

1. Comprehension Questionnaire

Instructions: This questionnaire is designed to assess your understanding of the cardiac magnetic resonance (CMR) report. The collected data will be used solely for research purposes to improve the quality of medical services. Please answer based on your genuine experience after reading the report. Only one option should be selected per question (single choice). The average completion time is approximately 1–3 minutes.

Note: This questionnaire is not intended for clinical diagnosis. Please refer to your attending physician for any treatment decisions.

Section I: Basic Information

1. Gender:

- ☐ Male ☐ Female

2. Age: ____ years

3. Highest Educational Attainment:

- ☐ High school or below ☐ Associate degree ☐ Bachelor's degree or above

4. Do you have a medical education background?

- ☐ Yes ☐ No

5. Monthly Income:

- ☐ Less than 5,000 RMB ☐ 5,000–10,000 RMB ☐ More than 10,000 RMB
-

Section II: Evaluation of the CMR Report

(Using a 5-point Likert scale: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree)

(A) Information Completeness

1. The report clearly provides the definition and prevalence of my diagnosed condition.

2. The report includes complete diagnostic findings, abnormality analysis, supporting rationale, and treatment recommendations.
3. The report comprehensively covers structural, functional, and tissue-level abnormalities of my heart.
4. The report provides reference ranges for normal values, helping me compare them with my results.

(B) Readability

1. The report is written in plain language that is easy to understand for non-specialists.
2. After reading the report, I have a clearer understanding of the nature and severity of my condition.
3. The report helps me understand the structural, functional, and tissue-level issues identified in my heart.
4. The explanation of diagnostic rationale and treatment suggestions is easy to comprehend.

(C) Diagnostic Clarity

1. The report provides a clear and specific diagnostic conclusion.
2. The report explicitly identifies the major abnormalities present in my heart.
3. The report includes differential diagnoses where applicable.
4. The diagnostic rationale presented in the report is sufficient and logically sound.
5. This report primarily discusses the evaluation and treatment of pulmonary (lung) function.

(D) Actionability

1. The treatment recommendations in the report are consistent with my medical history and current condition.
2. The proposed long-term management plan is tailored to my individual health needs.
3. The lifestyle modification suggestions provided are practical and relevant.
4. The report offers guidance on follow-up visits or future re-examinations.

Thank you for participating in this survey. Your feedback will help us improve the quality of medical services.

2. Performance Questionnaire

Instructions:

Thank you for participating in this survey. This questionnaire aims to assess the medical accuracy, clinical applicability, and patient-centeredness of LLM-generated detailed cardiac magnetic resonance (CMR) reports, to improve their use in radiological practice. Please answer each question based on your reading experience with the LLM-interpreted report. All responses will be used solely for research purposes and will not affect patient management in any way.

Section I: Core Evaluation

(Using a 5-point Likert scale: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree)

(A) Information Completeness

1. Does the report comprehensively extract the structural and functional findings of the heart?
2. Does the report fully extract the tissue characterization findings?
3. Does the report provide normal reference ranges to help patients compare with their values?
4. Does the report include diagnostic conclusions, diagnostic rationale, and suggested management or follow-up recommendations?

(B) Content Accuracy

1. Does the report accurately identify the core diagnosis and major abnormalities from the original CMR report?
2. Are key values consistent with those in the original report?
3. Does the AI interpretation retain essential medical details without omission or distortion?
4. Are both the primary diagnosis and differential diagnoses presented accurately?

(C) Structural Coherence

1. Is the report organized in a logical sequence (e.g., conclusion → structure → function → tissue)?
2. Does the AI properly segment and categorize content to avoid redundancy or disorganization?

3. Are the sections well-connected, and is the overall presentation logically coherent?
4. Does the report effectively summarize the key diagnosis and recommendations?
5. The report lacks any explicit diagnostic conclusion or corresponding clinical recommendations.

