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# 心脏磁共振成像技术在急性 ST 段抬高型心肌梗死诊治中的应用价值

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【摘要】随着经皮冠状动脉介入术的广泛开展,近年来急性 ST 段抬高型心肌梗死的病死率及致残率明显下降,远期存活患者数量巨大,对其精确评价及预后转归逐渐成为关注的焦点。心脏磁共振成像技术作为新兴的无创性心脏功能及组织定性检查手段,在心脏疾病的诊治中日益普及,但国内对其在急性 ST 段抬高型心肌梗死的患者病情评估中的作用一直未得到特别重视。现对心脏磁共振成像技术在急性 ST 段抬高型心肌梗死患者中的临床应用价值做一综述。

【关键词】心脏磁共振成像;急性 ST 段抬高型心肌梗死;预后
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# Application of Cardiac Magnetic Resonance Imaging in Diagnosis and Treatment of Acute ST-segment Elevated Myocardial Infarction

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【**Abstract**】With the widespread application of percutaneous coronary intervention, the mortality and morbidity of acute ST-segment elevation myocardial infarction has decreased dramatically. Precise evaluation and risk stratification in ST-segment elevation myocardial infarction have attracted more attention. Cardiac magnetic resonance imaging, as a new and noninvasive imaging modality, has demonstrated a great value in clinical practices. However, so far, the unique value of cardiac magnetic resonance in ST-segment elevation myocardial infarction has been overlooked, therefore, this review will highlight the unique value of cardiac magnetic resonance in the diagnosis and prognosis for patients with acute ST-segment elevation myocardial infarction.

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【**Key words**】Cardiac magnetic resonance; ST-segment elevated myocardial infarction; Prognosis

急性 ST 段抬高型心肌梗死(ST-segment elevated myocardial infarction, STEMI)是急性冠状动脉综合征中较为危急的一类。近年来,循证医学证据表明,随着心脏介入治疗技术的发展与普及,胸痛中心的建立以及急诊患者转运途径的日趋完善,STEMI 的病死率与致残率均有显著下降。因此,对 STEMI 患者介入术后的精准评价及预后评估成为新的热点问题。

心脏磁共振成像(cardiac magnetic resonance, CMR)技术因其无辐射、无创伤、多平面、多参数扫描、较高的空间及时间分辨率等优势,成为新兴的"一站式"检查手段[1]。其不仅能准确计算心功能指标,又可以通过对梗死危险区域(area at risk, AAR)、心肌内出血(intra myocardial hemorrhage, IMH)、心肌梗死范围大小(infarction size, IS)与微血管阻塞(microvascular obstruction, MVO)等定性、定量分析[2-4]提供更多临床参考信息。众多临床研究证实,以上磁共振参数的应用对 STMEI 患者预后的评估均有较好指导意义[2-10]。但在目前的临床实践中,对于 STEMI 的患者,心脏磁共振技术并非作为常规检查开展,其对心肌梗死患者预后的价值也未受到足够重视。现对 CMR 技术在 STEMI 患者中的临床应用价值做一介绍。

## 1　CMR 在 STEMI 诊断及鉴别诊断中的应用

临床上有部分 STEMI 患者因进行了急诊溶栓处理或者血栓自溶,入院后冠状动脉造影发现冠状动脉正常。此类患者的临床表现与心肌炎及一些心肌病症状相似,不易鉴别。Assomull 等[11]对 60 例胸痛入院发现肌钙蛋白增高但造影未见冠状动脉狭窄的患者完善 CMR 寻找病因,发现其中 50% 的患者为心肌炎、11.6% 发现心肌梗死及 3.4% 为心肌病。冠状动脉造影及常规影像学很难将此类患者准确诊断。临床上有些疾病如心肌炎、心包炎及心肌病都会引起心电图 ST 段抬高,表现类似于 STEMI。Stensaeth 等[12]从 1 145 例被怀疑为 STEMI 的患者中,发现 49 例冠状动脉正常的患者,通过 CMR 检查发现其中心肌炎、心包炎以及应激性心肌病为主要的致病原因,CMR 在上述疾病的病因学诊断中都起到了关键的鉴别及确诊的作用。借助 CMR 技术,不但可以对疑诊 STEMI 但冠状动脉完全正常的患者进行进一步确诊,还可以依照影像学诊断及时调整相应的治疗方案。

