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心脏磁共振成像评价缺血性心肌病的临床应用价值 *

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摘要 目的:评估心脏磁共振(cardiac magnetic resonance,CMR)功能成像在缺血性心肌病临床诊断中的价值。**方法:**使用飞利浦3.0T 磁共振仪,对 32 例临床确诊的缺血性心肌病患者进行 CMR 平扫及钆对比剂动态增强扫描。应用 Cardiac MR Analysis 软件进行相关后处理分析,计算左室射血分数、室壁增厚率等心功能参数并与超声心动图检查结果相比较。采用 17 节段分段法分析心脏形态学、心肌组织运动、局部灌注、延迟增强等特点,评价其临床应用价值。**结果:**所有患者的心功能参数均降低,包括左室射血分数、每搏输出量、心输出量和室壁增厚率,心脏磁共振和超声心动图的测量结果并无明显差异(49%± 5.3% vs 52% ± 8.2%; 42.8 mL± 8.9 mLvs 45.7 mL ± 10.6 mL; 3.5 L/min± 0.6 L/min vs 3.8 L/min± 0.9 L/min; 28%± 4%. vs 31% ± 6%) ($P>0.05$)。所有患者中存在室壁运动异常的为 184 段(184/544);其中心肌血流灌注信号减低的有 136 段(136/184),呈现心肌延迟强化的有 98 段(98/136)。**结论:**CMR 功能成像对于缺血性心肌病的临床诊疗及预后评估可提供与心肌形态及功能相关的重要信息。

关键词:缺血性心肌病;磁共振成像;心肌功能;心肌灌注;心肌活性

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Value of Cardiac MRI for Assessment of Ischemic Cardiomyopathy*

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ABSTRACT Objective: To investigate the clinic value of cardiac magnetic resonance (CMR) in diagnosis of ischemic cardiomyopathy. **Methods:** Thirty-two patients diagnosed ischemic cardiomyopathy clinically underwent MRI plain scan and Gd-DTPA dynamic enhancement scan. The results were analysed by cardiac post-processing software, cardiac functional parameters such as left ventricular ejection fraction were calculated. Cardiac morphology, motion, perfusion and delayed -enhancement were analysed to assess its clinical application value. **Results:** Cardiac functional parameters of all patients were decreased, including left ventricular ejection fraction, stroke volume, cardiac output and wall thickening rate. There was no significant difference between cardiac magnetic resonance and echocardiography (49%± 5.3% vs 52% ± 8.2%; 42.8 mL ± 8.9 mL vs 45.7 mL ± 10.6 mL; 3.5 L /min± 0.6 L/min vs 3.8 L/min± 0.9 L/min; 28%± 4%. vs 31% ± 6%, $P>0.05$). 184 segments (184/544) showed abnormal wall motion in all patients, among these segments, the segments of signal decreasing and delayed-enhancement were136 and 98 respectively. **Conclusion:** Multimodality CMR provides important information of myocardial morphology and function in diagnosis and prognosis evaluation for ischemic cardiomyopathy.

Key words: Ischemic cardiomyopathy; Magnetic resonance imaging; Myocardial function; Myocardial perfusion; Myocardial viability

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前言

缺血性心肌病是世界上发病率和死亡率最高的疾病之一,临床预后差, 最主要的病因是存在严重的冠状动脉疾病(coronary artery disease, CAD)[1-3]。CAD 发病率逐年激增,不良心血管事件的发生严重影响人类健康[4,5]。冠心病治疗的关键是及时有效的恢复心肌缺血区域的血液供应,其临床有效性和应用价值很大程度受到心肌存活性的影响,有研究表明心肌存活率大于10%的患者临床获益更明显[6,7]。因此,准确评估 CAD 患者的心脏形态学、功能学及血流动力学对于缺血性心脏病的诊断、治疗及其预后至关重要。新兴的心脏磁共振成像技术(cardiac magnetic resonance,CMR) 被视为心脏形态及功能的一站式扫

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描技术,已逐渐广泛应用于临床。本次研究旨在对比其与心动超声检查技术相比在识别与检测缺血性心肌病变方面的准确性及敏感性,探讨其对后续临床诊疗及预后评估的价值。