(D) Terminology Clarity

1. Does the AI accurately translate complex medical terms into language understandable by patients?
2. Does the report avoid misleading oversimplification (e.g., misrepresenting “mildly reduced EF” as “normal”)?
3. When multiple interpretations are possible, does the AI select the most clinically appropriate and understandable phrasing?
4. Does the report provide annotations or analogies to help patients understand core terms?

(E) Educational Value

1. Does the report clearly and concisely explain the definition of the diagnosed condition?
2. Does it mention the disease’s prevalence or population characteristics?
3. Does the report provide basic information on the disease course, typical progression, or common complications?
4. Does it describe the prognosis and influencing factors, such as disease severity or treatment adherence?

3. Standardized Prompt for Simplification of Cardiac MRI Reports

You are a medical interpretation expert with specialized knowledge in cardiovascular imaging. Your task is to generate a structured, patient-friendly explanation of a given cardiac magnetic resonance (CMR) report. The interpretation must ensure the accurate use of medical terminology while helping non-specialist readers understand both the structural and functional abnormalities, as well as their clinical implications. Each case has a primary diagnosis of one of the following cardiovascular conditions: hypertrophic cardiomyopathy (HCM), dilated cardiomyopathy (DCM), or coronary artery disease (CAD). The output must be written in Chinese and should contain approximately 1,000–2,000 Chinese characters.

Please organize your interpretation according to the following structure:

(1) Diagnostic Summary and Disease Overview: Provide a brief diagnosis followed by the definition of the disease, its epidemiology, and typical prognosis. This section should be consistent with the latest international and national clinical guidelines or expert consensus relevant to the specific disease. **(2) Diagnostic Basis:** Explain the key CMR findings that support the diagnosis, describe their clinical relevance, and include the major differential diagnoses. **(3) Morphological Abnormalities:** Describe abnormal structural findings such as chamber size or myocardial wall thickness. If quantitative measurements are provided, compare them with standard reference ranges and explain the clinical significance of deviations. Reference ranges for CMR quantitative parameters should follow the Society for Cardiovascular Magnetic Resonance (SCMR) reference values ("normal values"): 2025 update whenever applicable, and interpretations should take into account the patient's age, sex, body surface area (BSA), magnetic field strength, and post-processing methodology. **(4) Functional Abnormalities:** Report any impairment in systolic or diastolic function, including abnormal left ventricular ejection fraction (LVEF), and interpret these findings by comparison with the appropriate normal reference values. **(5) Tissue Characterization Abnormalities:** Include descriptions of myocardial fibrosis, e.g., late gadolinium enhancement (LGE), T1 value, edema, or fatty infiltration, along with their potential clinical implications. **(6) Other Findings:** Please mention any additional imaging findings, such as normal aspects of cardiac morphology, function, or tissue characteristics. **(7) Lifestyle and Follow-up Recommendations:** Provide

personalized lifestyle advice and follow-up suggestions based on the patient's disease type and age group.

Sections (2) to (4) should include only abnormal findings; normal structures or parameters should be omitted to reduce redundancy. Medical terms should be explained in lay language where necessary, with examples provided for complex concepts. The report must not include any personally identifiable information. Key medical terms and critical abnormalities may be highlighted using bold text to improve readability. Ensure that all content is medically accurate, logically organized, and written in clear, patient-friendly Chinese. At the end of each interpretation, please include the following standardized disclaimer: This report is based solely on imaging findings and is intended for reference only. It should not be used as a substitute for clinical diagnosis or treatment. Please consult your physician for personalized medical advice.

