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Advances in dilated cardiomyopathy evaluation via cardiac MRI diagnosis and prognosis: a literature review

Avanços na avaliação da cardiomiopatia dilatada por meio do diagnóstico e prognóstico da ressonância magnética cardíaca: uma revisão da literatura

Avances en la evaluación de la miocardiopatía dilatada mediante diagnóstico y pronóstico por resonancia magnética cardiaca: una revisión bibliográfica

Alex Fernando Abarca Real
https://orcid.org/0009-0002-9173-6066
Cardiologist, Chief of the Cardiology and Critical Area, Hospital Geriátrico Dr Bolivar Argüello P. Ecuador
nandos_afar@hotmail.com (correspondence)

Jessica del Rocio Flores Obregón
https://orcid.org/0009-0001-2097-3921
Graduate researcher. Physician, Hospital Geriátrico Dr Bolivar Argüello P. Ecuador
jessitaf@hotmail.com

Magaly Morelia Sacancela Usiña
https://orcid.org/0000-0002-8690-0039
Graduate researcher. Physician, Universidad de las Américas, Ecuador
magalysacancela@gmail.com

Juan José Martínez Saltos
https://orcid.org/0009-0000-8056-7602
Graduate researcher. Physician, Ministerio de Salud Pública del Ecuador
jjosemartinez111@gmail.com

Ronie Hugo Crespo Tonato
https://orcid.org/0009-0003-4070-9575
Independent graduate researcher. Physician, Ecuador
ronnycrespo18@gmail.com

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The use of cardiac magnetic resonance imaging (CMR) in diagnosing and managing dilated cardiomyopathy (DCM) offers significant practical implications for clinical practice. CMR provides precise evaluation of cardiac shape, function, and tissue composition, enhancing diagnostic accuracy and distinguishing between ischemic and non-ischemic DCM. Identification of mid-wall fibrosis using CMR aids in risk stratification and treatment planning, potentially improving patient outcomes and clinical care.
Originality/value:
This review underscores the evolving role of CMR in transforming the diagnosis, prognosis, and treatment of DCM. By synthesizing current research and guidelines, it highlights CMR's superiority over conventional methods like echocardiography in comprehensively assessing cardiac structure and function. Advanced CMR techniques, such as T1 mapping and late gadolinium enhancement (LGE) imaging, offer new prognostic indicators and enhance risk stratification in DCM. The discussion on CMR's application in familial DCM emphasizes the importance of integrating genetic data with imaging findings for optimized patient care. Overall, this review contributes to the growing evidence supporting CMR's pivotal role in advancing DCM management and improving patient outcomes.

ABSTRACT

With a variety of aetiologies and clinical presentations, Dilated Cardiomyopathy (DCM) presents considerable hurdles for both diagnosis and treatment. Cardiac magnetic resonance imaging (CMR) has become a useful diagnostic technique for DCM, providing information on the anatomy, physiology, and tissue properties of the heart. Using both well-established and recently developed CMR techniques, this review investigates the function of CMR in the diagnosis and treatment of idiopathic DCM. Using reliable databases, a thorough search of the literature was carried out with an emphasis on papers released between 2014 and 2024. English-language literature examining the clinical uses of CMR in idiopathic DCM were included in the inclusion criteria. A vital component of the assessment of dilated cardiomyopathy (DCM) is cardiac magnetic resonance imaging (CMR), which provides thorough insights into the anatomy and function of the heart. Precise evaluation of tissue properties, ventricular function, and cardiac shape is made possible by CMR, which helps DCM patients get an accurate diagnosis and risk assessment. The use of advanced CMR methods, such as T1 mapping and late gadolinium enhancement (LGE) imaging, yields significant insights into the underlying aetiologies and myocardial fibrosis. Furthermore, customized prognostic evaluations are provided by CMR-based risk stratification algorithms that include many factors, improving clinical decision-making in DCM treatment. Continuous developments are expected to improve prognostic utility and accuracy, which will need efforts to lower prices and increase accessibility in order to achieve better patient outcomes and wider clinical usage.

Keywords: Magnetic resonance, dilated cardiomyopathy, literature review, evidence.

