European Heart Journal Supplements (2025) **27** (Supplement 1), i40–i46
The Heart of the Matter
https://doi.org/10.1093/eurheartjsupp/suae099

ESC European Society of Cardiology

From thick walls to clear answers: approaches to diagnosing hypertrophic cardiomyopathy and its mimics

Filippo Angelini [1], Pier Paolo Bocchino [1], Veronica Dusi [1,2]*, Stefano Pidello[1], Gaetano Maria De Ferrari[1,2], and Claudia Raineri[1]

[1]Division of Cardiology, Cardiovascular and Thoracic Department, Città della Salute e della Scienza, Corso Bramante 88, 10126 Turin, Italy; and [2]Department of Medical Sciences, University of Turin, Corso Achille Mario Dogliotti, 14, 10126 Turin, Italy

KEYWORDS
Hypertrophic cardiomyopathy;
Amyloidosis;
Fabry disease;
Mitochondial disease;
Glycogen storage disease

Hypertrophic cardiomyopathy (HCM) is a genetic condition primarily caused by mutations in sarcomeric proteins, leading to abnormal thickening of the left ventricular wall. Although HCM is the most common genetic cardiovascular disorder, other conditions—such as cardiac amyloidosis, Fabry disease, and mitochondrial myopathies—can mimic its phenotype, complicating diagnosis. Accurate differentiation between HCM and its phenocopies is crucial, as these conditions differ in treatment, prognosis, and inheritance. This paper reviews the clinical, imaging, and laboratory tools essential for diagnosing HCM and its mimics, emphasizing the role of advanced diagnostics like cardiac magnetic resonance, genetic testing, and tissue characterization in guiding personalized management strategies.

Introduction

Hypertrophic cardiomyopathy (HCM) is a genetic condition predominantly caused by mutations in sarcomeric proteins, leading to abnormal thickening of the left ventricular (LV) wall not explained solely by loading conditions such as arterial hypertension or aortic stenosis. The clinical spectrum of HCM is broad, ranging from asymptomatic individuals to those experiencing heart failure, arrhythmias, and sudden cardiac death (SCD), which represents the most common cause of death in young athletes in the USA, the second after right ventricular arrhythmogenic cardiomyopathy in Europe. Hypertrophic cardiomyopathy has a prevalence of about 1:500, making it the most common genetic cardiovascular disease.[1] However, several other conditions can mimic HCM, complicating the diagnostic process. Accurate diagnosis is critical as these phenocopies can differ significantly in terms of prognosis, treatment, and inheritance patterns. Hypertrophic phenocopies include conditions such as cardiac amyloidosis, Fabry disease, mitochondrial myopathies, and rarer disorders like glycogen storage diseases (GSDs) and PRKAG2 syndrome.[2] In this paper, we will explore the differential diagnosis of HCM and its mimics (*Figure 1*), focusing on key clinical features, laboratory markers, electrocardiogram (ECG), advanced imaging modalities, and invasive tests.

Hypertrophic cardiomyopathy

Hypertrophic cardiomyopathy is primarily caused by variants in sarcomeric proteins, the most frequent being

*Corresponding author. Tel: +390116336022, Fax: +390116335564, Email: veronica.dusi@gmail.com