心脏磁共振报告通俗化解读标准化提示词（中文版本）

你是一位具备心血管影像专业知识的医学报告通俗化解读专家，擅长将复杂的心脏磁共振（CMR）报告转化为结构清晰、医学术语规范、通俗易懂的医学解释文本。你的任务是根据给定的 CMR 检查报告，输出一份高质量的患者友好的解读内容，既要保证医学术语准确无误，又需帮助非专业读者理解疾病的结构与功能变化及其临床意义。报告的主诊断为：肥厚型心肌病（HCM）、扩张型心肌病（DCM）或冠状动脉粥样硬化性心脏病（CAD）之一。输出语言为中文，全文字数控制在 1000-2000 字。如报告中涉及 CMR 定量指标，其正常参考范围应参考文献《Society for Cardiovascular Magnetic Resonance reference values (“normal values”) in cardiovascular magnetic resonance: 2025 update》，并结合患者年龄、性别、体表面积、扫描场强及后处理方法等因素进行合理解释。请按照以下结构输出内容：（1）诊断结论与疾病介绍，包括疾病定义、流行病学和典型预后，本部分应参考相应疾病的最新国内外指南或专家共识；（2）诊断依据，简要解释其医学意义，同时列出主要鉴别诊断要点；（3）形态学异常，例如心腔大小、心室壁厚等，如有数值请与正常范围进行对比并解释变化意义；（4）功能学异常，包括收缩与舒张功能、左心室射血分数等异常指标，结合正常值加以说明；（5）组织学异常，例如心肌纤维化（LGE）、T1 值、水肿等改变，并解释其临床意义；（6）其他发现，包括轻度瓣膜反流、心包改变或形态功能组织学的正常结构提示等；（7）生活方式及随访建议，根据患者疾病类型和年龄段，提供个性化的生活方式建议，并建议定期随访时间和项目。第（2）至（4）部分仅描述异常部分，避免冗余的正常结构描述；对于专业术语，请进行适度解释，必要时可举例说明。报告中不包含任何患者的个人信息，重要医学术语和关键异常可使用加粗方式标注突出。请务必保证所有医学内容准确、条理清晰，表达规范。最后，统一附加以下免责声明：“本报告基于影像学检查结果分析，仅供参考，不能替代临床诊断或治疗方案。具体诊断及治疗请咨询您的临床医生。”

4. Supplementary Representative Case: Original Report and Corresponding LLM-Generated Report

4.1 心脏磁共振检查报告中文版本

临床资料：女性，36 岁。

扫描所见：

检查时患者心律大致齐，心率约 64 次/分。

左房内径正常，左室内径正常（左房前后径约 25 mm，左室横径约 40 mm）。前间隔近中段增厚（室间隔最厚约 21 mm）；其余左室各节段室壁厚度大致正常（下壁约 5–7 mm，侧壁约 4–6 mm）。左室肌小梁粗重，前后乳头肌粗大。左室整体收缩功能在正常范围内，增厚心肌舒张顺应性减低。左室流出道通畅，二尖瓣未见“SAM”征，二尖瓣启闭正常，主动脉瓣启闭正常。右房、右室内径正常范围，右室壁无增厚，右室流出道通畅。右心功能正常。三尖瓣启闭大致正常。心包无增厚或积液。主肺动脉、升主动脉不宽（主肺动脉内径约 22 mm，同层面升主动脉内径约 24 mm）。

左心功能参数：LVEF 65%，CO 4.8 L/min，EDV 115.29 mL，EDVi 76.07 mL/m²。

心肌首过灌注未见明显异常。延迟增强扫描示前间隔近中段肌壁间灶状强化。

影像学印象：

非梗阻性肥厚型心肌病，主要累及前间隔近中段，伴局部心肌纤维化。

4.2 English Version of the Cardiac Magnetic Resonance Report

Clinical information: A 36-year-old woman.

CMR Findings: The examination was performed during sinus rhythm with a heart rate of approximately 64 beats/min.

The left atrium and left ventricular cavity were of normal size (anteroposterior left atrial diameter, 25 mm; left ventricular end-diastolic transverse diameter, 40 mm). There was asymmetric hypertrophy predominantly involving the basal-to-mid anterior interventricular septum, with a maximal end-diastolic wall thickness of 21 mm. The remaining left ventricular wall segments were within normal thickness (inferior wall, 5 – 7 mm; lateral wall, 4 – 6 mm). Prominent left ventricular trabeculations and hypertrophied papillary muscles were noted.

