·综 述·

持续性心房纤颤的辅助消融策略

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【摘 要】心房纤颤（简称房颤）是一种临床上最常见的持续性心律失常，发病率高，危害大。近年来，房颤的非药物治疗取得了较快发展，其中肺静脉隔离（PVI）就是一种有效的治疗方法。这种方法对于阵发性房颤患者治愈率较高，而在持续性房颤和长时程房颤患者中疗效一般。本综述主要探讨针对持续性房颤患者的最新辅助消融策略及其机制，包括线性消融、复杂碎裂心房电位（CFAE）消融、神经节（丛）消融、主频率消融、转子消融和与房颤触发相关的其他解剖位点消融。

【关键词】心房颤动；消融技术；辅助消融

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Adjunct ablation strategies for persistent atrial fibrillation

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【Abstract】Atrial fibrillation (AF) is one of the clinically most common sustained arrhythmia, with high incidence and major hazards. In recent years, great achievements have been made in its non-pharmacologic therapeutic strategies. Among them, pulmonary vein isolation (PVI) is recommended by recent guidelines as an effective procedure to control AF, and its efficacy is higher in paroxysmal AF than in persistent and long-standing persistent AF. This article reviewed and summarized the state-of-the-art of adjunct ablation strategies for patients with persistent AF, including linear ablation, ablation of complex fractionated atrial electrograms (CFAE), ablation of ganglionated plexi, dominant frequency, rotors and other anatomical sites frequently involved in AF triggers.

【Key words】atrial fibrillation; ablation techniques; adjunct ablation

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1 概 述

心房纤颤（简称房颤）是临床上最常见的房性心律失常之一，其发病率在全世界持续增长[1]。它是卒中和心力衰竭的独立危险因素，房颤患者较窦性心律患者的死亡率增加3倍[2]。对于复发性房颤患者，抗心律失常药物是转复和预防复发的次要手段，而导管消融治疗越来越受到人们的重视[3]。多项随机对照临床研究显示，导管消融能更好地治疗房颤、改善症状，提高生活质量并有可能降低因房颤所致的血栓栓塞事件的发生风险[4]。目前，已有多项研究发现并证实了房颤触发和维持的电生理和解剖靶位。Haïssaguerre等[5]发现起源于肺静脉（pulmonary veins，PVs）的异位兴奋灶可诱发阵发性房颤的发生，而对于大多数房颤，特别是阵发性房颤患者，经验性肺静脉隔离（pulmonary vein isolation，PVI）能够治愈该病[7]。

最新指南推荐：（1）对于有症状的阵发性房颤患者或不能耐受至少一种Ⅰ类或Ⅲ类抗心律失常药物的阵发性房颤患者，导管射频消融治疗是其首选治疗方法；（2）对于持续性房颤患者，也推荐使用导管消融治疗[8,9]。

与阵发性房颤相比，导管消融治疗持续性房颤和长时程房颤效果不理想，PVI后复发率高达60%[10]。所以，非阵发性房颤患者除了需要PVI治疗

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外，还需要对其他靶点进行消融，以达到治愈房颤、预防复发的目的[11]。本文旨在综述持续性房颤射频消融术中除PVI外的其他辅助消融技术。

2 线性消融

从胚胎学、解剖学和电生理学角度看，左房后壁可以认为是PVs延续区[12]。外科手术已证实，左房后壁在房颤的触发和维持上起着重要作用[13]，甚至有人认为有些房颤起源仅局限于此[14,15]。Oral等[16]将80名慢性房颤患者随机分成两组，一组行PVI治疗，另一组行非整环后壁线性消融治疗。平均随访9个月，第一组术后复发率为28%，而另一组为25%（P = 0.8）。此外，姚焰采用步进法左房线性消融持续性房颤研究中发现，左房房顶、左心耳嵴部和二尖瓣峡部消融能终止9.3%持续性房颤，在此基础上行右侧肺静脉前庭线性消融及冠状窦左心房侧后壁线性消融能够终止32.6%的持续性房颤，长期随访成功率为72.1%。由此可见在PVI消融术同时增加线性消融，能提高手术成功率及窦性心律维持率。常见的线性消融位点包括左房顶部线、二尖瓣峡部线、三尖瓣峡部线、二尖瓣环左房后壁线和冠状窦。