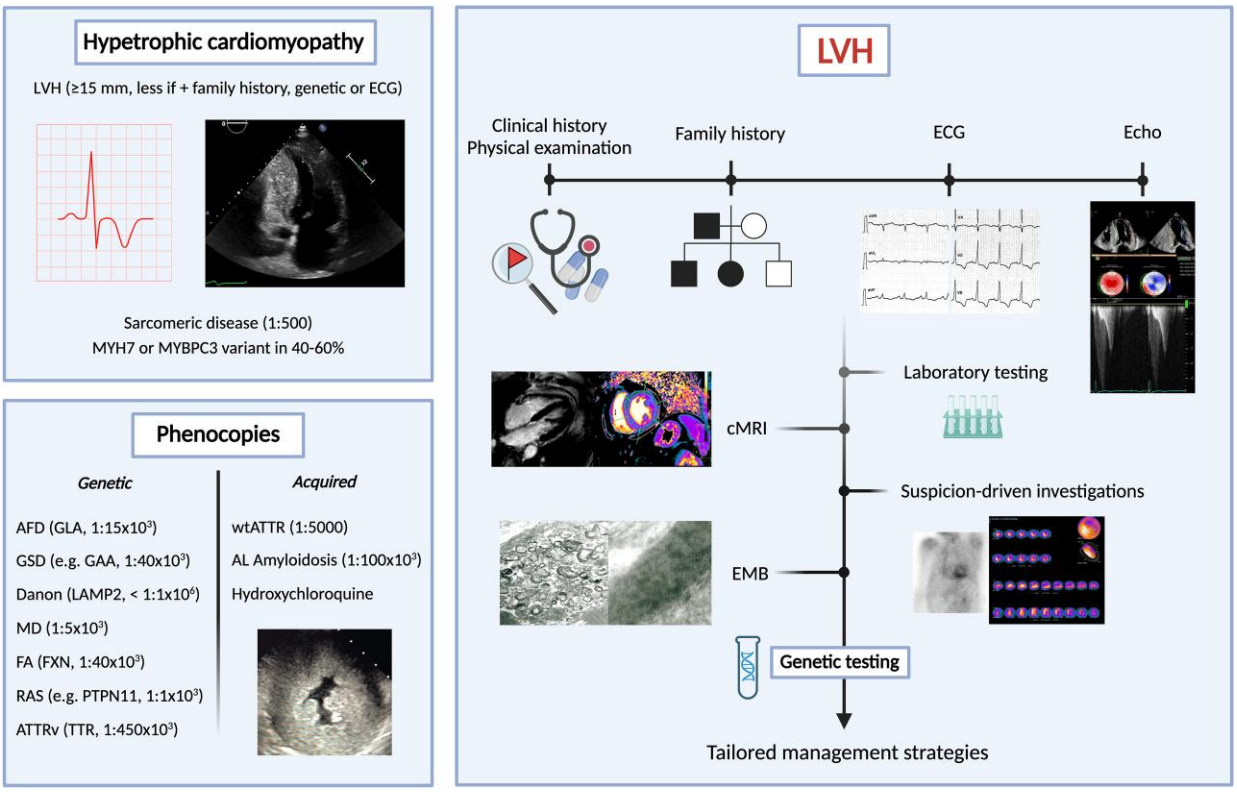

Figure 1 Diagnostic flowchart for differentiating hypertrophic phenotypes. AFD, Anderson-Fabry disease; cMRI, cardiac magnetic resonance imaging; ECG, electrocardiogram; EMB, endomyocardial biopsy; FA, Friedreich's ataxia; GSD, glycogen storage disease; LVH, left ventricular hypertrophy; MD, mitochondrial disease.

MYH7 (beta-myosin heavy chain) and MYBPC3 (myosin-binding protein C). Left ventricular hypertrophy (LVH) is the hallmark of the disease, which can be asymmetric, concentric or apical. In adults, HCM is diagnosed based on a LV wall thickness ≥ 15 mm in any myocardial segment not explained by loading conditions, or lesser degrees (13–14 mm) in association with family history, genetic findings, and ECG abnormalities.[1] The disease is characterized by disorganized cardiac muscle fibres (myofibrillar disarray) and interstitial fibrosis. Other characteristic features include diastolic dysfunction, microvascular dysfunction, and, in most cases, dynamic left ventricular outflow tract (LVOT) obstruction at rest or during exercise.

Hypertrophic phenocopies: mimicking conditions

Several systemic, metabolic, and genetic diseases can cause HCM-like phenotypes. These phenocopies represent 5–10% of cardiomyopathies with a hypertrophic phenotype and must be identified as their management, treatment, and outcomes differ significantly from those of HCM.[3]

Cardiac amyloidosis, be it either due to light-chain (AL) or transthyretin (ATTR) amyloidosis, is amongst the most frequent mimics of HCM. It involves extracellular deposition of amyloid fibrils within the myocardium, leading to stiffening and thickening of the ventricular walls. Cardiac amyloidosis may present with heart failure symptoms, often with preserved ejection fraction and cardiac arrhythmias. As amyloidosis is a systemic disorder, patients may show several extracardiac signs and symptoms such as peripheral neuropathy, bilateral carpal tunnel syndrome, and chronic kidney disease.[4]

Fabry disease is a rare X-linked lysosomal storage disorder caused by variants in the GLA gene, which leads to deficient α-galactosidase A and accumulation of globotriaosylceramide (Gb3) in various tissues, including the heart. Fabry disease typically affects young males and is associated with systemic manifestations such as renal dysfunction, neuropathy, and angiokeratomas. Early recognition of the disorder is paramount, as enzyme replacement therapy, by allowing symptomatic improvement and disease stabilization, is most beneficial when commenced in the earliest stages of the disease.[5]