## 2　CMR 在 STEMI 病情评价及预后判断中的应用

### 2.1　CMR 可以精确测定左右心室功能

左心室射血分数(LVEF)是 STEMI 患者最强的生存预测指标之一,也是心肌梗死后心功能不全的患者是否需要安置植入式复律除颤器的重要评估指标[13]。临床常用的非侵入性检查中,超声心动图是心功能评价最常用的检查,二维超声对心功能的评测均依赖对心室腔形态学的假设计算。而 STEMI 患者室壁运动异常及室壁瘤形成常常改变了心腔的结构与形态,因此二维超声心动图对 STEMI 患者心功能评价的准确性有限[14]。三维超声技术被证实有较高准确性和可重复性[15],但因声窗较窄而其应用受到限制。心肌核素显像在心功能评价中可重复性较好,但因其空间及时间分辨率较低加之存在电离辐射,而不作为最理想的检查手段。CMR 不同于以往二维测量技术,可以准确地测定真实心室容积、射血分数以及心肌质量。CMR 通常采用稳态自由进动(steady-state free precession, SSFP)电影序列测定心室功能,完成四腔心(左右心房、心室)、两腔心(左房及左室)、三腔心(左房、左室及左室流出道)以及一系列自心底到心尖短轴连续性扫描(用于观测左右心室)。通过手动描记收缩末期及舒张末期各短轴层面上左心室内膜及外膜,定量计算出左心室质量、左室舒张末期容积、左室收缩末期容积以及 LVEF。临床中常用舒张末期容积 > 20% 用来定义不利的左心室重构[16-20]。同时根据体表面积计算相应的心指数、舒张末期容量指数、收缩末期容量指数等指标。Wu 等[21]研究证实心脏磁共振测定的射血分数、舒张末期容量指数与 IS 都是未来心血管事件发生的预测因子。同时心肌节段性应变的计算可以更好地评估心肌节段性运动异常,提供更多的临床信息。Wong 等[22]将网格标记(tagging)心肌应变与延迟强化图像结合,发现磁共振网格标记得到的心肌周向应变是心肌节段性收缩功能改善很好的预测指标,其与钆剂延迟强化及 MVO 结合会提供额外的临床价值。

对于右心室而言,因为其肌壁较薄、形状不规则,超声等通过形态学估测计算功能的传统评价方法不能达到预期的评价效果。CMR 通过多层面电影成像可以准确地测定右心室舒张末期容积、右心室收缩末期容积、右心室射血分数、右心室每搏量等功能指标。一直以来 STEMI 患者的右心室功能没有受到足够重视,相关研究也不多。Bodi 等[23]利用家猪建模和临床研究得出结论:单纯的前壁心肌梗死,也会出现右心室壁的受累,右心室心功能相应减低。Miszalski-Jamka 等[24]应用 CMR 技术对 99 例 STEMI 后患者进行了为期 3 年的随访,发现早期右室心肌梗死面积与右心室心功能不全是 STEMI 预后的独立预测因素,右心室射

血分数的测量可能对 STEMI 后左心室心功下降患者的危险分层有特殊的意义。Larose 等[25]对 147 例发生心肌梗死 1 月后的患者行心脏磁共振检查,经过 17 个月的随访证实右心室射血分数 <40% 是心肌梗死患者死亡的独立预测因子。可见 CMR 对右心室心功能的精确计算可对 STEMI 患者的预后评估带来更多信息。