RESUMO

Com uma variedade de etiologias e apresentações clínicas, a cardiomiopatia dilatada (CMD) apresenta obstáculos consideráveis tanto para o diagnóstico quanto para o tratamento. A ressonância magnética cardíaca (RMC) tornou-se uma técnica de diagnóstico útil para a CMD, fornecendo informações sobre a anatomia, a fisiologia e as propriedades do tecido do coração. Usando técnicas de RMC bem estabelecidas e recentemente desenvolvidas, esta revisão investiga a função da RMC no diagnóstico e tratamento da CMD idiopática. Usando bancos de dados confiáveis, foi realizada uma pesquisa completa da literatura com ênfase em artigos publicados entre 2014 e 2024. A literatura em inglês que examina os usos clínicos da RMC na CMD idiopática foi incluída nos critérios de inclusão. Um componente vital da avaliação da cardiomiopatia dilatada (CMD) é a ressonância magnética cardíaca (RMC), que fornece informações detalhadas sobre a anatomia e a função do coração. A avaliação precisa das propriedades do tecido, da função ventricular e do formato cardíaco é possível por meio da RMC, o que ajuda os pacientes com CMD a obter um diagnóstico preciso e uma avaliação de risco. O uso de métodos avançados de CMR, como o mapeamento T1 e a imagem de realce tardio com gadolínio (LGE), produz percepções significativas sobre as etiologias subjacentes e a fibrose miocárdica. Além disso, avaliações prognósticas personalizadas são fornecidas por algoritmos de estratificação de risco baseados em CMR que incluem muitos fatores, melhorando a tomada de decisões clínicas no tratamento da DCM. Espera-se que os desenvolvimentos contínuos melhorem a utilidade e a precisão do prognóstico, o que exigirá esforços para reduzir os preços e aumentar a acessibilidade, a fim de obter melhores resultados para os pacientes e um uso clínico mais amplo.

Palavras-chave: Ressonância magnética, cardiomiopatia dilatada, revisão da literatura, evidências.

RESUMEN

Con una variedad de etiologías y presentaciones clínicas, la miocardiopatía dilatada (MCD) presenta obstáculos considerables tanto para el diagnóstico como para el tratamiento. La resonancia magnética cardiaca (RMC) se ha convertido en una técnica diagnóstica útil para la MCD, ya que proporciona información sobre la anatomía, la fisiología y las propiedades tisulares del corazón. Esta revisión investiga la función de la RMC en el diagnóstico y el tratamiento de la MCD idiopática mediante técnicas de RMC bien establecidas y de reciente desarrollo. Utilizando bases de datos fiables, se llevó a cabo una búsqueda exhaustiva de la literatura con énfasis en los artículos publicados entre 2014 y 2024. Los criterios de inclusión incluyeron la literatura en inglés que examinaba los usos clínicos de la RMC en la MCD idiopática. Un componente vital de la evaluación de la miocardiopatía dilatada (MCD) es la resonancia magnética cardiaca (RMC), que proporciona una visión completa de la anatomía y la función del corazón. La RMC permite evaluar con precisión las propiedades de los tejidos, la función ventricular y la forma del corazón, lo que ayuda a los pacientes con MCD a obtener un diagnóstico y una evaluación del riesgo precisos. El uso de métodos avanzados de RMC, como el mapeo T1 y las imágenes con realce tardío de gadolinio (RTG), aporta información significativa sobre las etiologías subyacentes y la fibrosis miocárdica. Además, los algoritmos de estratificación del riesgo basados en la RMC proporcionan evaluaciones pronósticas personalizadas que incluyen muchos factores, lo que mejora la toma de decisiones clínicas en el tratamiento de la MCD. Se espera que los continuos avances mejoren la utilidad y precisión de los pronósticos, lo que requerirá esfuerzos para reducir los precios y aumentar la accesibilidad con el fin de lograr mejores resultados para los pacientes y un uso clínico más amplio.

Palabras clave: Resonancia magnética, miocardiopatía dilatada, revisión bibliográfica, evidencia reciente.

INTRODUCTION

The most prevalent kind of cardiomyopathy, dilated cardiomyopathy (DCM), may have a variety of reasons and manifest clinically as heart failure, sometimes necessitating heart transplantation, as well as an increased risk of ventricular arrhythmias and/or sudden cardiac death (McKenna et al., 2017). In the absence of aberrant loading circumstances (such as uncontrolled hypertension, valvular heart disease, congenital heart disease, or severe coronary artery disease), idiopathic DCM is characterised by a dilated left ventricle (LV) with reduced systolic function (Koutalas et al., 2013).

