The Importance of the Learning Curve in the Positive Predictive Value of Magnetic Resonance Myocardial Perfusion Imaging

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Magnetic resonance myocardial perfusion imaging (MRMPI) has an excellent accuracy for the detection of coronary artery disease[1] with positive predictive value (PPV) ranging from 77% to 83%,[2-4] according to the population studied. Variations in outcomes depend on several factors, such as cardiovascular risk, previous cardiovascular events, the type of vasodilator used or the magnetic field of the resonator, etc.

In the so-called real world, another reason that leads to the difference in the results of the 7method is the learning curve (LC). The change in the positive predictive value (PPV) of MRMPI has been investigated over the years since the implementation of single-center service.

From May 2013 to April 2017, MRMPI with dipyridamole was performed in 415 patients on the Achieva 1.5T device (Philips Healthcare, Best, The Netherlands). The protocol consisted of cine-resonance imaging scans followed by infusion of dipyridamole 0.56 mcg/kg in 4 minutes or 0.84 mcg/kg in 6 minutes in those cases where there was no increase of 20% of basal heart rate nor symptoms related to vasodilator use. In the end, 0.1 mmol/kg gadolinium at 5 ml/sec was administered, followed by 40 ml of saline solution for acquisition of perfusion images. Immediately after that, cine-resonance images of short-axis basal, middle and apical segments of the left ventricle were taken in order to investigate new segmental deficit induced by the stressor. Aminophylline injection was administered to reverse the effects of the drug. From the tenth minute of contrast infusion, late enhancement images were taken and then a new pulse for resting perfusion with 0.1 mmol/kg of gadolinium was performed. For diagnostic purposes, those tests with perfusion deficit in at least one myocardial segment, with or without associated late enhancement (LE), and without abnormalities in resting perfusion in the absence of LE, were considered positive.[4]

Comparison of MRMPI results was performed with cardiac catheterization (CAT). For this purpose, an active search was conducted in the Hemodynamic Service of the institution as well as through contact with the attending physicians requesting the CAT results when performed. The tests were considered positive when the perfusion deficit occurred in segments corresponding to coronary territory with stenosis ≥ 70% or left coronary trunk stenosis ≥ 50%.

Of the total, 87 tests (21%) were considered positive (Chart 1) and CAT was identified in 67 of them (22 women, mean age 69.1 years). Fifty-one tests were considered true positives (TP), allowing to calculate PPV in 76% (Table 1). When separated by year of service experience, the PPV was 70%, 67%, 82% and 85% in the first, second, third and fourth year respectively (Chart 2) or 69% and 83% for the groups of the first two years and from the third year, respectively (Chart 3).

The analysis of the actual improvement in the quality of the method was limited since the information of only most positive tests that led to CAT did not allow the analysis of sensitivity, specificity, negative predictive value (NPV) and accuracy of MRMPI in the service.

It is known that the LC is fundamental for improving the results of medical practice in all areas, but statistical data are hardly found about this statement. The literature presents articles on LC mainly in relation to invasive procedures. Regarding cardiovascular imaging methods, it has been demonstrated that there is improvement in results from the first year of experience with computed tomography angiography of the coronary arteries.[5] Regarding the assessment of left ventricular volumes through CMR, it was seen that beginner cardiologists tend to underestimate final systolic and diastolic volumes and overestimate left ventricular mass.[6] Upon analyzing a new technique for evaluating right ventricular (RV) systolic function by echocardiogram – the systolic excursion of the RV outflow tract – care was taken to eliminate the initial learning phase for echocardiographers to acquire expertise with the method.[7]

It is believed that it is important to recognize that initially the results of imaging methods may be short of those in the literature and the data presented here corroborate this in the scenario of MRMPI. Therefore, it is fundamental to remember the meaning of the LC, both for the cardiologist responsible for the method in its initial phase, to systematically seek familiarity with the factors that decrease diagnostic accuracy, as well as for the requesting physicians, to avoid drawing early negative conclusions regarding the method.