1 资料与方法

1.1 临床资料

收集 2017 年 6 月至 2018 年 5 月期间因胸闷、气促、心前区不适等症状于我院行心脏 MRI 检查的 32 例缺血性心肌病患者的资料,男性 18 例,女性 14 例,年龄 42-64 岁。

纳入标准:具有明确心肌缺血的临床症状;心电图示 ST 段改变;冠状动脉造影或冠状动脉 CTA 检查示冠状动脉明确狭窄; 可同时提供详细的临床资料及超声心动图检查结果。排除 标准:具有 MRI 检查禁忌症(金属异物、幽闭恐怖症);严重心律失常;合并心肌病或瓣膜病;屏气不良;严重肝肾功能不全者。

1.2 检查方法

心脏扫描使用 Philips Ingenia 3.0 T MR 扫描仪, 最大梯度场 45 mT/m,最大梯度切换率 200 mT/m/ms。呼吸门控和心电门控联合监测, 使用心脏磁共振检查专用的相控阵表面线圈,采用 FSE 序列进行心脏和大血管成像、SSFP 序列进行电影成像。扫描切面包括左室四腔心长轴、两腔心长轴、左室短轴及左室流出道。采用飞利浦公司 Portal 6.0.3 Patch 工作站的 Cardiac MR Analysis 软件进行后处理, 计算左室射血分数、每搏输出量、心输出量和室壁增厚率等心功能参数;在短轴位进行心肌 MR 首过灌注显像,采用 DYN-sBTFE-3sl 序列,反转时间(TI) 180-250 ms, 延迟时间 (TD)0-500 ms。注入钆喷酸葡胺(Gd-DTPA) (0.1 mmol/kg, 3.5 mL/s) 10 mL 后即刻开始扫描;15 min 后行心肌延迟增强扫描。

1.3 图像后处理分析与评价

利用自带的后处理软件,分别于收缩末期和舒张末期在短轴电影序列上逐层手动勾画心内外膜(不包含乳头肌),软件自动分析计算得到左室射血分数 (Left ventricular ejection fraction)、每搏输出量(Stroke volume) 、心输出量(Cardiac output)和室壁增厚率(Wall thicking rate)等心功能参数。另外,由 2 名影像科医师共同完成图像分析,以意见一致为准。采用 17 节段分段法进行左室心肌结构划分[8]。应用 5 分法进行心肌延迟强化程度分级[9],0 分:无强化;1 分:1%-25%透壁性强化;2 分:26%-50%透壁性强化;3 分:51%-75%透壁性强化;4 分:76%-100%透壁性强化。室壁增厚率(心脏短轴位)=(收缩末期心肌厚度 - 舒张末期心肌厚度)/ 舒张末期心肌厚度。

1.4 统计学方法

采用 SPSS 19.0 统计软件进行数据分析。心功能各参数值用均数± 标准差的形式表示,$P<0.05$ 为差异有统计学意义。

2 结果

心功能参数:32 例缺血性心肌病患者的心功能参数均降低,包括左室射血分数、每搏输出量、心输出量和室壁增厚率,心脏磁共振和超声心动图的测量结果并无明显差异 (49%± 5.3% vs 52% ± 8.2%; 42.8 mL ± 8.9 mL vs 45.7 mL ± 10.6 mL; 3.5 L/min± 0.6 L/min vs 3.8 L/min± 0.9 L/min; 28%± 4% vs 31% ± 6%)($P>0.05$)。

室壁运动情况:共计 544 个心肌节段,存在室壁运动异常的为 184 段(184/544)(表 1);心肌血流灌注情况:心肌血流灌注信号减低的有 136 段(136/184),心脏 MRI 检查所显示的心肌缺血范围与彩色多普勒超声及心电图检查结果基本相同。

心肌延迟强化情况:呈现心肌延迟强化的有 98 段(98/136),其中 72 个节段表现为心内膜下延迟强化,26 个节段表现为透壁性延迟强化。应用 5 分法进行心肌延迟强化程度分

