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斑点追踪成像技术评估非瓣膜性房颤左心耳血栓形成的研究进展

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[摘　要] 非瓣膜性心房颤动是临床上常见的心律失常类型之一，容易形成心房血栓，导致脑卒中、血栓栓塞、心力衰竭等疾病的风险增加。大部分非瓣膜性房颤患者血栓形成于左心耳。因此，早期发现和预测左心耳血栓形成对全身栓塞的诊治和预防有重要临床意义。斑点追踪成像在评价左心耳血栓形成方面的价值尚不清楚，本文旨在对斑点追踪成像技术评估非瓣膜性房颤患者左心耳血栓形成的价值进行综述。

[关键词] 斑点追踪成像技术；左心耳血栓；自发显影；左心房应变；左心耳应变

Research progress of speckle-tracking imaging in the evaluation of left atrial appendage thrombosis in patients with non-valvular atrial fibrillation

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Abstract Non-valvular atrial fibrillation is one of the common types of arrhythmia in clinical practice. It is easy to form atrial thrombosis, and lead to an increasing risk of stroke, thromboembolism, heart failure and other diseases. Studies have shown that most patients with non-valvular atrial fibrillation form thrombus in the left atrial appendage. Therefore, early detection and prediction of left atrial appendage thrombosis have important clinical significance for the diagnosis, treatment, and prevention of systemic embolism. With the development of ultrasound technology, the value of speckle-tracking imaging in evaluating left atrial appendage thrombosis is still unclear. This article aims to review the value of speckle-tracking imaging in evaluating left atrial appendage thrombosis in patients with non-valvular atrial fibrillation.

Keywords speckle-tracking imaging; left atrial appendage thrombosis; spontaneous echo contrast; left atrium strain; left atrial appendage strain

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非瓣膜性心房颤动(以下简称“房颤”)是临床上常见的心律失常类型之一，目前房颤的发病率呈逐年上升趋势，截至2010年，房颤的全球患者约有3 350万[1]。随着我国人口逐渐老龄化，房颤患者逐年增加，80岁以上人群房颤的发病率>8%，预计患病人数以及总患病率在未来仍会明显增加。左心耳(left atrial appendag，LAA)是房颤患者不容忽视的触发点，与房颤维持有关[2]，约90%的与房颤相关的血栓栓子来自LAA，并与左心房及LAA功能障碍有关[3]，还与卒中、全身栓塞(systemic embolism，SE)、心力衰竭和全因病死率相关，使卒中风、心力衰竭风险、痴呆和病死率的风险增加数倍[4]。血栓栓塞事件是房颤的最常见并发症[5-7]。经食道超声心动图(transthoracic echocardiography，TEE)从心脏后方观察心内结构，可清晰地显示LAA结构，是目前扫描有创查LAA的首选技术手段，被认为是识别或排除左房(left atrial，LA)、LAA血栓及自发显影(spontaneous echo contrast，SEC)的金标准[6]。但由于TEE的相对及绝对禁忌证较多，许多患者检查时受到限制。因此，寻找一种无创、安全、便捷的技术尤为重要。斑点追踪成像(speckle tracking echocardiography，STE)通过评估心肌应变和应变率，可发现早期心脏的运动及功能异常，应变和应变率成像可预测和评估多种在心脏疾病(例如心力衰竭、心肌病、冠状动脉疾病等)中的风险分层[8-10]。目前，STE评估LAA血栓形成的价值尚不清楚。因此，本文旨在探讨STE技术在评估非瓣膜性房颤患者LAA血栓形成中的研究进展。

1 LAA 血栓形成的机制及形态

LAA是心脏发育过程中左心房的残余附属结构，也是左房最易形成血栓的部位[11]。目前，电子计算机断层扫描(computed tomography，CT)和心脏磁共振(cardiac magnetic resonance，CMR)根据LAA的形态结构特点划分为为仙人掌形、鸡翅形、菜花形和风向标形4种形态[12]。其中结构形态最简单的鸡翅样形态在脑卒中/短暂性脑缺血发作中的发病率明显超过其他类型的LAA血栓患者[13]。因此，复杂的LAA结构是LAA血栓形成的独立危险因素之一。在房颤患者中，左心房及LAA的收缩紊乱会导致血流停留及流速减缓，这也是导致LAA血栓形成的危险因素之一[14]。LAA血栓形成主要包括SEC、泥浆样改变、血栓形成3个阶段[15]。SEC是一种反映血液流动缓慢和血细胞聚集形成的超声特征图像。随着血液流动停滞的进展，SEC变得致密并具有粘黏性外观，即泥浆样改变，进而形成致密稳定的血栓，更容易引起SE的发生。

2 STE

2.1 STE 的原理

STE基于高帧频二维灰阶超声图像，识别心肌组织内独特的声学标记或“斑点”的空间运动，即在1个心动周期中逐帧扫描某个斑点的位置，通过自相关技术主动匹配各个斑点位置，准确追踪每个斑点的运动轨迹，可以使用特定的软件算法计算心肌运动速度、应变、应变率及心脏扭转变形情况[16-17]。