In conclusion, the MRMPI is a widely studied method in the context of diagnostic investigation of coronary artery disease presenting a good PPV. However, it is necessary to consider the need for the LC for a service to reach the PPV similar to that in the literature. In this single-center experience, this occurred from the third year, perhaps due to the low volume

Keywords

Predictive Value of Tests; Myocardial Perfusion Imaging; Magnetic Resonance Imaging; Coronary Artery Disease.

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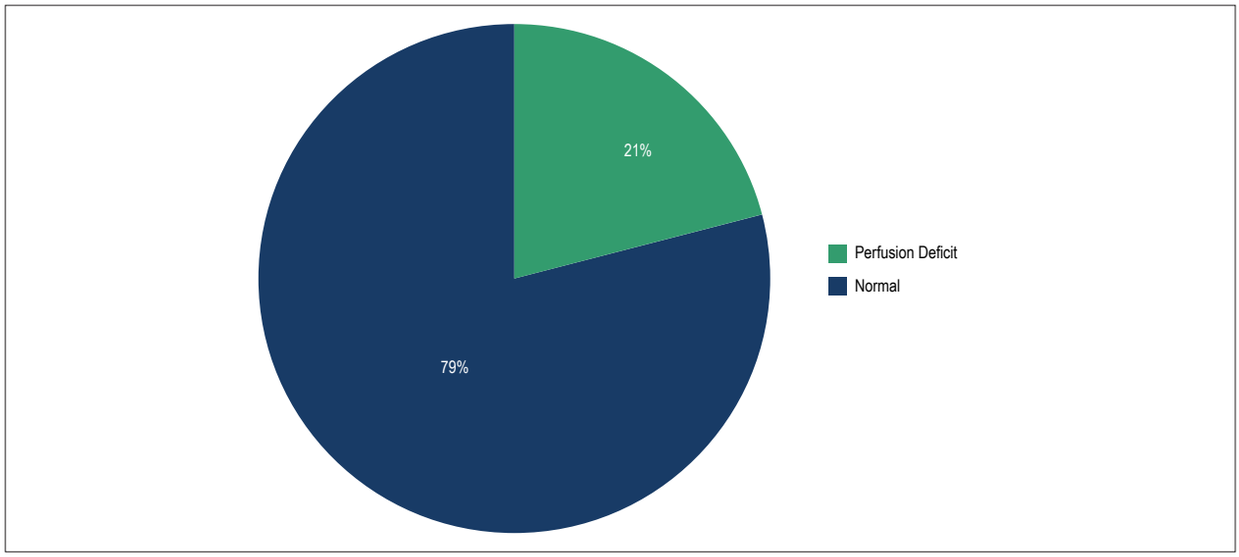

Chart 1 – *Percentage of exams with and without perfusion deficit.*

Table 1 –

	Positive tests	CAT	True positive	False positive	PPV
YEAR 1	24	20	14	6	70%
YEAR 2	15	12	8	4	67%
YEAR 3	31	22	18	4	82%
YEAR 4	17	13	11	2	85%
TOTAL	87	67	51	16	76%