表 1 左心室心功能参数心脏磁共振和超声检查结果

Table 1 Left ventricular function parameters: cardiac magnetic resonance and echocardiographic findings

Left ventricular ejection fraction(%)		Stroke volume(mL)	Cardiac output (L/min)	Wall thicking rate(%)
MRI	49 ± 5.3	42.8 ± 8.9	3.5± 0.6	28%± 4%
TTE	52 ± 8.2	45.7 ± 10.6	3.8± 0.9	31% ± 6%

表 2 左心室室壁运动

Table 2 Left ventricular wall Motion

Wall motion	Slight hypomolitily	Severe hypomolitily	Akinesis	Dysfunction	Total
Myocardial segments	60	74	44	6	184

表 3 左心室心肌延迟强化评分

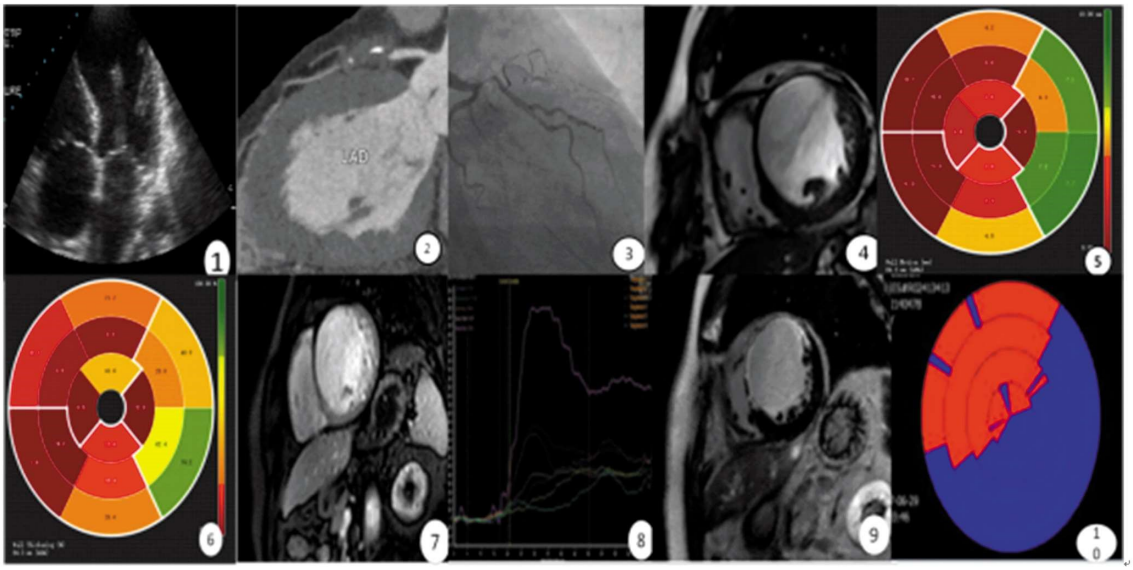
Table 3 Left ventricular myocardial delayed-enhancement score

Score	1	2	3	4	Total
Myocardial segments	46	26	18	8	98

表 4 左心室心肌灌注和延迟强化

Table 4 Left ventricular myocardial perfusion and delayed-enhancement

Myocardial intensity	hypo-perfusion merely	hypo-perfusion and delayed-enhancement	delayed-enhancement
Segments	42	94	4



男，56 岁，心悸胸闷

图① :超声心动图；图② :冠脉 CTA；图③ :DSA；图④ :心脏电影序列；图⑤ :心肌运动牛眼图；图⑥ :心肌室壁厚度牛眼图；图⑦ :心肌首过灌注显像；图⑧ :心肌灌注时间 - 信号强度曲线；图⑨ :心肌延迟增强显像；图⑩ :心肌延迟强化牛眼图