Due mostly to variances in geographic locations and modifications in diagnostic criteria, the incidence of DCM varies from 1/2500 to 1/250 persons (Merlo et al., 2018). Up to 40% of DCM may be inherited, according to recent genetic screening research, and the pathophysiology of the disease has been linked to abnormalities in more than 40 distinct genes (Schultheiss et al., 2019).

DCM was once thought to be an irreversible condition with a poor prognosis and a late diagnosis. However, thanks to advancements in pharmacological and surgical treatment, the prognosis of DCM has significantly improved, with an estimated 85% survival rate after 10 years without the need for a heart transplant (Porcari et al., 2019).

Today's patients, however, often have substantial contractile dysfunction and bilateral ventricular remodelling by the time they are recognised, which is indicative of a protracted period of silent disease progression without symptoms and the onset of myocardial fibrosis. Extensive description of these variables is essential for bettering clinical care and prognostic grouping of DCM patients. In this context, cardiac magnetic resonance (CMR) appears as a dependable imaging technique that offers key information on tissue composition as well as functional and structural data (Abbasi et al., 2013). Tissue characterization is helpful in the differential diagnosis of secondary causes of DCM and in assessing the likelihood of ventricular remodelling, which may help to guide customised treatment plans. Imaging techniques such as late gadolinium enhancement (LGE) and qualitative/quantitative parameters such as T1 mapping, T2 mapping, and T2* mapping are employed in this process (Francone, 2014) .

This paper reviews the use of CMR in the diagnosis and treatment of idiopathic DCM, including a comprehensive summary of the clinical applicability of both established and newly developed CMR contrast-based approaches. This aligns with the latest data and recommendations that surpass conventional prognostic indicators like ejection fraction.

METHODS

We used an integrative approach in this study to investigate the use of cardiac magnetic resonance (CMR) in the identification and management of idiopathic dilated cardiomyopathy (DCM). We searched credible resources like Scopus, Google Scholar, and PubMed for papers that were published between 2014 and 2024. "Dilated cardiomyopathy," "cardiac magnetic resonance," "CMR," and associated phrases were among the important search terms. To ensure a thorough coverage of the subject, search queries were refined using Boolean operators.

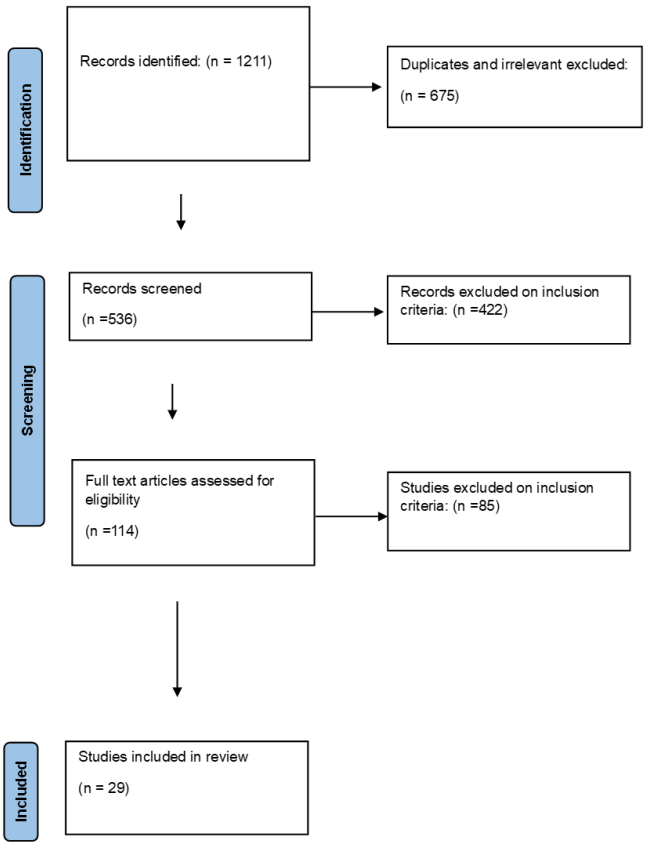
Inclusion and exclusion criteria:

Studies had to fulfill certain criteria in order to be included: they had to be published in English within the allotted time frame, look into the clinical uses of CMR in idiopathic DCM, involve human subjects, and provide important new information about the condition's diagnosis, prognosis, or course of treatment. Studies that did not fit these criteria, were not methodologically rigorous, or did not make a significant contribution to our knowledge of the uses of CMR in idiopathic DCM were excluded. Based on these standards, every chosen research was carefully assessed to make sure it was relevant and applicable to the goals of the review.