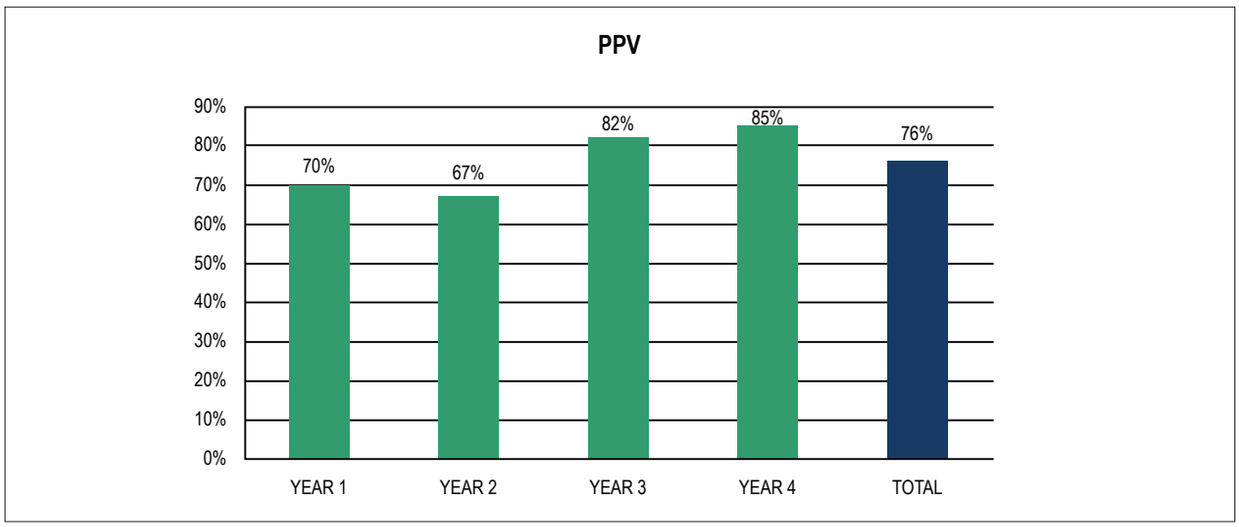

Chart 2 – *Analysis of positive predictive value according to the year of experience.*

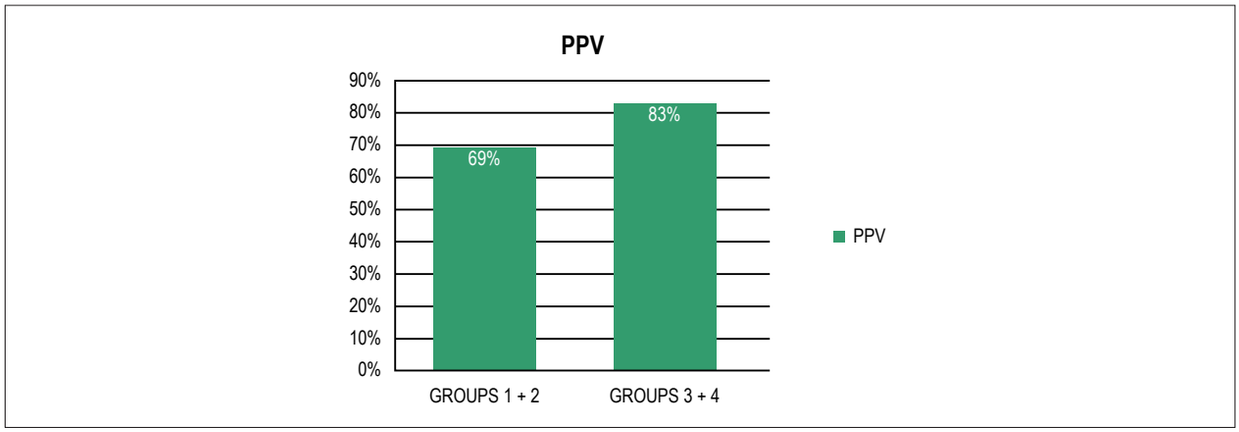

Chart 3 – *Analysis of positive predictive value according to the first and second half of experience.*

of exams performed at the institution. On the other hand, the results were excellent from the fourth year.

Authors' contributions

Research creation and design: Santana GF; Data acquisition: Santana GF, Gomes TO, Vieira ACR, Santos OP; Data analysis and interpretation: Santana GF, Gomes TO; Manuscript drafting: Santana GF; Critical revision of the manuscript as for important intellectual content: Gomes TO.

Potential Conflicts of Interest

There are no relevant conflicts of interest.

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