3 复杂碎裂心房电位（complex fractionated atrial electrograms，CFAE）消融

持续性房颤很可能并不是由PVs持续释放异位电位所致。根据Moe等的“多发折返子波”假说，持续性房颤时心房无规律电活动是心房内多个独立的折返子波在不应期弥散分布于不均匀介质中随机扩散的结果[17,18]。子波源于不同的慢传导区域，围绕解剖或功能位点旋转并彼此相互碰撞，这种各异性的传导就形成了CFAE[19]。虽然这些致房颤的复杂折返环随机产生且不易准确标记，但该象充分表明房颤的触发和维持机制可能与CFAE有关[12]。Nademanee等[14]首次系统描述了CFAE的特点，CFAE为低振幅电位（0.06到0.25mv），激动周期≤120ms或短于冠状窦周长，有2～3个折返，连续无恒定基线的心房激动波；并对包含所有类型的房颤患者行基于CFAE的射频消融治疗，随访1年成功率高达91%。

继Nademanee等的研究之后，有许多研究都证实了CFAE消融在房颤消融中的辅助作用。Haïsaguerre等[14,15]将CFAE消融方法加入到他们对长时程房颤患者的分步连续性消融中。分步消融包括PVI,左房房顶线性消融,冠状窦及左房下壁消融，心房内高频低幅CFAE消融和二尖瓣峡部、左心耳根部线性消融。消融过程中可观察到所有患者都出现了房颤周期延长现象，其中87%的病例消融后出现房性心动过速，13%术中转复窦性心律。房性心动过速患者先标记后消融，大多可以成功[15]。

Hunter等[20]首次将CFAE分级。Grade 1：连续碎裂电位。Grade 2：间断碎裂电位。Grade 3：间歇性碎裂电位；Grade 4：复杂电位。Hunter等推测连续碎裂电活动（Grade 1和2）可能与局灶机制相关，而少量的碎裂信号（Grade 4）更多地反应了折返机制。间歇性碎裂电位（Grade 3）可能是一种被动波，也可能是远场电位和局灶电位重叠所致，其对房颤的维持无明确意义。目前所有的研究结果都提示，CFAE消融对于非阵发性房颤患者预后有益。

无论是何种房颤类型，心房因素在房颤维持机制、术中电位标记和导管消融上都越来越受到重视。Nademanee等[12]首次报道了对持续性房颤和长时程房颤患者进行CFAEs消融的成功率达91%。同一研究小组对674名患者持续2年随访的结果显示CFAEs消融成功率为85%[21]。但这些研究都是非随机研究，Oral等并没有发现PVI后加CFAEs消融能提高患者窦性心律维持率[22]。根据本中心研究，CFAEs消融在系统PVI基础上可能提高手术成功率及术后窦性心律维持率。

4 神经节（丛）（gangllonated plexuses，GPs）消融

心脏自主神经系统是机体自主神经系统的一部分，包括交感神经系统和副交感神经系统。而GPs主要存在于心外膜脂肪垫中[23]，特别是PVs前庭中。右房和上腔静脉交界处也存在着GPs之间以及GPs和心房心肌膜之间的广泛连接[24]。

众多研究已明确了自主神经系统在房颤触发和维持上的作用，其机制包括易化自主心房提早除极，缩短心房和PV有效不应期等[25,26]。基于这一理论，许多学者认为GPs消融是除PVI以外的重要辅助消融手段[21,27,28]。通常，GPs多可通过高频刺激心房心内膜后迷走反应定位[21,28]。一项随机性研究纳入了67名阵发性房颤患者，他们被随机分入PVI组和PVI + GP消融组，平均随访10个月，PVI组中仅有45.5%的患者未复发，而PVI + GP消融组则高达73.5%[29]。Pachon等[29]首次利用实时频谱标测系统快速有效地识别具有含高频双极心房电位的心肌区域（如房颤巢）。Arruda等[30]在一项前瞻性随机研究中评估了房颤巢消融的辅助作用，结论

