequences used in the tests

Sequence	N (%)
CINE SSFP	923 (91.7)
Fast Spin Echo (FSE)	570 (56.7)
T1-T2 and T2 with fat saturation	549 (54.6)
Flow sequence	410 (40.8)
Perfusion sequence	596 (59.2)
T1 Mapping	58 (5.8)
T2 Mapping	56 (5.6)
Tagging sequence	23 (2.3)
RT sequence	861 (85.6)
MR angiography	40 (4.0)
3D navigator (coronary arteries)	20 (2.0)

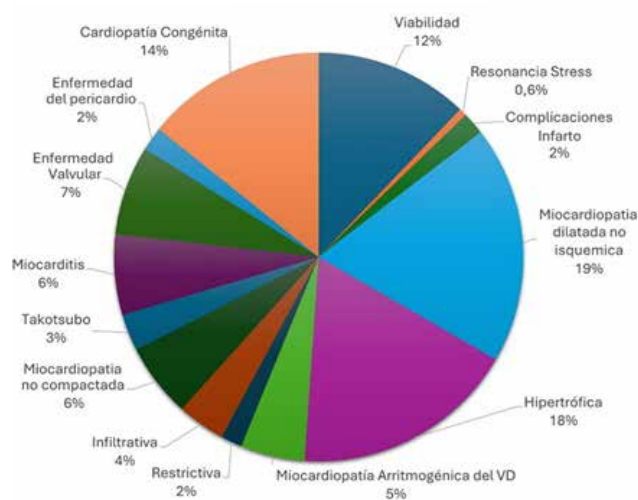


FIGURE 1.

Main cardiac MRI indications

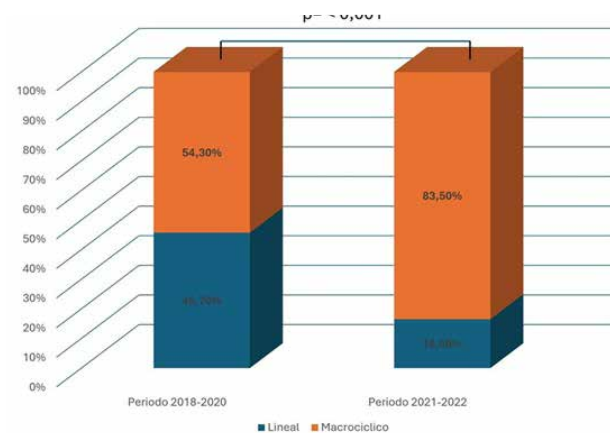


FIGURE 2.

Use of macrocyclic gadolinium contrast in the two periods analyzed.

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