2.2 应变及应变率

应变是指物体的变形能力，代表心肌在张力作用下发生形变的能力[18]。根据心肌运动模式，心脏的应变主要包括圆周、纵向、径向及旋转角度4个方面。而应变率(strain rate，SR)则表示心肌发生应变的速度，可用于评估心脏整体及局部功能变化。

3 STE 评估 LAA 血栓的应用进展

3.1 左心房应变与 LAA 血栓形成的联系

当房颤发生时，左心房收缩紊乱，心房功能受损，内径扩张，从而导致血流减缓，促进LAA形成血栓，因此左心房的功能与LAA血栓形成密切相关，早期发现左房功能改变有助于预测和评估LAA血栓形成。临床上，经胸超声心动图通常是在心尖双平面切面上利用Simpson规则或面积长度椭球体法来预估左房容积，但由于左房扩张通常是不对称的，且在前后方向上不太明显，此方法的结果存在误差。研究[19]发现：与CMR和CT相比，经胸超声心动图测量的左房容积通常较小，CMR与CT无显著差异。因此，心房功能的评估仍面临局限性，而STE通过追踪左心房各个切面，可以发现早期的心房功能改变，是一种主要对心房功能进行评估的测量方法[20]。Kurzawski等[21]通过对63例射血分数降低性心力衰竭患者的左心房纵向应变研究，发现左房纵向应变是预测LAA血栓形成的最佳独立因子。近期一项研究[22]通过对144例非瓣膜性房颤患者进行分析，发现左房的纵向应变与LAA血栓形成有关，在经胸超声心动图测量左房应变可以无创性评估和预测LAA停滞和LAA血栓的存在。

表明其与CHA2DS2-VASc评分联合可能提高LAA血栓形成的预测能力[23]，为CHA2DS2-VASc评分提供了更多的诊断信息，同时也可以改善低CHA2DS2-VASc评分患者的血栓栓塞的风险分层[24]，但仍需要大量随机研究来证明心房应变是否可以用于房颤患者的血栓风险分层[25]。通过左房应变评估左房功能可以预测急性缺血性卒中患者LAA血栓的形成[26]，对心源性栓塞具有预测价值[27]。综上，分析左房应变可预测和评估LAA血栓的形成，且潜力巨大。

3.2 LAA应变与LAA血栓形成的联系

当房颤发生时，LAA运动功能紊乱，血流停滞且缓慢，左心房压力负荷和容量负荷增加，LAA对左心房血流动力学的调节作用减弱，易形成血栓[28]。研究[29-30]表明：房颤患者的LAA壁运动功能明显受损，血流速度明显降低，形成LAA血栓的风险增加，从而导致血栓栓塞发生。LAA的血流速度与LAA血栓的形成密切相关，是预测LAA SEC与血栓形成的独立因素，与CHA2DS2-VASc评分的预测作用几乎一致[30]。因此，LAA功能与LAA血栓的形成联系密切。但是TEE检查仅提供了关于LAA腔内整体变化的信息，但不能反映局部LAA壁运动异常，对发现早期的LAA功能障碍有一定局限性。STE可以无创、便捷地发现LAA早期的运动功能受损，因此有望成为新的评估与分析LAA功能的方法。非瓣膜性房颤患者的LAA壁应变能力降低，相关的室壁损伤与LAA峰值血流速度降低相关，同时LAA的应变参数也可以通过预测房颤患者LAA流速的降低，从而预测LAA血栓的形成[31]。研究[32]发现：峰值正应变的降低、较低的LAA排空速度与较高的LAA SEC或血栓形成发生率呈正相关，LAA排空速度、LAA面积变化、LAA应变与致密SEC/血栓的存在独立相关[33]。此外，Jankajova等[34]对80例进行电复律的非瓣膜房颤患者的LAA的应变及应变率进行分析，结果表明：在非瓣膜性房颤患者中，LAA应变、应变率是缺血性卒中和全身血栓栓塞形成的重要预测指标，可以补充和提高CHA2DS2-VASc评分的预测能力[35-36]。综上，LAA的应变率分析可能是一个补充和完善CHA2DS2-VASc评分以及细化非瓣膜性房颤患者的血栓栓塞风险分层的新指标，可预测房颤患者LAA SEC和血栓形成的存在。因此，STE技术分析LAA壁应变可以预测LAA峰值流速，两者均可预测LAA血栓形成。

4 结语

目前，临床上多采纳非瓣膜性房颤患者的血栓来源于LAA这一学说，虽然TEE是诊断LAA血栓形成的金标准，但由于它是半侵入性的，对技术要求比较高，且禁忌证较多，限制了其在临床上的使用。STE技术具有无创、便捷的特点，可评估左心房和LAA整体和局部心肌变形的能力，与其他技术相比，STE具有可重复性以及不依赖固定的声波角等优点，因此可以更好地早期识别房颤患者引发卒中的高危人群和低风险人群，并适当指导抗凝治疗，为预测和评估非瓣膜房颤患者LAA SEC和血栓的形成开辟了一个新的研究领域，左心房及LAA的应变、应变率是否有望成为预测与评估非瓣膜性房颤患者LAA血栓形成的新的危险因素指标，仍需大量临床研究证明。目前关于STE评估LAA应变和应变率的研究较少，而由于现有研究的领域及样本量受限，因此未来仍需进一步探究二维STE技术对于LAA血栓形成的评估价值。

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