Global left ventricular systolic function was preserved, although impaired diastolic compliance of the hypertrophied myocardium was observed. The left ventricular outflow tract was unobstructed, without systolic anterior motion (SAM) of the mitral valve. Mitral and aortic valve motion was normal.

The right atrium and right ventricle were normal in size. No right ventricular hypertrophy was identified, and the right ventricular outflow tract was patent. Right ventricular systolic function was preserved. Tricuspid valve motion was unremarkable. No pericardial thickening or pericardial effusion was present. The main pulmonary artery and ascending aorta were within normal caliber (main pulmonary artery, 22 mm; ascending aorta, 24 mm).

Quantitative assessment of left ventricular function demonstrated a left ventricular ejection fraction (LVEF) of 65%, cardiac output of 4.8 L/min, end-diastolic volume (EDV) of 115.3 mL, and indexed end-diastolic volume (EDVi) of 76.1 mL/m².

First-pass perfusion imaging showed no evidence of myocardial perfusion defects. Late gadolinium enhancement (LGE) imaging demonstrated focal mid-wall enhancement in the basal-to-mid anterior interventricular septum, consistent with replacement myocardial fibrosis.

CMR Diagnosis:

Non-obstructive hypertrophic cardiomyopathy with asymmetric hypertrophy predominantly involving the basal-to-mid anterior interventricular septum, accompanied by focal mid-wall myocardial fibrosis as demonstrated by late gadolinium enhancement.

4.3 详解版心脏磁共振报告

一、诊断结论及疾病定义及其流行病学及预后

诊断结论：非梗阻性肥厚型心肌病，主要累及左心室前间隔近中段，并伴局部心肌纤维化。

疾病定义：肥厚型心肌病是一种以左心室心肌增厚为主要特点的心肌疾病，且这种增厚不能完全由高血压、瓣膜病等其他心脏或全身性疾病解释。成人通常以左心室任一节段舒张末期最大室壁厚度 ≥ 15 mm 作为重要诊断标准，有明确家族史或致病基因背景者， ≥ 13 mm 也可支持诊断。本例主要表现为**前间隔增厚**。简单来说，就是心脏局部肌肉“变厚了”。本次检查显示左心室血液流向主动脉的通道仍然通畅，因此影像诊断为**非梗阻性肥厚型心肌病**。

流行病学：肥厚型心肌病是全球最常见的遗传性心肌病之一，临床患病率约为 **1/500**，可发生于任何年龄，以青壮年较为常见，但也可在儿童或老年时期首次被诊断。

预后：肥厚型心肌病患者的预后存在较大个体差异。多数患者经规范随访和治疗后可长期保持病情稳定，并获得接近正常人群的预期寿命；少数患者可逐渐出现心力衰竭、心律失常或心源性猝死等并发症，因此需要长期随访和个体化风险评估。

二、诊断依据（包含主要鉴别诊断）

（一）诊断依据

1、前间隔近中段增厚

室间隔最厚约 **21 mm**。女性短轴 CMR 基底前间隔正常参考范围约 5-10 mm，中段前间隔约 4-8 mm。

2、增厚呈局部、不对称分布

本例心肌增厚主要累及前间隔，而下壁约 5-7 mm、侧壁约 4-6 mm，其余左室节段室壁厚度大致正常。这种“局部明显增厚、其他节段相对正常”的不对称分布，符合肥厚型心肌病的典型形态特点。

3、非梗阻性表现

左室流出道是血液从左心室进入主动脉的主要通道。本次检查显示该通道保持通畅，提示静息状态下血液排出未受到明显阻挡。

同时，二尖瓣未见 **SAM 征**。**SAM** 是“二尖瓣收缩期前向运动”的简称，指心脏收缩时二尖瓣前叶异常向室间隔方向移动。当前间隔明显增厚时，异常移动的二尖瓣可能进一步靠近增厚的室间隔，使左室流出道变窄，甚至形成动态梗阻，并可同时影响二尖瓣正常关闭。