Danon disease is an X-linked lysosomal storage disorder caused by variants in the LAMP2 gene. It is characterized by profound LVH, which can be confused with HCM, and involves other systems, such as skeletal muscle and the central nervous system. Danon disease often presents with early-onset cardiomyopathy in males, associated with skeletal myopathy and intellectual disabilities. Heart failure develops early, and arrhythmias are common.[6]

Glycogen storage diseases, particularly Types II (Pompe disease) and III (Cori disease), can cause HCM-like phenotypes due to the accumulation of glycogen within cardiomyocytes. Pompe disease is an autosomal recessive disorder caused by variants in the GAA gene,

leading to acid α-glucosidase deficiency. In its infantile form, it causes severe LVH with early-onset heart failure. The adult form presents with milder LVH but progressive muscle weakness and respiratory difficulties. Enzyme replacement therapy is available for Pompe disease and can slow the progression of cardiac involvement.[7]

PRKAG2 syndrome is a rare autosomal dominant disorder caused by variants in the PRKAG2 gene, leading to abnormal glycogen accumulation in the myocardium and LVH. It often presents with early-onset LVH. PRKAG2 syndrome is associated with an ECG pattern similar to ventricular pre-excitation and progressive conduction system disease.[8]

Friedreich's ataxia (FA) is an autosomal recessive disorder caused by variants in the FXN gene, leading to mitochondrial dysfunction. Although FA primarily affects the nervous system, it often causes cardiac hypertrophy. Friedreich's ataxia typically presents with progressive ataxia, scoliosis, and peripheral neuropathy, but cardiomyopathy occurs in the majority of patients, leading mostly to heart failure symptoms.[9]

Mitochondrial myopathies are a group of disorders caused by variants in mitochondrial DNA or nuclear genes encoding mitochondrial proteins. These conditions can lead to multisystem involvement, including cardiac hypertrophy. Mitochondrial myopathies are often associated with myopathic facies and symptoms of muscle weakness, neurological deficits, and metabolic disturbances, including diabetes mellitus.[10]

RASopathies constitute a broad spectrum of genetic disorders arising from germline pathogenic variants in genes that encode proteins involved in the RAS/mitogen-activated protein kinase signal transduction pathway. The most frequent form is Noonan syndrome. Patients show, in association with cardiac hypertrophy, facial dysmorphisms, growth retardation, cryptorchidism, cognitive impairment, bleeding disorders, and renal malformations. Additional cardiovascular abnormalities include pulmonary valve stenosis, mitral valve dysplasia, and atrial and ventricular septal defects. Overall, 5–10% of patients experience severe clinical presentations in infancy, culminating in a 1-year mortality rate of 70%.[6]

Diagnostic pathway

Clinical history and physical examination

A thorough personal and family history associated with a careful physical examination represents the foundation of the diagnostic approach for HCM and its mimics. The age of diagnosis offers crucial insights into the aetiology of various types of HCMs. Inborn errors of metabolism and congenital dysmorphic syndromes are more prevalent in infants and young children compared with older children and adults. Conversely, wild-type transthyretin-related amyloidosis is a condition that primarily affects elderly individuals. For HCM, a family history of SCD or unexplained heart failure at a young age is often a crucial clue. Patients may present with exertional dyspnoea, chest pain, syncope, or palpitations, and physical examination might reveal findings such as a harsh systolic murmur due to dynamic LVOT obstruction. In contrast, mimicking conditions like Fabry disease, mitochondrial myopathies, or amyloidosis often present with extracardiac features, such as neuropathy, renal insufficiency, or skeletal muscle weakness. These non-cardiac manifestations can offer pivotal clues to the underlying diagnosis and should not be overlooked.[3] For example, bilateral carpal tunnel and lumbar spinal stenosis in the context of cardiac hypertrophy may be valuable 'red flags' for cardiac amyloidosis, whereas hypohidrosis, acroparesthesias, or angiokeratomas may suggest Fabry disease (*Table 1*).

