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封面文章

左心室血栓(left ventricular thrombus, LVT)是急性心肌梗死(myocardial infarction, MI)后常见且严重的并发症之一,可显著增加脑卒中及全身动脉栓塞风险,严重影响患者预后。近年来,随着急诊再灌注治疗水平不断提高,心肌梗死患者的生存率明显改善,但LVT仍是影响患者长期预后的重要并发症之一。深入阐明LVT形成的血流动力学特征,探索客观、可靠的影像学定量指标,对于优化临床风险评估和治疗决策具有重要意义。

目前,心脏磁共振(cardiac magnetic resonance, CMR)能较好地显示左心室血栓的形态及位置,已成为诊断LVT的重要影像学方法。然而,CMR的传统序列主要关注血栓的形态学改变,难以定量评价左心室复杂的血流动力学特征,尚缺乏能够客观反映左心室血流动力学异常的定量CMR影像学指标。

近年来,四维血流磁共振成像(four-dimensional flow magnetic resonance imaging, 4D Flow MRI)能够实现整个心动周期内三维血流的可视化及定量分析,可同步评价左心室血流组分及血流动能等血流动力学参数,为研究心肌梗死后左心室血流动力学改变及其与LVT形成的潜在关系提供了新的研究手段。

本研究应用4D Flow MRI分析心肌梗死患者左心室血流动力学特征,比较MI伴LVT组、MI不伴LVT组及健康对照组三组之间左心室功能参数、四种血流组分及血流动能参数的差异。定量资料采用独立样本 t 检验进行组间比较,定性资料采用Pearson卡方检验或Fisher精确概率法进行比较。将相应指标纳入多因素logistic回归分析,筛选与LVT存在独立相关性的血流动力学指标,并采用受试者工作特征曲线评价其预测效能。结果显示,MI患者存在明显的左心室血流重构,表现为直接血流减少、残余血流增加及整体血流动能下降,其中上述改变在LVT患者中更为显著。进一步分析显示,直接血流与LVT存在独立相关性,并具有良好的预测效能,可作为传统形态学评估的重要补充指标,协助临床提高MI合并LVT的多维度风险分层能力。详见内文第49页。

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Left ventricular thrombus (LVT) is one of the most common and serious complications following acute myocardial infarction (MI), substantially increasing the risk of stroke and systemic arterial embolism and adversely affecting patient prognosis. Although advances in timely reperfusion therapy have markedly improved the survival of patients with MI in recent years, LVT remains an important determinant of long-term clinical outcomes. Therefore, elucidating the hemodynamic characteristics associated with LVT formation and identifying objective and reliable imaging biomarkers are of great clinical significance for optimizing risk stratification and therapeutic decision-making.

Currently, cardiac magnetic resonance (CMR) provides excellent visualization of the morphology and location of left ventricular thrombi and has become an important imaging modality for the diagnosis of LVT. However, conventional CMR sequences primarily focus on morphological assessment and are unable to quantitatively characterize the complex intracavitary hemodynamics of the left ventricle. Consequently, quantitative CMR-derived imaging biomarkers that objectively reflect abnormal left ventricular hemodynamics remain limited.

Recent advances in four-dimensional flow magnetic resonance imaging (4D Flow MRI) enable comprehensive visualization and quantitative assessment of three-dimensional intracardiac blood flow throughout the cardiac cycle. By simultaneously evaluating left ventricular flow components and kinetic energy, 4D Flow MRI provides a novel approach for investigating post-infarction hemodynamic alterations and their potential association with LVT formation.

In this study, 4D Flow MRI was used to characterize left ventricular hemodynamics in patients with MI. Left ventricular functional parameters, four flow components, and kinetic energy parameters were compared among patients with MI and LVT, patients with MI without LVT, and healthy controls. Continuous variables were compared using the independent-samples *t* test, whereas categorical variables were analyzed using the Pearson chi-square test or Fisher's exact test, as appropriate. Variables associated with LVT were further entered into multivariable logistic regression analysis to identify independent hemodynamic correlates of LVT. Receiver operating characteristic curve analysis was subsequently performed to evaluate their predictive performance. The results demonstrated significant left ventricular flow remodeling in patients with MI, characterized by reduced direct flow, increased residual volume, and decreased overall kinetic energy, with these alterations being more pronounced in patients with LVT. Further analysis identified direct flow as an independent hemodynamic correlate of LVT, exhibiting good predictive performance. These findings suggest that direct flow may serve as a valuable quantitative complement to conventional morphological assessment, thereby improving multidimensional risk stratification for LVT in patients with MI. Please see text page 49.

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