Categorization and analysis:

Based on their clinical uses and important findings about the application of CMR in idiopathic DCM, a selection of papers was grouped and examined. Prognostic evaluation and risk stratification, therapeutic monitoring and therapy assistance, and diagnostic accuracy and etiology discrimination were among the categories covered. To provide a thorough review of CMR's clinical usefulness in idiopathic dilated cardiomyopathy, data were synthesized within each category. This technique provided insights into the function of CMR in improving the diagnosis, prognosis, and therapy of idiopathic DCM, ensuring a systematic and comprehensive study.

Figure 1. Flow diagram for literature review



Source: own elaboration (2024)

RESULTS AND DISCUSSION

Cardiac Magnetic Resonance:

The noninvasive diagnostic imaging technique known as cardiac magnetic resonance (CMR) has received substantial validation. In the treatment of patients with dilated cardiomyopathy (DCM), its capacity to evaluate cardiac shape and function as well as to accurately and consistently characterise myocardial tissue, is essential (Vitrella et al., 2019). It specifically improves diagnostic precision, helps identify the cause of left ventricular (LV) dysfunction, and facilitates prognosis classification.

Evolving Role of CMR in Cardiomyopathy:

The term "non-ischemic DCM" refers to a group of disorders with a variety of clinical manifestations and natural histories that mainly impact the heart muscle. Knowing the cause of each form of cardiomyopathy is crucial for clinical decision-making as it affects the best course of therapy and prognosis (Porcari et al., 2019). The diagnosis, aetiology, risk assessment, and prognosis are all significantly impacted by cardiovascular imaging (Neubauer et al., 2019). First, CMR offers valuable insights into the aetiology and prognosis of underlying heart failure by characterising the myocardial tissue using numerous distinct imaging parameters. According to the most recent guidelines on cardiomyopathy from the European Society of Cardiology (ESC 2023), CMR (Class IIa, Level C) should be taken into consideration in DCM in order to differentiate between an ischemic and non-ischemic aetiology, and in HCM in order to make a differential diagnosis and evaluate the diagnostic criteria (Arbelo et al., 2023).

Chamber size quantification, myocardial wall thicknesses, ventricular function and mass measurement using conventional cine sequences, steady-state free precession (SSFP), in short and long axis (2, 3, and 4 chamber) view, and tissue characterization sequences are all essential components of a precise and repeatable cardiac evaluation. Myocardial vitality may be evaluated and histological alterations and fibrosis biomarkers are correlated with fibrosis detected by late gadolinium enhancement (LGE) (Valbuena-López et al., 2016). With considerable specificity, the LGE pattern enables the differential diagnosis of ischemia vs non-ischemic DCM (Brown et al., 2019). When it comes to DCM, mid-wall fibrosis is an independent predictor of death and morbidity in addition to left ventricular ejection fraction (LVEF). LGE was seen in around 30% of

carriers with maintained LVEF in a research including 150 phospholamban (PLN) p.Arg14del mutant carriers. This finding suggests fibrosis may be an early hallmark of PLN p.Arg14del cardiomyopathy, which may result in HF and ventricular arrhythmia (Te Rijdt et al., 2019).

A new and reliable CMR method that provides quantitative measurements of the cardiac signal is called T1 mapping. It produces a pixel-by-pixel parametric map where each pixel represents the color-coded absolute value of T1 (Baggiano et al., 2020). Additionally, it assesses the extracellular volume (ECV) percentage directly from T1 measurements both before (native T1) and after gadolinium delivery. Recent research indicates that ECV and native T1 are becoming independent prognostic indicators of mortality in DCM patients, regardless of the existence of both LVEF and LGE [12]. Additionally, it seems that an elevated native T1 value exists as a pre-existing imaging signal of unfavourable outcomes prior to the occurrence of LGE [13]. For individuals with hypertrophic cardiomyopathy (HCM), the presence of fibrosis detectable microscopically in CMR on LGE pictures also constitutes a risk factor. The likelihood of sudden cardiac death (SCD) is correlated with the degree and prevalence of fibrosis in LGE (He et al., 2018). Particularly when LGE is ≥15% of the left ventricular (LV) mass, which revealed a considerable increase in SCD risk, the magnitude of LGE seems to have greater discriminating value than its existence (Chan et al., 2014). Even in non-hypertrophic segments with retained contraction function or in individuals without LGE, increased native myocardial T1 values and an elevated ECV percentage were seen in HCM patients, indicating that myocardial tissue remodelling may occur prior to morphological and functional alterations (Xu et al., 2020). Additionally, the CMR became essential for identification and arrhythmic event risk categorization in individuals with arrhythmogenic cardiomyopathy.