Physicians must also be aware of a patient's drug history as some treatments, such as hydroxychloroquine, may induce acquired storage disorders leading to HCM phenocopies.[11]

Also, detailed family history may provide important clues on the potential pattern of inheritance of the disease. This allows not only to identify other clinically affected family members but also to bolster the accuracy of the proband's initial diagnosis. For example, autosomal dominant inheritance is distinguished by a 50% chance of offspring harbouring the variant if a parent carries it, with a penetrance that, albeit possibly incomplete, tends to be pretty high. X-linked inheritance should be considered if males are the primary or most severely affected individuals; in some X-linked conditions, such as Anderson–Fabry disease and Danon disease, female carriers can develop milder and delayed symptoms because of the unequal silencing of X chromosomes (Lyonization). Matrilinear inheritance is characteristic of mitochondrial diseases, where only women transmit the disease to their children, regardless of the child's gender.[2]

Electrocardiogram

Due to its wide availability and low cost, ECG usually represents the first diagnostic tool for cardiomyopathies screening, as it may hint suggestive patterns of disease.[12]

Atrial enlargement, atrial fibrillation, and atrial flutter are common findings.

A short PR interval and δ wave alongside LVH should raise suspicion of lysosomal storage disorders, PRKAG2 variants, Fabry disease, or mitochondrial diseases; this feature mimics ventricular pre-excitation, although some reports excluded anterogradely conducting accessory pathways during electrophysiological studies.[13] Notably, δ waves with regular or only mildly reduced PR interval, which persist unaffected even after premature beats with PR changes, should rise the suspicious of fascicular-ventricular pathways (FVPs), that have been described particularly in the setting of storage cardiomyopathy PRKAG2 related.[14] Prompt recognition of FVPs as a first potential sign of a PRKAG2 syndrome rather than of idiopathic origin is crucial also due to the high probability of progression towards a complete atrioventricular block in the former case. Finally, an isolated borderline (120–130 ms) or mildly reduced PR interval (due to P wave shortening) without δ wave has been associated with the initial stages of Fabry disease as an expression of atrial intracellular glycosphingolipids and enhanced sodium channel function.[15]

Atrioventricular block may be present in cardiac amyloidosis as well as in late Fabry disease.

The presence of Q waves could reflect either transmural fibrosis and consequential loss of local electrical forces or

Table 1 Diagnostic snapshot of key characteristics across hypertrophic phenotypes

Age of onset	
Infants	**Pompe, MD**
Children	**HCM, Danon, PRKAG2, MD**
Adults	**HCM, AFD, Danon, PRKAG2**
Elderlies	**Amyloidosis**
Inheritance	
AD	**HCM, amyloidosis, PRKAG2, RASopathies**
AR	**FA, Pompe**
X-linked	**AFD, Danon**
Matrilinear	**MD**
Clinical features	
Learning difficulties, mental retardation	**Danon, MD**
Muscle weakness	**GSD, MD**
Deafness	**AFD, MD**
Visual impairment	**Amyloidosis, AFD, Danon, MD**
Angiokeratoma	**AFD**
Cryptogenic Stroke	**AFD, MD**
Paranaesthesia	**Amyloidosis, AFD**
Sensory abnormalities	
Neuropathic pain	
Carpal tunnel syndrome (bilateral)	**Amyloidosis (ATTR)**
Facial dysmorphism, wide neck	**RASopathies**
Short stature	
Lentigines/café-au-lait spots	
ECG	
Short PR, δ wave	**AFD, Danon, GSD, PRKAG2, MD**
AV block	**Amyloidosis, AFD, Danon**
Q waves	**HCM, AFD**
Low QRS voltage	**Amyloidosis**
Extreme LVH	**Danon, Pompe**
RBBB	**AFD**
Giant TWI	**HCM (apical)**
Laboratory	
↑ CK	**Danon, GSD, MD**
↑ AST/ALT	
↓ eGFR	**Amyloidosis, AFD**
Proteinuria	
Immunofixation	**Amyloidosis**
↑↑ NT-proBNP	**Amyloidosis**
↑ Troponin	
↓ α-Gal	**AFD**
Lactic acidosis	**MD**
Myoglobinuria	
↓ WBC	**MD (Barth)**
Imaging	
Asymmetric LVH	**HCM**
LVOTO	
SAM	
Crypts	
Extreme LVH	**Danon, Pompe**
Biventricular hypertrophy	**AFD, Amyloidosis**
Thick valves	**Amyloidosis**
Interatrial septum thickening	
Myocardial sparkling	
Pericardial effusion	
Patchy mid-wall LGE in hypertrophic areas	**HCM**
Diffuse subendo LGE ↑ Native T1 and ECV	**Amyloidosis**
Inferolateral LGE ↓ Native T1	**AFD**

