Non-compaction cardiomyopathy: How Can Imaging Contribute?

José de Arimateia Batista Araújo-Filho, Antonildes Nascimento Assunção-Jr., José Rodrigues Parga

Instituto do Coração do Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo; Hospital Sírio-Libanês, São Paulo, SP – Brazil

Non-compaction cardiomyopathy (NCCM) is a rare heterogeneous condition morphologically characterized by ventricular hypertrabeculation, with formation of deep intertrabecular recesses and differentiation of two distinct myocardial layers: a compacted one and a non-compacted.[1] As for the clinical presentation, although a significant portion of the patients may be asymptomatic, this condition may be associated with severe heart failure, thromboembolic events and ventricular arrhythmias.[2]

A number of gaps persist on etiopathogenesis, propaedeutic and treatment of NCCM; however, a relevant increase (an exponential increase in tertiary centers) in the diagnosis of NCCM has been observed in recent years. This is partially due to the increased awareness of the medical community about the disease, the recommended family screening and advances in cardiovascular imaging techniques. As opposed to this increase, there is a current concern of the societies of clinical cardiology and cardiovascular imaging on the growing number of false-positive cases diagnosed, with a tendency to overdiagnosis of the disease.[1]

The scientific evidence available today no longer supports the classical theory that failures in the myocardial compaction process during the first weeks of fetal life were a pathophysiological substrate for NCCM.[3] Furthermore, it is unclear, to date, whether ventricular hypertrabeculation classically associated with NCCM characterizes a separate form of cardiomyopathy (genetically defined or not), a phenotypic trait shared by different cardiomyopathies[4] or simply an "epiphenomenon" without any additional clinical implications.

It is worth noting that the cardiac morphological analysis isolated by any imaging method is insufficient for the definitive diagnosis of NCCM, and there is no diagnostic tool – not even any genetic tools – that can accurately attest its recognition. The absence of a gold standard is the main reason why all imaging tests available have different limitations in the propaedeutic of NCCM, which justifies frequent reports of "probable" diagnostic impressions, to the detriment of the use of terms such as "suggestive" or "compatible" on suspicion of the disease. Especially regarding NCCM, one should have the primary understanding that clinical evaluation is absolutely sovereign, being of central importance for an accurate diagnosis and therapeutic decision. A flowchart suggested by Aung et al.[5] for the flow of patients suspected with NCCM has been widely accepted and is represented in figure 1.

Among the imaging methods available for evaluating ventricular hypertrabeculation, cardiovascular magnetic resonance imaging (CMRI) is considered the best diagnostic modality due to its superior spatial resolution (with better evaluation of the apical segments – most frequently affected). It is also the method with the greatest reproducibility in the evaluation of cardiac function, which is important in the follow-up of these patients. The Petersen criterion in CMRI (non-compacted myocardium - NC/Compacted ≥ 2.3) has been the most used one because it presents high post-test probability in populations at higher risk.[1]

CMRI is still especially important in the differential diagnosis of cases of ventricular hypertrabeculation associated with different cardiopathies or even observed in normal individuals (including athletes and pregnant women), and is able to detect the presence of focal myocardial fibrosis using myocardial late enhancement (MLE), usually related to lower ejection fraction, ventricular arrhythmia and worse prognosis.[6]

In addition to its importance in the risk stratification of patients with clinical suspicion of NCCM, a recent multicenter study[2] evaluated the prognostic importance of CMRI findings by following up 113 patients for 48 ± 24 months and concluding that no adverse events (from hospital admission to death due to cardiac causes) occurred in the absence of ventricular dilatation or positive MLE, corroborating the relevant value of the method in the context of the disease.

In recent years, technological innovations, including T1 mapping using CMRI, have introduced new concepts in myocardial characterization in several cardiomyopathies, with an incremental value to the LE technique. This new and promising technique has allowed a non-invasive investigation of changes in the interstitial myocardial architecture potentially associated with cardiomyopathies in general (ischemic and non-ischemic cardiomyopathies) by estimating myocardial extracellular volume (ECV), an important indirect measure for the detection of diffuse interstitial fibrosis.[7] If, on the one hand, focal fibrosis detected by MLE is considered an irreversible myocardial damage, even after treatment, on the other hand, T1 mapping innovates by allowing the recognition of diffuse myocardial disorders in early and potentially treatable stages.[8]

Specifically in patients diagnosed with NCCM, our recent group demonstrated, through T1 mapping, the existence of an extracellular expansion by diffuse interstitial fibrosis

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Mailing Address: José de Arimateia Batista Araújo-Filho •
Instituto do Coração do Hospital das Clínicas da Universidade de São Paulo
Setor de Imagem Cardiovascular
Av. Dr. Enéas Carvalho de Aguiar, 44, 1 subsolo. Postal Code 05403-900, Cerqueira César, São Paulo, SP - Brazil
E-mail: ariaraujocg@gmail.com