4、局部心肌纤维化

延迟增强（LGE）扫描显示**前间隔近中段肌壁间灶状强化**，提示局部心肌纤维化。LGE 是在磁共振图像上寻找心肌内类似“瘢痕”组织的一种方法。“**心肌纤维化**”可以理解为正常心肌内部出现类似“**瘢痕**”的组织。这些区域通常不如正常心肌柔软，也可能影响心脏电活动稳定性。

（二）主要鉴别诊断

1、运动员心脏：

长期高强度训练可出现生理性心肌增厚，但通常心腔大小、舒张功能和纤维化表现不同。

2、高血压性心脏病：

长期高血压也可导致心肌增厚，但通常更偏向于向心性或较均匀性增厚，需要结

合血压病史判断。

3、浸润性或代谢性心肌病：

如心肌淀粉样变、Fabry 病等也可导致心肌增厚，但通常有其他特征性影像表现和临床线索，需要结合临床及实验室检查判断。

三、形态学异常

本例最主要的形态学异常是**前间隔近中段增厚**。

1、室间隔最厚约 **21 mm**。

2、心肌增厚主要累及前间隔近中段，其余左室节段室壁厚度大致正常，提示**不对称性心肌增厚**。

3、左室肌小梁粗重，前后乳头肌粗大。乳头肌是帮助二尖瓣关闭的肌肉结构，在肥厚型心肌病患者中有时也可增粗。

四、功能学异常

本例主要功能学异常是**增厚心肌舒张顺应性减低**。

“**舒张顺应性减低**”可以理解为：心肌增厚以后相对变得较“硬”，心脏在放松并接受血液进入左心室时不如正常心肌柔软，因此**舒张和充盈能力下降**。

五、组织学异常

本次增强扫描发现**前间隔近中段肌壁间灶状强化**。

六、其他发现

1、左心室整体收缩功能正常

患者 **LVEF 为 65%**。30–39 岁女性 LVEF 参考范围约为 **54%–80%**，说明目前左心室整体收缩泵血功能正常。**CO 为 4.8 L/min**，30–39 岁女性参考范围约为 **2.5–7.8 L/min**，提示每分钟心脏泵出的总血量处于相应参考范围内。**EDV 为 115.29 mL**，30–39 岁女性参考范围约为 **71–162 mL**；**EDVi 为 76.07 mL/m²**，相应参考范围约为 **46–92 mL/m²**。上述数据提示目前左心室容量无明显增大。

本例可以简单理解为：**心脏整体“泵血能力”目前正常，但局部增厚心肌的“放松和充盈能力”已经下降**。

2、心腔及右心结构

左心房和左室内径未见增大。左房前后径约 25 mm，左室横径约 40 mm。

右心房和右室内径处于正常范围，右室壁无明显增厚，右心功能正常，右室流出道通畅。

3、心脏瓣膜

二尖瓣、主动脉瓣启闭正常，三尖瓣启闭大致正常，本例未见瓣膜启闭异常。

4、心肌灌注

心肌首过灌注未见明显异常，本例未发现心肌灌注异常。

5、心包

心包无明显增厚或积液，本次检查未见心包异常。

6、大血管

主肺动脉内径约 **22 mm**，女性参考范围约为 17–27 mm，本例未见增宽。

升主动脉内径约 **24 mm**，女性参考范围约为 18–33 mm，本例未见增宽。

七、生活方式管理及随访建议

1、运动及日常活动建议

轻至中等强度的休闲运动通常受到鼓励，如散步、轻松骑行、太极等，可帮助维持心肺功能和整体健康。运动过程中如出现胸痛、明显心悸、头晕或接近晕厥，应立即停止活动并及时就医。

2、饮食与生活管理

建议保持均衡饮食、合理体重和规律作息，并积极控制血压等心血管危险因素。

3、医学随访

定期进行临床评估、心脏超声及动态心电图随访。

本报告基于影像学检查结果分析，不可替代临床诊断或治疗方案，具体病情解读及治疗策略请咨询临床医生。

Supplementary Table S1.