AD, autosomal dominant; AR, autosomal recessive; AFD, Anderson-Fabry disease; AV, atrioventricular; ECV, extracellular volume; eGFR, estimated glomerular filtration rate; FA, Friedreich's ataxia; GSD, glycogen storage disease; HCM, hypertrophic cardiomyopathy; LGE, late gadolinium enhancement; LVH, left ventricle hypertrophy; LVOTO, left ventricle outflow tract obstruction; MD, mitochondrial disease; NT-proBNP, N-terminal pro B-type natriuretic peptide; RBBB, right bundle branch block; SAM, systolic anterior motion; TWI, T-wave inversion; WBC, white blood cells.

initial QRS vector abnormalities due to disproportionate segmental hypertrophy.[16]

Increased QRS voltages are usually found in HCM and phenocopies, but they are seldom isolated findings. Extremely high QRS amplitude suggests the presence of storage disease, while disproportionately low voltages in the limb leads (QRS amplitude < 5 mm) compared with the degree of LVH should raise suspicion on cardiac amyloidosis, by evidencing myocardial interstitium expansion.

QRS complex fragmentation reflects intraventricular conduction delay and may be a sign of myocardial fibrosis; it was inconsistently associated with unfavourable prognosis in HCM. Bundle branch blocks are uncommon in HCM and can be a result of invasive interventions on the LVOT, while the right bundle branch block is typical of Fabry disease.

Repolarization abnormalities are extremely common in HCM and its mimics. T-wave inversion (TWI), usually preceded by ST segment depression, is common in sarcomeric HCM and Fabry disease and deep TWI in lateral leads is a typical finding in apical HCM.

Laboratory testing

Laboratory testing is critical for the diagnosis of certain phenocopies, particularly metabolic and infiltrative disorders.

Cardiac amyloidosis often presents with a disproportionate elevation in N-terminal pro B-type natriuretic peptide (NT-proBNP) and troponin levels due to myocardial stress and infiltration. Serum and urine electrophoresis with immunofixation, along with free light chain assays, are essential for diagnosing AL amyloidosis.

A key diagnostic marker in Fabry disease is reduced α-galactosidase A enzyme activity, especially in male patients. Elevated plasma lyso-Gb3 levels are highly specific for Fabry disease and can aid in early diagnosis.

In GSD, elevated blood levels of creatine kinase, lactate, and glycogen can be found. Genetic testing is often required for definitive diagnosis. Enzyme assays can confirm α-glucosidase deficiency in Pompe disease.

Increases in lactate and myoglobinuria are key features of mitochondrial disease, and in some cases, leukopenia may be a marker of disease (Barth syndrome).[2,3]

Echocardiography

Echocardiography is the first-line imaging modality in the assessment of HCM and its mimics due to its wide availability, and it may help identify the underlying disease thanks to its ability to accurately assess ventricular walls hypertrophy, systolic and diastolic functions, valvular morphology, and haemodynamic indirect assumptions.

In HCM, echocardiography typically reveals asymmetric hypertrophy of the interventricular septum, although hypertrophy can be concentric or localized to other regions. Left ventricular outflow tract obstruction, evoked or exacerbated by the Valsalva manoeuvre or stress, is a hallmark feature and can be evaluated with Doppler echocardiography. Ancillary signs of HCM include wall crypts, papillary hypertrophy, and apical aneurysm, which also yields a prognostic role.

Echocardiographic findings of cardiac amyloidosis include concentric biventricular hypertrophy, a speckled or granular myocardial texture, often associated with atrial septal thickening and pericardial effusion. Diastolic dysfunction is common, and strain imaging may reveal a characteristic 'apical sparing' pattern, with reduced longitudinal strain in all segments except the apex.

Fabry disease typically presents with concentric LVH on echocardiography and aortic root enlargement; LVOT obstruction and mitral valve thickening may be observed.

Echocardiography in GSD shows marked concentric LVH, especially in the infantile forms (wall thickness > 30 mm); progressive ventricular dysfunction can occur in advanced stages of the disease.

PRKAG2 syndrome can mimic the echocardiographic features of HCM, showing LVH without significant LVOT obstruction.[1]

Cardiac magnetic resonance

Cardiac magnetic resonance imaging (cMRI) has become a mandatory tool for differentiating between HCM and its mimics; it is first recommended at baseline assessment, thanks to its advanced tissue characterization capabilities and the ability to provide detailed information on myocardial fibrosis, infiltration, and structural anomalies.[17]

In HCM, cMRI typically shows asymmetric hypertrophy, often involving the interventricular septum. Late gadolinium enhancement (LGE) is frequently patchy and located in hypertrophic regions. The extent of myocardial LGE also serves for prognostic purposes.[18] Native T1 values are usually normal or only mildly elevated.