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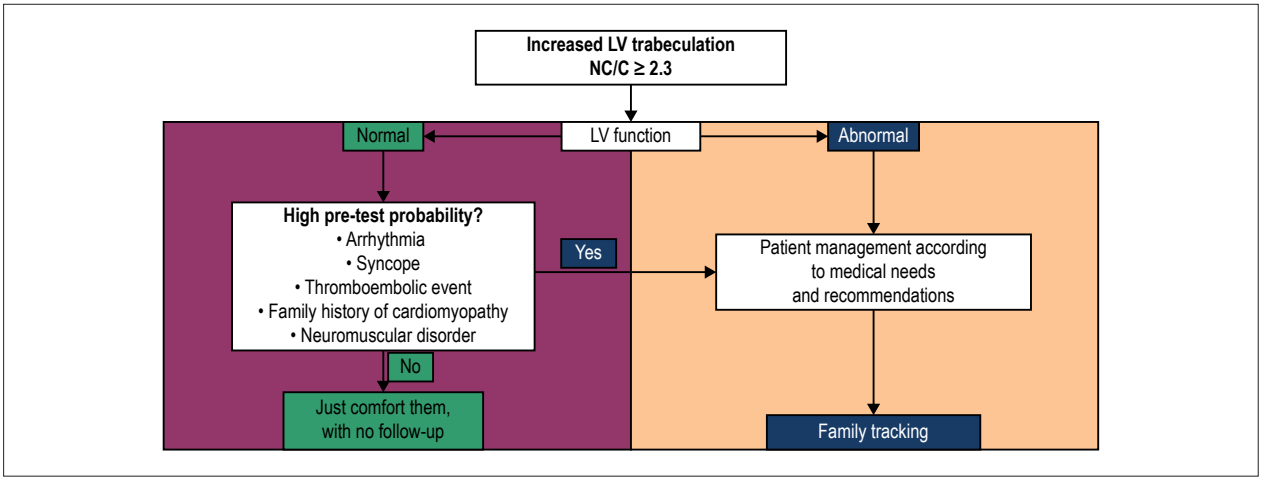

Figure 1 – *Propaedeutic algorithm proposed by Aung et al.[5] for the clinical management of patients with ventricular hypertrabeculation. LV: left ventricle; NC/C: non-compacted/compacted myocardium ratio.*

in the myocardium without focal fibrosis on LE, which was associated with increased ventricular dysfunction and arrhythmias using 24-hour Holter.[9] These findings suggest the potential value of this technique in refining risk stratification also in patients with NCCM, which still needs to be clinically validated in future prospective studies with more adequate designs. Another finding of this study was especially relevant: the absence of correlation between the size of hypertrabeculation and the amount of interstitial fibrosis, indicating that this ventricular disorder is most probably an epiphenomenon than a mediator of adversity.

Apart from all of these concerns, new efforts for multicenter and prospective studies with proper correlation between clinical and genetic data and imaging and pathology findings are essential to shed new light on the mystery of this intriguing and heterogeneous condition, elucidating many of the gaps that still persist on this topic.

Authors' contributions

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Potential Conflicts of Interest

There are no relevant conflicts of interest.

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References

1. Towbin JA, Lorts A, Jefferies JL. Left ventricular non-compaction cardiomyopathy. Lancet. 2015;386(9995):813–25.
2. Andreini D, Pontone G, Bogaert J, Roghi A, Barison A, Schwitter J, et al. Long-term prognostic value of cardiac magnetic resonance in left ventricle noncompaction. J Am Coll Cardiol. 2016;68(20):2166-81.
3. Anderson RH, Jensen B, Mohun TJ, Hons BA, Petersen SE, Aung N, et al. Key Questions Relating to Left Ventricular Noncompaction Cardiomyopathy: Is the Emperor Still Wearing Any Clothes? Can J Cardiol [Internet]. 2017;1–11. Can J Cardiol. 2017;33(6):747–57.
4. Arbustini E, Weidemann F, Hall JL. Left ventricular noncompaction: A distinct cardiomyopathy or a trait shared by different cardiac diseases? J Am Coll Cardiol. 2014;64(17):1840–50.
5. Aung N, Zemrak F, Mohiddin SA, Mbc HB, Petersen SE, Hil DP. LV Noncompaction Cardiomyopathy or Just a Lot of Trabeculations? 2017;10(6):4–7.
6. Nucifora G, Aquaro GD, Pingitore A, Masci PG, Lombardi M. Myocardial fibrosis in isolated left ventricular non-compaction and its relation to disease severity. Eur J Heart Fail. 2011;13(2):170–6.
7. Taylor AJ, Salerno M, Dharmakumar R, Jerosch-Herold M. T1 Mapping Basic Techniques and Clinical Applications. JACC Cardiovasc Imaging. 2016;9(1):67–81.
8. Puntmann VO, Peker E, Chandrashekhar Y, Nagel E. T1 Mapping in Characterizing Myocardial Disease: A Comprehensive Review. Circ Res. 2016;119(2):277–99.
9. Araujo-Filho JAB, Assuncao-Jr AN, Tavares de Melo MD, Lima CR, Dantas Jr RND, Nomura CH, Salemi VMC, Parga JR. Myocardial T1 mapping and extracellular volume quantification in patients with left ventricular non-compaction cardiomyopathy. Eur Heart J Cardiovasc Imaging 2018; 19(8):888-95.