图① 超声显示左心室略扩张，局部室壁变薄，节段性室壁运动减弱。图② 冠脉 CTA 显示左前降支非钙化斑块及混合斑块，局部管腔近似闭塞。图③ DSA 证实左前降支局部管腔闭塞。图④ 心脏核磁左室短轴电影示左心室前壁及室间隔前壁运动减弱。图⑤ 牛眼图显示左心室前壁及室间隔弥漫性运动减弱。图⑥ 牛眼图显示左心室前壁及室间隔局部室壁变薄。图⑦ 注入钆剂后左室短轴位首过灌注显示左心室前壁及室间隔心肌呈低信号的灌注缺损表现。图⑧ 时间 - 信号强度曲线示左心室前壁及室间隔灌注曲线斜率减低。图⑨ 注入钆剂 15 分钟后进行延迟强化成像，左室前壁及室间隔心内膜下见条状高信号的延迟强化表现。图⑩ 牛眼图显示左室前壁及室间隔斑片状延迟强化灶。

Male, 56 years old, palpitation and chest tightness

Fig. ① : Echocardiogram; Fig. ② : Coronary CTA; Fig. ③ : DSA; Fig.④ : Cardiac cine sequence; Fig. ⑤ : Bulls'eye plots of myocardial motion ; Fig. ⑥ : Bulls'eye plots of myocardial wall thickness ; Fig.⑦ : Myocardial first pass perfusion imaging; Fig. ⑧ : Myocardial perfusion time-signal intensity curve; Fig. ⑨ : Myocardial delayed enhancement imaging; Fig.⑩ :Bulls'eye plots of myocardial delayed enhancement

Fig. ① ultrasound revealed a slightly expansion of ventriculus sinister , thinning of the local ventricular wall, and hypomotility of segmental ventricular wall . Fig. ② . Coronary artery CTA showed non calcified plaques and mixed plaques in the left anterior descending branch,Local lumen is approximate occlusion. Fig. ③ . DSA confirms that the left anterior descending branch is occluded. Fig. ④ .The left ventricular anterior wall and septal anterior wall motion decreased in cardiac magnetic resonance imaging. Fig. ⑤ Bulls'eye plots shows the diffuse motion of the left ventricle and the interventricular septum is weakened. Fig. ⑥ Bulls'eye plots of shows that the anterior wall and the interventricular septum of the left ventricle become thinner. Fig. ⑦ Short-axis first-pass perfusion of left ventricle after gadolinium injection revealed hypointense perfusion defect of left ventricular anterior wall and septal myocardium. Fig. ⑧ Time - signal intensity curve showed that the slope of the left ventricular anterior wall and ventricular septal perfusion curve decreased. Fig. ⑨ _Delayed contrast-enhanced imaging was performed 15 minutes after gadolinium injection. Strip-like high signal enhancement was seen in the anterior wall of left ventricle and subendocardial septum. Fig. ⑩ Bulls'eye plots of shows the delayed enhancement of left ventricular anterior wall and ventricular septum.

级时，结果为 1 分、2 分、3 分和 4 分的心肌节段分别为 46、26、18 和 8。（表 2 和表 3）。

3 讨论

缺血性心肌病是世界范围内重要的致死及致残病因，最主要的病因是存在严重的冠状动脉疾病(coronary artery disease, CAD)。CAD 发病率居高不下，严重影响人类身心健康[10]。在缺血性心肌病早期阶段，有效评估心脏功能、局部血流灌注及心肌组织的活性对其临床诊断及预后评估至关重要。目前，冠状动脉造影（coronary angiography，CAG）仍是诊断 CHD 的金标准，但因有创性使其临床应用受限，难以作为冠心病的筛查手段[11]。近年来，CMR 技术因其独特的价值与优势，被认为是极有应用前景与价值的无创性检测缺血性心肌病变的影像学手段。

缺血性心肌病导致心肌细胞能量代谢不足，早期阶段心肌组织的收缩功能和左室射血分数 (left ventricular ejection fraction, LVEF)不同程度的减低，继而心肌组织的舒张功能也受限[12]。因此，早期评价缺血性心肌病患者的心功能状况尤为重要。目前在临床上被广为应用的两种评估心功能的影像学检查方法是超声心动图和 CMR，前者以其价格低廉、简单方便、易于操作等优势是检测心功能最常用的影像学检查手段。但尚存在一些不足之处，一方面，首先其空间分辨率有限，其次是在进行左室几何体积假定恒定的情况下对心内外膜进行单一层面的勾画，测量结果的准确性有待提高与改善[13]。CMR 不仅可静态测量心肌组织室壁厚度，还可以实时心脏电影播放模式动态显示室壁及瓣膜运动状况，以此判断心脏功能[14]。另外，室壁增厚率同样也可作为检测心肌组织运动异常的参数，对于慢性缺血患者而言，该参数往往低于正常人，且敏感性更高[15]。尽管，在我们的研究中，心脏磁共振和超声心动图在所有患者的左室射