In contrast to HCM, cMRI in amyloidosis shows diffusely elevated native T1 values and increased extracellular volume due to amyloid infiltration; LGE often involves subendocardial or transmural regions and may appear global, a key differentiator from the patchy LGE seen in HCM. The inability to fully null the myocardium during LGE imaging represents a distinctive feature.

One of the key cMRI findings in Fabry disease is reduced native T1 values, which is specific for Fabry disease and reflects the accumulation of glycosphingolipids within cardiomyocytes. Late gadolinium enhancement is often localized at the basal inferolateral wall, and concentric hypertrophy is typically observed. Mitochondrial myopathies often show elevated native T1 values due to fibrosis and myocardial damage. Late gadolinium enhancement is typically patchy, and additional findings may include ventricular dilation and systolic dysfunction in advanced cases.

In PRKAG2 syndrome, LGE is less prominent compared with sarcomeric HCM. cMRI may reveal diffuse hypertrophy without extensive fibrosis, and native T1 values are usually only mildly elevated. Glycogen accumulation in the myocardium leads to distinctive imaging findings, helping to differentiate it from HCM.[3]

Bone scintigraphy

Bone scintigraphy offers a non-invasive option for detecting ATTR amyloidosis, a role previously held primarily by endomyocardial biopsy (EMB); AL amyloidosis must be excluded when scheduling a bone scintigraphy scan, as over 20% of patients with AL cardiac amyloidosis exhibit Grade 2 or 3 radiotracer uptake.[4] If monoclonal gammopathy is ruled out through serum and urine analysis, Grade 2 or 3 myocardial radiotracer uptake on bone scintigraphy demonstrates 100% specificity and positive predictive value for ATTR-cardiac amylodisos.[19] To minimize false-positive results caused by misinterpretation of radiotracer blood pooling as myocardial uptake, obtaining single-photon emission computed tomography images alongside bone scintigraphy scans is strongly recommended.

Endomyocardial biopsy

Endomyocardial biopsy is a valuable invasive diagnostic tool in hypertrophic heart disease. In patients with suspected cardiomyopathy, EMB can help diagnosis and management if other clinical investigations point to possible myocardial inflammation, infiltration, or storage that cannot be diagnosed using other techniques. Key histopathologic features of HCM include disarrayed myocyte hypertrophy with interstitial fibrosis. In contrast, the histopathologic features of cardiac amyloidosis are amyloid deposits, which are typically seen as amorphous, extracellular material staining with Congo red dye under polarized light, and myocyte atrophy secondary to the pressure exerted by the amyloid deposits. Fabry disease is characterized by the accumulation of glycosphingolipids within lysosomes, leading to a 'foamy' appearance of heart muscle cells, and interstitial fibrosis. Albeit rare, complications following EMB may occur, including ventricular arrhythmias and cardiac perforation; for this reason, EMB should be pursued when non-invasive diagnostic tools are insufficient for achieving a definite diagnosis and should be performed in centres with experienced cardiologists and pathologists.[20]

Genetics

Genetic testing plays a pivotal role in the diagnosis of HCM and its mimics. Hypertrophic cardiomyopathy can be inherited as a Mendelian autosomal dominant disease associated with variants typically located in genes encoding for sarcomeric proteins, although rare pathogenic variants in non-sarcomeric genes have also been described. Genetic testing may identify pathogenic/likely pathogenic variants in genes such as

MYH7 and MYBPC3, which are commonly associated with HCM; however, the genetic complexity of HCM is compounded by heterogeneity, incomplete penetrance, and variable expression, along with the challenges in definitively determining the pathogenicity of genetic variants. When investigating LVH, genetic testing may also identify transthyretin variants, associated with hereditary amyloidosis, or GLA variants, which are linked to Fabry disease. Additionally, genetic testing can be used to identify at-risk family members, enabling early detection and preventive measures. It can also aid in risk stratification and prognostication, helping to determine the likelihood of disease progression and the need for more aggressive monitoring or interventions.[21]

Advanced diagnostic challenges and future perspectives

The increasing use of advanced imaging modalities, particularly cMRI and and genetic testing, has revolutionized the diagnostic approach to HCM and its phenocopies. However, challenges remain, particularly in cases where imaging and clinical features overlap between different conditions and during initial stages of the diseases when ventricular hypertrophy may be subtle and non-specific. For instance, both HCM and amyloidosis can present with substantial LVH and fibrosis, but the distribution of fibrosis and the presence of systemic features are critical differentiators. T1 mapping, extracellular volume quantification on cMRI and newer biomarkers are likely to improve diagnostic specificity and reduce time to diagnosis. Additionally, advances in genetic testing, particularly whole-exome and whole-genome sequencing, are poised to play an increasingly important role in diagnosing rare genetic conditions such as PRKAG2 syndrome and mitochondrial disorders. The integration of multiomic approaches, combining genomics, proteomics, and metabolomics, will likely enhance our ability to diagnose and treat these conditions in a more personalized manner.