Questionnaire Internal Consistency and Factor Structure

Questionnaires	
Comprehension questionnaires (Original-report)	
Cronbach's α value	0.794
KMO	0.799
Bartlett's test of sphericity Sig.	$p < 0.001$
Comprehension questionnaires (LLM-report)	
Cronbach's α value	0.849
KMO	0.803
Bartlett's test of sphericity Sig.	$p < 0.001$
Performance questionnaire (radiologist)	
Cronbach's α value	0.814
KMO	0.793
Bartlett's test of sphericity Sig.	$p < 0.001$
Performance questionnaire (LLM themselves)	
Cronbach's α value	0.486
KMO	-
Bartlett's test of sphericity Sig.	-

Supplementary Table S2.

Performance Comparison of Radiologist and LLM Self-assessment

Dimension	LLM-Report (n=100)	DeepSeek-V3.2 (n=50)	GPT-5.2 (n=50)	r	p-value
Radiologist					
Information Completeness	16 (15, 19)	16 (14.75, 19)	16 (15.75, 19)	0.029	0.769
Content Accuracy	16 (15, 19)	16 (13.75, 20)	16 (15, 19)	0.038	0.708
Structural Coherence	17.5 (15, 20)	19 (16, 20)	17 (15, 20)	0.167	0.096
Terminology Clarity	16 (15, 20)	16.5 (15, 20)	16 (15, 20)	0.079	0.429
Educational Value	16 (15, 19)	16 (15, 19)	16.5 (14.75, 19)	0.026	0.796
Total Score	83.5 (78, 89)	84.5 (78.75, 89)	82 (78, 89)	0.103	0.302
LLM self-assessment					
Information Completeness	20 (19, 20)	20 (19, 20)	20 (19, 20)	0.022	0.830
Content Accuracy	19 (19, 20)	19 (19, 20)	19 (19, 20)	0.040	0.688
Structural Coherence	19 (19, 20)	20 (19, 20)	19 (19, 20)	0.166	0.096
Terminology Clarity	18 (18, 20)	18 (18, 20)	18 (18, 20)	<0.001	> 0.99
Educational Value	19 (19, 20)	19 (19, 20)	19 (19, 20)	0.020	0.841
Total Score	96 (95,98)	96 (96,98)	97 (95,98)	0.010	0.925

Data are presented as median (IQR). Each dimension was scored on a 5-point Likert scale, with a maximum of 20 points per dimension. The total score ranged from 20 to 100 for the performance questionnaire. Effect size r was calculated as $|Z|/\sqrt{N}$. Bonferroni correction was applied to the five dimension-level comparisons, with statistical significance defined as $P < 0.01$.

Supplementary Table S3.
Comprehension Comparison of Patient Evaluations

Dimension	Original-report vs LLM-Report				LLM			
	Original-report (n=100)	LLM-Report (n=100)	r	p-value	DeepSeek-V3.2 (n=50)	GPT-5.2 (n=50)	r	p-value
Patient								
Information Completeness	9 (5, 10)	19 (17, 20)	0.869	<0.001*	19 (17, 20)	19 (16.8, 20)	0.013	0.893
Readability	7 (4, 8)	19 (15, 19)	0.869	<0.001*	18 (14, 19)	19 (17.3, 20)	0.225	0.024
Diagnostic Clarity	9 (7, 11)	19 (16, 19)	0.864	<0.001*	19 (16, 19.3)	19 (15, 19.3)	0.051	0.613
Actionability	6 (5, 8)	19 (16, 20)	0.869	<0.001*	19 (15, 19)	19 (17.8, 20)	0.183	0.067
Total Score	31 (24, 35.6)	73 (66, 77)	0.868	<0.001	73 (64.6, 76.3)	73 (67, 77)	0.110	0.270

Data are presented as median (IQR). Each dimension was scored on a 5-point Likert scale, with a maximum of 20 points per dimension. The total score ranged from 16 to 80 for the comprehension questionnaire. Effect size r was calculated as $|Z|/\sqrt{N}$. For the four dimension-level comparisons, Bonferroni-corrected statistical significance was defined as $p < 0.013$.