Cardiac Imaging in Familial DCMs:

Echocardiography has defined DCM as follows: LV enlargement; LV end diastolic diameter (LVEDD) greater than 117% (2SD (112%) plus 5%); LV end diastolic volume (LVEDV) greater than 2SD of the predicted value, as corrected for age and body surface area, excluding any known cause resulting in the myocardial abnormality observed (Lau et al., 2023). These parameters indicate the degree of systolic impairment.

The gold standard for measuring myocardial mass, ejection fraction, and ventricular volume is cardiovascular magnetic resonance imaging (CMR). Furthermore, myocardial oedema is detected by CMR and, if present, may indicate an inflammatory aetiology for the observed phenotype (Lau et al., 2023). A large extracellular volume (ECV) percentage and a long native myocardial T1 duration may be useful in distinguishing DCM from iron overload cardiomyopathy or athletic heart adaptation. For the purpose of assessing the likelihood of malignant ventricular arrhythmias, the presence, pattern, and load of late gadolinium enhancement (LGE) may be useful. In certain cases, echocardiography may not be the best option, in which case CMR is suggested as a substitute. Early DCM is characterised by progressive increases in chamber size, aberrant strain, and LGE (Japp et al., 2016). Imaging-based longitudinal investigations conducted over several years are necessary to define the course of DCM in genetically prone individuals. Higher volume and ejection fraction repeatability are provided by CMR, which may also make it possible to identify minute variations in mutant carrier monitoring. Even in patients with established diffuse fibrosis, whose native T1 is lengthy and ECV is high, LGE may be misleadingly comforting since it identifies replacement fibrosis but not diffuse fibrosis.

According to an ESC Position Paper, Amin et al. showed that integrating CMR with genetic data improves DCM classification and causes a shift in treatment (Amin et al., 2020). LGE's measure of fibrosis in DCM is predictive of hospitalisation and death, especially ventricular arrhythmias (Gao et al., 2019).

Genetic variations implicated in a DCM phenotype have been investigated using imaging features of DCM (Becker et al., 2018). Four related genes were found by valuing around 6,000 cardiac imaging patients from the Candidate Gene Association Resource (CARe) Study and over 2,000 participants from the Multi-Ethnic Study of Atherosclerosis (MESA) with CMR. Based on the variants most strongly associated with DCM phenotypic variables on CMR, Pirrucello et al, analysed CMR-derived left ventricular measurements in 36,000 UK Biobank and 2000 Multi-Ethnic Study of Atherosclerosis participants, discovering 45 new loci and creating a polygenic score for DCM prediction (Pirruccello et al., 2020).

Traditional Risk Stratification Approach in DCM:

About 30% of people with DCM still have a deadly risk of developing SCD, which is related to arrhythmia. An implanted cardiac defibrillator (ICD) is a useful tool in the fight against SCD. According to current recommendations, an ejection fraction (EF) of less than 35% should be used to select for ICD (Priori et al., 2015). However, the majority of cases of SCD occur in people with maintained systolic function (EF > 35%) who had not previously shown signs of primary preventive ICD. According to the DANISH experiment, having an ICD implanted may increase survival for younger patients. According to subgroup analysis, patients under 70 years old who had ICDs had a substantial survival advantage because they were at a reduced risk of non-sudden death; as a result, their calculated ratio of sudden to non-sudden death was greater (Køber et al., 2016).

While LVEF values might range across various imaging modalities, CMR has been the gold standard method for assessing LV volume and function and has the additional advantage of tissue characterisation. An indexed left ventricular end-diastolic volume (LVEDVi) on CMR > 120.5 mL/m2 and the presence of more than three segments with midwall fibrosis are independent predictors of all causes of death (Guaricci et al., 2021). Because of direct right ventricular involvement, Juillière et al. found that right ventricular ejection fraction (RVEF) is a minor predictor of hospitalisation for heart failure (HF) in patients with DCM and an independent predictor of all-cause mortality (Perone et al., 2024). The left atrial volume index (LAVi), a sensitive indicator of LV filling pressure and a significant predictor of transplant-free survival and heart failure risk, is another parameter that might be assessed by CMR (Perone et al., 2024).