Conclusions

Hypertrophic cardiomyopathy and its mimics represent a diverse group of conditions that share a common phenotype of increased wall thickness. Accurate differentiation between these entities is crucial for guiding management, prognostication, and family screening. While ECG and echocardiography remain cornerstones of diagnosis, cMRI has become invaluable for tissue characterization, particularly in distinguishing HCM from infiltrative and metabolic disorders such as amyloidosis and Fabry disease. Biomarkers and genetic testing provide additional diagnostic clarity, particularly for metabolic disorders and rare genetic conditions. The complexity of diagnosing these conditions underscores the need for a multidisciplinary approach to ensure that patients receive the most accurate diagnosis and appropriate treatment. Continued advancements in imaging, molecular diagnostics, and biomarker discovery will further refine the diagnostic process and improve outcomes for patients with cardiomyopathies and hypertrophic phenotype.

Funding

None delcared.

Conflict of interest: none declared.

Data availability

No new data were generated or analysed in support of this research.

References

1. Arbelo E, Protonotarios A, Gimeno JR, Arbustini E, Barriales-Villa R, Basso C, Bezzina CR, Biagini E, Blom NA, de Boer RA, De Winter T, Elliott PM, Flather M, Garcia-Pavia P, Haugaa KH, Ingles J, Jurcut RO, Klaassen S, Limongelli G, Loeys B, Mogensen J, Olivotto I, Pantazis A, Sharma S, Van Tintelen JP, Ware JS, Kaski JP; ESC Scientific Document Group. 2023 ESC guidelines for the management of cardiomyopathies. *Eur Heart J* 2023;**44**:3503–3626.
2. Bakalakos A, Monda E, Elliott PM. The diagnostic and therapeutic implications of phenocopies and mimics of hypertrophic cardiomyopathy. *Can J Cardiol* 2024;**40**:754–765.
3. Rapezzi C, Arbustini E, Caforio AL, Charron P, Gimeno-Blanes J, Heliö T, Linhart A, Mogensen J, Pinto Y, Ristic A, Seggewiss H, Sinagra G, Tavazzi L, Elliott PM. Diagnostic work-up in cardiomyopathies: bridging the gap between clinical phenotypes and final diagnosis. A position statement from the ESC Working Group on Myocardial and Pericardial Diseases. *Eur Heart J* 2013;**34**:1448–1458.
4. Garcia-Pavia P, Rapezzi C, Adler Y, Arad M, Basso C, Brucato A, Burazor I, Caforio ALP, Damy T, Eriksson U, Fontana M, Gillmore JD, Gonzalez-Lopez E, Grogan M, Heymans S, Imazio M, Kindermann I, Kristen AV, Maurer MS, Merlini G, Pantazis A, Pankuweit S, Rigopoulos AG, Linhart A. Diagnosis and treatment of cardiac amyloidosis: a position statement of the ESC working group on myocardial and pericardial diseases. *Eur Heart J* 2021;**42**:1554–1568.
5. Averbuch T, White JA, Fine NM. Anderson-Fabry disease cardiomyopathy: an update on epidemiology, diagnostic approach, management and monitoring strategies. *Front Cardiovasc Med* 2023;**10**:1152568.
6. Hong KN, Eshraghian EA, Arad M, Argirò A, Brambatti M, Bui Q, Caspi O, de Frutos F, Greenberg B, Ho CY, Kaski JP, Olivotto I, Taylor MRG, Yesso A, Garcia-Pavia P, Adler ED. International consensus on differential diagnosis and management of patients with Danon disease: JACC state-of-the-art review. *Am Coll Cardiol* 2023;**82**:1628–1647.
7. Kishnani PS, Steiner RD, Bali D, Berger K, Byrne BJ, Case LE, Crowley JF, Downs S, Howell RR, Kravitz RM, Mackey J, Marsden D, Martins AM, Millington DS, Nicolino M, O'Grady G, Patterson MC, Rapoport DM, Slonim A, Spencer CT, Tifft CJ, Watson MS. Pompe disease diagnosis and management guideline. *Genet Med* 2006;**8**:267–288.
8. Nagueh SF. Anderson-Fabry disease and other lysosomal storage disorders. *Circulation* 2014;**130**:1081–1090.
9. Cook A, Giunti P. Friedreich's ataxia: clinical features, pathogenesis and management. *Br Med Bull* 2017;**124**:19–30.
10. Meyers DE, Basha HI, Koenig MK. Mitochondrial cardiomyopathy: pathophysiology, diagnosis, and management. *Tex Heart Inst J* 2013;**40**:385–394.
11. Yogasundaram H, Putko BN, Tien J, Paterson DI, Cujec B, Ringrose J, Oudit GY. Hydroxychloroquine-induced cardiomyopathy: case report, pathophysiology, diagnosis, and treatment. *Can J Cardiol* 2014;**30**:1706–1715.
12. Bernardini A, Crotti L, Olivotto I, Cecchi F. Diagnostic and prognostic electrocardiographic features in patients with hypertrophic cardiomyopathy. *Eur Heart J Suppl* 2023;**25**:C173–C178.
13. Konrad T, Sonnenschein S, Schmidt FP, Mollnau H, Bock K, Ocete BQ, Münzel T, Theis C, Rostock T *et al*. Cardiac arrhythmias in patients with Danon disease. *Europace* 2017;**19**:1204–1210.
14. Sternick EB, Oliva A, Gerken LM, Magalhães L, Scarpelli R, Correia FS, Rego S, Santana O, Brugada R, Wellens HJ. Clinical, electrocardiographic, and electrophysiologic characteristics of patients with a fasciculoventricular pathway: the role of PRKAG2 mutation. *Heart Rhythm* 2011;**8**:58–64.