### 2.2 CMR 对 AAR 及 IS 的定性定量分析

急性心肌梗死后,由于梗阻血管支配区域的心肌氧气供需失衡导致局部心肌缺血,从而引起局部代谢与超微结构的改变。如缺血持续存在,这种改变将变得不可逆而出现自心内膜下向心外膜的“波浪式效应”[26]。此期间,梗死心肌周围会出现大面积炎症及水肿。磁共振成像 T2 加权自旋回波序列对心肌组织水含量很敏感,可用来检测心肌炎、急性心肌梗死等心肌水信号较高的疾病。有研究发现心肌梗死发生后 30 min 便可出现 T2 信号的增强,说明水肿可以作为急性心肌梗死出现不可逆性梗死之前的早期标志[27]。同时 T2 加权高信号的有无可以用于急性及陈旧性心肌梗死的鉴别[28]。临床上 T2 加权对 AAR、IMH 及存活心肌(myocardial salvage)的定量定性测定对评价急性心肌梗死的心肌损伤程度有一定意义。AAR 表示心肌梗死发生时发生完全缺血坏死可能的心肌组织。Carlsson 等[29]通过对 16 例初发 STEMI 并行初次经皮冠状动脉介入术的患者进行同期 CMR 与单电子发射计算机断层成像术对比,证实心肌梗死后 1 周的 T2 加权 CMR 可以准确评估心肌危险区域,同时还可以通过 AAR 与梗死面积的差值对可挽救心肌进行定量。也有研究试图利用 T1 mapping 技术对 AAR 进行定量分析,发现在 3T 场强下 T1 mapping 技术在评价 AAR 时准确性甚至可以媲美 T2 mapping 技术[30],但这种技术的临床价值依旧需要更多临床应用证据。

钆对比剂在其聚集浓度较高的组织中可以缩短组织 T1 弛豫时间并增强 T 加权下的信号强度,根据此原理可以选择性识别钆剂摄取增加或者减少的区域。静脉注入钆对比剂若干分钟后,钆对比剂在坏死及纤维化心肌中的聚集浓度较正常心肌组织高,导致 T1 信号高于正常心肌组织,这种现象被称为钆对比剂延迟增强(late gadolinium enhancement, LGE)。临床上根据 LGE 出现的位置及分布特点可以对心肌炎、心肌淀粉样变性等特殊的心脏疾病进行相应的鉴别诊断[1,31]。

IS 是 STEMI 患者心肌坏死程度的客观指标,更小的梗死面积常被认为可以得到更多的临床获益[32]。常用梗死心肌占心肌质量的百分比表示。诸多研究发现 STEMI 后从急性期开始,心肌梗死面积会随时间变化发生不同程度的进行性缩小[33-34],因此心肌梗死面积测定的时间窗确定仍存在争议。不过随着相关研究的开展,心肌梗死面积对 STEMI 患者预后的预测价值得到了肯定。Wu 等[21]通过用心脏磁共振对 122 例 STEMI 患者进行急性期及心肌梗死后 4 个月的扫描发现,急性期的 IS 与 STEMI 后左室重构高度相关,其对预后的预测作用甚至优于 LVEF 和收缩末期容积指数。Husser 等[33]对 250 例 STEMI 患者进行心肌梗死后 1 周内及 6 个月后的磁共振扫描,发现 1 周内透壁延迟强化范围是主要心血管严重不良事件的独立预测因子,而 6 个月后的心肌梗死面积的预后价值并不优于 1 周内的测值。

CMR 图像分析中对 AAR 及 IS 的定量尚无公认的最佳标准方法。常用在 T2 加权自旋回波序列及 LGE 图像上信号强度高于远端正常心肌 2 倍标准差、3 倍标准差、5 倍标准差、半峰全宽度(full width at half maximum, FWHM)、最大类间方差法(Otsu method)及手动描记进行定量分析。有研究发现即便是有经验的观察者用纯手动描记方法测得的 AAR 和 IS 都较其他方法的可信度差,而 FWHM 测得的 IS 和 Otsu 方法测得的 AAR 可信度均较高[35]。

## 3 CMR 对心肌梗死后再灌注损伤的评价

STEMI 罪犯血管的尽早开通以及缺血心肌的早期再灌注一直是公认的减小梗死面积,减少不良预后的主要治疗措施。但在恢复血流供应的同时,也会引起再灌注损伤,引起心肌细胞的进一步死亡及梗死面积的扩大。严重的再灌注损伤可以导致无复流。再灌注损伤的形成原因较为复杂,大致可归纳为以下几点:急性血管内皮功能障碍、远端血管血栓栓塞、中性粒细胞填塞、氧自由基的产生、心肌细胞钙超负荷、血管收缩、心肌水肿以及炎症反应[36]。CMR 评价再灌注损伤主要通过评价 IMH 与 MVO。