LGE as a New Approach to Risk Stratification in DCM:

Ventricular arrhythmias and sudden cardiac death are defined by risk stratification in individuals with DCM. The presence of LGE alters the prognosis during the risk assessment, indicating a poorer result (Hammersley, Jones, et al., 2023). those with LGE had a higher risk of adverse cardiovascular events than those without microscopically detectable fibrosis, according to research by Becker et al (Becker et al., 2018). LGE predicted cardiovascular death as the outcome in DCM participants, with a pooled OR of 3.40 and ventricular arrhythmic events of 4.52. LGE was shown by Alba et al. to be an unfavorable prognostic factor in a group of 1672 DCM patients (Alba et al., 2020). There was a 4.0% yearly risk of SCD or suitable ICD shock for those with LGE (39%) present. Rather, Di Marco and colleagues emphasized the robust negative predictor of LGE across the whole LVEF. Compared to patients with LGE present and an LVEF > 35%, those with an LVEF between 21% and 35% and no LGE were considered low-risk (Di Marco et al., 2021).

One in three DCM patients have LGE; the most prevalent pattern is non-ischemic, and the midwall or subepicardial distribution is often seen. Additive prognostic indicators may be found in a variety of patterns and places. Increased unfavorable arrhythmic risk is linked to subepicardial distribution, ring-like pattern, and septal or multiple-site placement. Additionally, a number of studies revealed that the presence of numerous patterns was associated with an elevated risk (Alba et al., 2020)(Di Marco et al., 2021). However, the prognosis is also altered by the dispersion place. When comparing individuals with LGE in the septum and free wall to those with LGE in the septum alone, Claver et al. reported a higher rate of sudden cardiac death (Claver et al., 2023). Rather, it is thought that LGE shown in the right ventricular insertion is an indiscriminate pattern. A significant reduction in the incidence of arrhythmic events was observed in subjects with the right ventricular insertion points pattern (IP-LGE pattern) as compared to the IP and LV–LGE pattern (LGE present in both the left ventricle and the right ventricular insertion points) in a large cohort study of patients with idiopathic DCM. Additionally, it was shown that LGE-negative individuals had a comparable incidence. Lastly, only around 5% of DCM patients had the ischemia pattern identified (Claver et al., 2023). This LGE pattern was linked to lower long-term outcomes, according to De Angelis et al, with an adjusted hazard ratio of 2.1 (De Angelis et al., 2022). Notably, our group conducted a recent prospective observational cohort study examining the natural history of fibrosis in 254 patients with early non-ischaemic DCM assessed by CMR (median follow-up 7.9 years). The study revealed that fibrosis develops early in the phenotypic course and that thorough characterization improves risk stratification and may help with clinical management (Hammersley, Jones, et al., 2023).

T1 and ECV Quantification in DCM:

Extracellular volume (ECV) and T1 mapping may help with risk categorization in DCM patients. This non-invasive method of evaluating cardiac fibrosis may be useful, particularly in patients whose LGE results are negative.

A prospective longitudinal, multicenter investigation with a 2-year follow-up of 225 patients having a formal diagnosis of DCM was carried out by Cadour et al. (Cadour et al., 2023). They showed that in this cohort, T1 mapping acted as an independent predictor of occurrences associated to arrhythmias. Furthermore, it was shown that in individuals with both positive and negative LGE, the predictive significance of T1 mapping was substantially linked to cardiac mortality and heart transplantation (Li et al., 2022). T1 mapping had a considerable predictive significance in a group of 1242 DCM patients, according to a recent meta-analysis (Kiaos et al., 2020). In particular, the composite outcome of death and morbidity had an HR of 1.20.

ECV also seems to be a potential method that may help with prognosis classification in DCM patients. ECV was shown to be an independent predictor of ventricular tachycardia in DCM by Rubiō et al (Rubiś et al., 2021). It was shown that ECV with a value > 32.1% was an independent predictor and linked to a four-fold increase in the risk of heart failure events in addition to the incidence of arrhythmia-related events (Cadour et al., 2023). Moreover, ECV showed predictive significance even in DCM patients with negative LGE (Li et al., 2022). In 240 patients with DCM followed for a median of 3.8 years, Vita et al. found that for every 10% increase in ECV, there was a 2.8-fold adjusted increase in risk of major adverse cardiovascular events (MACE) ($p < 0.001$) (Vita et al., 2019). Rather, ECV was linked to an HR of 1.38 for a composite outcome of death and morbidity, as shown by Kiaos et al (Kiaos et al., 2020).