15. Parisi V, Baldassarre R, Ferrara V, Ditaranto R, Barlocco F, Lillo R, Re F, Marchi G, Chiti C, Di Nicola F, Catalano C, Barile L, Schiavo MA, Ponziani A, Saturi G, Caponetti AG, Berardini A, Graziosi M, Pasquale F, Salamon I, Ferracin M, Nardi E, Capelli I, Girelli D, Gimeno Blanes JR, Biffi M, Galiè N, Olivotto I, Graziani F, Biagini E. Electrocardiogram analysis in Anderson-Fabry disease: a valuable tool for progressive phenotypic expression tracking. *Front Cardiovasc Med* 2023;**10**:1184361.
16. Koga Y, Yamaga A, Hiyamuta K, Ikeda H, Toshima H. Mechanisms of abnormal Q waves in hypertrophic cardiomyopathy assessed by intracoronary electrocardiography. *J Cardiovasc Electrophysiol* 2004;**15**:1402–1408.
17. Maron MS. Clinical utility of cardiovascular magnetic resonance in hypertrophic cardiomyopathy. *J Cardiovasc Magn Reson* 2012;**14**:13.
18. Fortuni F, Angelini F, Abete R, Raineri C, Sclesi L, Turco A, Crimi G, Leonardi S, Ghio S, Oltrona Visconti L, De Ferrari GM. The prognostic value of late gadolinium enhancement in hypertrophic cardiomyopathy: an updated meta-analysis. *Eur J Prev Cardiol* 2020; **27**:1902–1905.
19. Gillmore JD, Maurer MS, Falk RH, Merlini G, Damy T, Dispenzieri A, Wechalekar AD, Berk JL, Quarta CC, Grogan M, Lachmann HJ, Bokhari S, Castano A, Dorbala S, Johnson GB, Glaudemans AW, Rezk T, Fontana M, Palladini G, Milani P, Guidalotti PL, Flatman K, Lane T, Vonberg FW, Whelan CJ, Moon JC, Ruberg FL, Miller EJ, Hutt DF, Hazenberg BP, Rapezzi C, Hawkins PN. Nonbiopsy diagnosis of cardiac transthyretin amyloidosis. *Circulation* 2016;**133**:2404–2412.
20. Porcari A, Baggio C, Fabris E, Merlo M, Bussani R, Perkan A, Sinagra G. Endomyocardial biopsy in the clinical context: current indications and challenging scenarios. *Heart Fail Rev* 2023;**28**:123–135.
21. Lopes LR, Ho CY, Elliott PM. Genetics of hypertrophic cardiomyopathy: established and emerging implications for clinical practice. *Eur Heart J* 2024;**45**:2727–2734.