研究发现在心肌梗死再灌注的动物模型中有红细胞从血管内皮间隙逸出而形成出血性损伤的现象[37]。对病例的研究中发现心肌间质出血只发生在经过再灌注的 STEMI 患者中[38]。因此临床上常将心肌间质出血作为评价再灌注损伤的指标。CMR 图像上表现为 T2 加权序列上高信号区——AAR 中间的低信号区域。一般认为发生 IMH 的患者常伴随较大的梗死面积以及较差的预后[2-39]。

MVO 是指 STEMI 行经皮冠状动脉介入术后直径 <200 μm 的冠状动脉血管的无复流现象。其形成原因包括:血栓及斑块的栓塞、血管内皮功能异常、心肌水肿及 STEMI 治疗后的微血管功能障碍[40]。研究表明

MVO 的出现多伴随心肌梗死后心肌功能恢复较差的结局[41]。在完全或接近透壁心肌梗死的患者中,尽管早期成功进行再灌注治疗,IMH 等再灌注损伤也常常伴随 MVO 出现[38]。Regenfus 等[42]通过对 STEMI 患者进行为期 6 年的随访发现 MVO 是主要心血管并发症的最强预测因子,与现有临床指标及 LVEF 共同提供了临床预后的价值。IMH 与 MVO 无论在影像学还是组织学上都具有高度的相关性[39,43],IMH 与 MVO 同时出现常发生在初始心肌梗死溶栓治疗血流低于 3 级的病例中,也就是初始心肌梗死较严重的人群中[44]。

检查过程中分为早期 MVO 及晚期 MVO:早期 MVO 是指在钆对比剂首过灌注过程中延迟的灌注缺损;晚期 MVO 是指当对比剂注入 10 min 后于延迟强化的梗死区域中间出现的低信号区域。早期及晚期 MVO 对预后的预测作用对比尚无定论。Wong 等发现晚期 MVO 相比于早期 MVO 对 STEMI 发生 90 d 后的 LVEF 有很强的预测作用。Klug 等[40]通过对 129 例 STEMI 患者进行平均为期 52 个月的随访,他们认为早期 MVO 对急性心肌梗死的远期预后更有意义。de Waha 等[6]通过对 438 例 STEMI 患者平均随访 19 个月也发现了相似的结论。

考虑到延迟强化成像需要造影剂的注入,肾功能不全的患者成为禁忌,相应的新技术也正在研究并逐步应用到临床。Carrick 等[45]利用 T1 mapping 技术对心肌梗死后患者进行观察,发现梗死灶核心区 T1 值可以作为心肌梗死患者的梗死定性及预后评价无对比剂的指标。也有研究发现 T1 mapping 技术可以在评价心肌可逆性损伤中为 LGE 及 T2 作为补充,但该方法还需要更多组织学及临床应用的证据证实[46]。

## 4　CMR 对 STEMI 病情评估的其他应用

除以上应用外,心脏磁共振成像标准序列对于心脏解剖形态、瓣膜功能等均有更好的掌握。Jobs 等[47]应用心脏磁共振成像技术发现,STEMI 后中到大量的心包积液是患者不良预后的标志之一。同时心脏磁共振成像也可以更直观定性瓣膜反流、狭窄以及发现心腔内血栓等,对患者出院后的治疗用药及随访检查提供了很好的指导。

## 5　CMR 技术在 STEMI 中的应用前景与挑战

CMR 技术不仅可以清晰直观地展示心脏的解剖形态、瓣膜功能,准确地计算左右心室功能评价心室运动的协调性,同时还可以对 STEMI 后 AAR、IMH、IS 及 MVO 等心肌整体及局部的组织学变化进行定性、定量分析。对评估 STEMI 患者风险和预后以及相应治疗方案的制定都有重要的参考价值。与此同时该检查仍面临一些挑战。考虑到磁共振成像检查本身的禁忌,例如幽闭恐惧症、体内金属植入物、心脏起搏器植入后等不能完成扫描;同时由于心脏磁共振扫描需要较长的时间、多次长时间闭气以及对比剂注入,STEMI 后一些心功能较差、不能平卧、严重的心律失常、肺功能和肾功能受损的患者均难以完成检查。未来随着 CMR 技术的发展将可能逐步克服这些缺陷,提高 CMR 临床应用的实用性。更重要的是深入研究 CMR 在急性心肌梗死中的价值,将对于 STEMI 患者的危险分层及个体化治疗方案的制定提供精准影像引导。

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