血分数、每搏输出量、心输出量和室壁增厚率等心功能参数测量结果方面并无明显差异。

CAD 患者往往存在不同程度的冠状动脉狭窄，从而导致心肌组织血流分布不均，引起犯罪血管供应区域的心肌组织血流灌注降低，诱发心肌缺血、坏死、心功能受损[16]。DSA 是诊断 CAD 的重要手段，能为临床医师提供丰富的冠状动脉解剖学信息，但尚不能反映心肌组织微循环状况的改变，不能解决缺血性心肌病诊断的全部问题[17]。对于 CAD 患者而言，功能性毛细血管床大量减少和广泛的微血管床受损是导致心肌组织血流灌注减低最重要的病理生理学机制[18]。近年来，随着 CMR 技术的发展，利用首过灌注显像，即通过静脉高速团注钆剂后，获取动态灌注曲线，从而评价心肌局部血流灌注情况。心肌组织缺血时，由于局部毛细血管床数量的减少，相比于正常心肌组织，局部对比剂流入缓慢，缺血区域呈现首过灌注信号减低。另外，因其空间分辨率相对较高的优势，对于心内膜下的缺血灶更敏感。先前的研究结果证实，心肌灌注成像对心肌缺血的敏感性和特异性分别达 87%和 85%。

对于缺血性心肌病患者而言，临床治疗的主要目的是及时恢复心肌血供使存在缺血性损伤但仍存活的心肌组织得以挽救。因此，准确的判断心肌组织活性对于指导临床工作具有至关重要的作用。心肌缺血区域常同时存在冬眠心肌、顿抑心肌及瘢痕心肌组织。冬眠心肌和顿抑心肌尚处于早期缺血阶段，仍具有一定的活性，属于可逆性受损心肌。当冠状动脉长期阻塞时即会引起心肌梗死。因此，及时准确的判断心肌组织的存活性极其重要，有助于临床预后评估。瘢痕心肌组织因增大的细胞外间质容积，引流血管及淋巴管的减少，导致钆剂廓清障碍，而表现为病变心肌的延迟强化。钆对比剂延迟强化 MRI 成像 (Late gadolinium enhancement cardiac MR imaging, LGE-CMR)，能够反映心肌组织的微循环状况及其病理生理学状态，被认为是判断坏死心肌的可靠指标，可准确有效的区分存活心肌和坏死心肌，从而指导临床的再血管化治疗，已成为目前判断心肌坏死的金标准。本次研究中有 98 个左室心肌节段表现为不同透壁性程度的延迟强化，与犯罪血管供血区域一致，其中一例患者的延迟强化区域出现条形的低信号，预示存在微循环障碍，往往与不良的临床预后相关，主要的机制是局部微血管阻塞出现无再复流现象。

在 CMR 扫描过程中，对患者呼吸配合、心率等要求较高，屏气不好、心率不齐均易造成图像运动伪影而直接影响诊断质量，降低诊断的敏感性和特异性。另一方面，目前的心脏后处理流程相对比较复杂和耗时，亟需研发和普及简便有效的图像后处理软件，节省心脏功能显像的后处理时间，简化心血管成像、后处理及诊断的工作流程及可操作性。本次研究例数较少，并且缺乏与 PET、SPECT 等其他检查方法的比较，在以后进一步的研究中有待改进与完善。

总之，心脏 MRI 检查因其独特的价值有优势，已逐渐广泛应用于临床。心脏造影、心肌首过灌注与心肌延迟增强多技术成像可有效评价心肌功能、局部血流灌注及心肌组织活性，对于缺血性心肌病的临床诊疗及预后评估意义重大。

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