Promising metrics for DCM patient risk classification include T1 mapping and ECV. For these parametric mapping sequences to be widely used in clinical practice and to be used consistently, larger, multicenter trials are needed. Important prognostic indicators might be added by T1 mapping and ECV to the DCM decision-making algorithm with negative LGE. These methods do, in fact, have the sensitivity to evaluate the illness during its early stages and provide fresh prognostic guidance based on the current standard of clinical and echocardiographic characteristics. Patients with DCM may benefit greatly from a multiparametric strategy that includes LGE, T1 mapping, and ECV for arrhythmia risk classification.

Advanced LGE-Based Methods: Myocardial Entropy and Grey Zone Fibrosis:

Novel improved approaches are gaining traction in the field of cardiac imaging and might potentially provide good outcomes. When doing a CMR, the signal intensity in the myocardium is measured using LGE methods to determine the myocardial entropy, also known as left ventricular entropy (Antiochos et al., 2022). The goal of its use, as stated in the prior work, is to give more comprehensive tissue characterization when LGE pictures are acquired by looking at the extent to which fibrosis extends across the left ventricle above and beyond the visual and signal intensity thresholds presently employed in LGE imaging. Entropy is an independent predictor of death or arrhythmic events in patients who present with systolic dysfunction or retained left ventricular ejection fraction, according to several research in the area (Hammersley, Zaidi, et al., 2023). The aforementioned research also makes clear that entropy may also be evaluated in LGE pictures with minimum postprocessing when there is no macroscopic scar, identifying hidden cardiac risk factors, which can often be the case for these particular individuals.

A combination of viable and non-viable myocardium, grey zone fibrosis (GZF) has been identified as a marker of the arrhythmogenic substrate and has been connected to arrhythmic events in a number of investigations (Leyva et al., 2022). The idea behind its application stems from the pathophysiological role of fibrosis in arrhythmogenic events. Fibrotic corridors disrupt the normal function of the heart, obstructing electrical conduction and triggering the re-entry ventricular arrhythmia mechanism, which can be fatal to the patient. As a result, this investigation found that whereas individuals in the highest tertile of GZF had a significant risk of SCD or ventricular arrhythmias (VA), those in the lowest tertile had a low risk of both conditions (Leyva et al., 2022).

CMR's limitations in DCM:

While CMR is the gold standard for diagnosing cardiomyopathies, there are several limitations that need to be understood. Undoubtedly, there are recognised difficult investigations, such as those involving patients with arrhythmias or poor respiratory cooperation, which might make even volumetric analysis less than ideal. A growing number of patterns associated with high-risk genotypes, such Filamin C or Desmoplakin, have come to our attention. As previously noted, LGE patterns are predictive of SCD, ventricular tachycardia, all-cause mortality, and cardiovascular hospitalisation (Halliday et al., 2017). They may also be linked to certain kinds of DCM. On the other hand, LGE patterns are seen in between 60 and 90 percent of DCM patients, indicating a high degree of variability and, in some situations, a restricted specificity (Im et al., 2019). Furthermore, our comprehension of the many genotypes in hereditary DCM, their pathophysiology, and their phenotypic manifestation remains vast. Furthermore, the function of native mapping in cardiomyopathy has been investigated and is now undergoing further evaluation; still, patients with implanted devices lack certified reference numbers.

The review paper highlights how new imaging methods have a revolutionary effect on the diagnosis, prognosis, and treatment of dilated cardiomyopathy (DCM), a complicated cardiovascular illness. It focuses on the significance of cardiac magnetic resonance imaging (CMR) in this assessment. Due to its varied clinical history and complex origin, dilated cardiomyopathy—which is defined by left ventricular dilatation and systolic dysfunction—poses major clinical hurdles. Although echocardiography and other conventional diagnostic modalities have been essential in detecting structural problems in the heart, cardiac magnetic resonance (CMR) provides unmatched benefits in clarifying the properties of the heart's tissue and offering a thorough evaluation of the heart's function.

A major development in cardiovascular imaging is the use of CMR in the diagnosis and prognostication of DCM. Conventional DCM diagnostic standards have mostly depended on echocardiography, emphasizing systolic dysfunction and left ventricular hypertrophy (Lau et al., 2023). Nonetheless, cine sequences and steady-state free precession (SSFP) imaging provide accurate assessment of chamber size, myocardial wall thickness, and ventricular function, making CMR a unique benefit (Hammersley, Jones, et al., 2023). Furthermore, myocardial fibrosis and inflammatory alterations may be identified by tissue characterisation made possible by CMR. These findings are crucial in differentiating between ischemia and non-ischemic etiologies of DCM (Vitrella et al., 2019). The critical significance that CMR plays in risk assessment and treatment decision-making is highlighted by its capacity to identify mid-wall fibrosis, an independent predictor of unfavorable outcomes. CMR's capacity to precisely describe cardiac tissue is one of the major discoveries emphasized in the study, which helps distinguish between ischemia and non-ischemic causes of DCM. Methods like T1 mapping and late gadolinium enhancement (LGE) provide insightful information on inflammation and cardiac fibrosis, which helps with diagnosis and prognosis (Valbuena-López et al., 2016; Brown et al., 2019; Te Rijdt et al., 2019).

The talk focuses on the changing role of CMR in treating familial DCMs, a condition in which a hereditary predisposition makes therapy and disease progression more difficult (Lau et al., 2023). According to Neubauer et al. (2019), CMR is the gold standard for evaluating cardiac anatomy and function in these patients due to its superiority in estimating myocardial mass, ejection fraction, and ventricular volume. Crucially, extracellular volume (ECV) and cardiac edema may be detected by CMR, which offers significant insights into the pathophysiology and prognosis of the illness, especially when conventional echocardiogram may not be able to make a definitive diagnosis (Rubiō et al., 2021). The significance of a multidisciplinary approach in addressing familial DCMs is highlighted by the integration of CMR with genetic data, which improves diagnosis accuracy and treatment planning.

The research highlights how CMR has enabled a paradigm change in the way that risk categorization for DCM patients is done. CMR provides new prognostic signals, such as late gadolinium enhancement (LGE) and T1 mapping, to guide therapeutic measures, whereas prior techniques depended on left ventricular ejection fraction (LVEF) criteria (Guaricci et al., 2021). Fibrosis-related LGE patterns are strong indicators of unfavorable cardiovascular events, such as ventricular arrhythmias and sudden cardiac death (Becker et al., 2018). Furthermore, by identifying grey zone fibrosis (GZF) using sophisticated CMR methods, DCM's arrhythmogenic substrate is highlighted, improving risk assessment and directing individualized treatment plans (Leyva et al., 2022).

CONCLUSIONS

The study concludes by highlighting the critical role that cardiac magnetic resonance imaging (CMR) has played in changing the landscape of the diagnosis and treatment of dilated cardiomyopathy (DCM). Comprehending the structure, function, and tissue properties of the heart in great detail, cardiac magnetic resonance imaging (CMR) allows for accurate risk assessment and customized treatment plans based on the unique needs of each patient. Advanced CMR methods including T1 mapping and late gadolinium enhancement (LGE) imaging when combined provide unmatched diagnostic precision and prognostic value, which in turn improves patient outcomes and sharpens clinical judgment in DCM treatment.

Still, there are a few limitations to CMR despite its many benefits. Its broad acceptance and application in clinical practice is impeded by obstacles such as restricted availability, high cost, and contraindications in certain patient categories. In addition, the interpretation of CMR results requires specific knowledge and experience, emphasizing the need of continuing education and training programs to provide the best possible use of this potent imaging technique in DCM treatment.

Future developments in CMR seem to have potential for improving the technology's diagnostic and prognostic value in DCM. Targeted therapy interventions and risk classification algorithms may be further refined by advances in imaging technology, such as enhanced temporal and spatial resolution and the creation of new imaging biomarkers. Moreover, initiatives to lower the cost and improve accessibility to CMR imaging, along with longer clinical training programs, will be crucial to integrating these developments into standard clinical practice and, eventually, enhancing patient care and DCM treatment results.

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	% of contribution of each author				
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A. theoretical and conceptual foundations and problematization:	40%	15%	15%	15%	15%
B. data research and statistical analysis:	40%	15%	15%	15%	15%
C. elaboration of figures and tables:	40%	15%	15%	15%	15%
D. drafting, reviewing and writing of the text:	40%	15%	15%	15%	15%
E. selection of bibliographical references	40%	15%	15%	15%	15%
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