是虽然加用房颤巢导致消融绝对获益较少（阵发性房颤绝对危险性减少9%，持续性房颤患者减少10%），但它仍能减少房颤复发。解剖学上，在PV前庭水平，自主神经位点分布与CFAE分布吻合。因此，自主神经节可以在传统PVI消融或者是在CFAE消融中一并被有效消融[31]。

5 主频率（dominant frequency，DF）消融

对房颤患者心房电位进行电位标测研究发现，房颤患者心房内总是存在从高DF区域到低DF区域的特有电位梯度。具有高DF的心房区域可能与房颤触发和维持相关，故该区域可能是消融靶点[32]。Sanders等[33]对房颤患者的左房电位进行实时频谱标测，并对高DF区域行射频消融，术后发现房颤周期延长[从（180 ± 30）ms延长到（198 ± 40）ms；$P < 0.0001$，Kappa = 0.77]，19例阵发性房颤患者中有17例术中复律，持续性房颤患者无一例实现术中复律。Verma等[31]报道，与PVI消融组相比，PVI + DF消融组在术后1年的无心律失常生存率上无差异。

6 转子消融

目前有研究发现，房颤患者心房内存在一种稳定快速的折返环，将其命名为“转子”，而转子也将成为房颤消融新的靶点[34]。加利福尼亚圣地亚哥大学的一项研究应用64极篮状电极标测房颤患者左、右心房电位，并通过一种新型系统识别持续性转子（旋转波）和局灶电位（向心房周围扩散的离心电位）[35]。转子是连续顺时针或逆时针旋转的活动电位，它与房颤的维持息息相关。一旦发现转子和局灶电位存在持续时间超过10min，就可以认为它们是房颤产生的原因。CONFIRM（The Conventional Ablation for Atrial Fibrillation With or Without Focal Impulse and Rotor Modulation）研究首次提示房颤的维持可能与位置固定的转子和局灶电位相关，其所在区域为射频消融靶位。该研究将92名患者分为两组，一组患者接受PVI消融治疗（$n = 71$），另一组患者接受PVI消融和局灶电位、转子消融（focal impulse and rotor modulation，FIRM）治疗（$n = 36$）。97%的患者发现了位置固定的转子和局灶电位，80%的转子位于左房，20%位于右房。通过植入式事件记录仪随访监测显示，PVI + FIRM消融成功率高达82.4%，较PVI消融治疗44.9%的成功率高（$P < 0.001$）。但Miller等[36]认为，一旦心房容积超过篮状标测导管的最大体积时，这种标测方法的可靠性就值得商榷了。是否所有类型房颤患者都存在转子，消融后是否可明显改善预后，目前许多研究都在积极证实之中。

7 非肺静脉触发位点消融

非PV触发位点在PVI术后复发、特别是非阵发性房颤PVI术后复发中起到了重要作用。非肺静脉触发位点大多存在于心房游离壁、界嵴、房室交界区、冠状窦、Marshall韧带、左心耳中。消融Marshall韧带通常可从左房下壁心内膜面消融至左下肺静脉入口，也可通过导丝和球囊经Marshall静脉灌注酒精以达到有效的Marshall韧带的电隔离作用。Di Biase等[37]发现三分之一的房颤复发患者均存在左心耳触发位点。一旦发现左心耳中存在触发灶，应对其行完全电隔离才能保证手术成功。

8 结 论

PVI治疗是目前房颤射频消融治疗的基石，特别是在阵发性房颤中效果明确[38]。但对于持续性房颤和长时程房颤，单行PVI治疗，手术成功率及术后窦性心律维持率较低。近年来，除PVI以外的辅助消融技术得到了广泛的研究。通过研究发现，广泛线性消融、心房CFAE消融、转子消融及非肺静脉触发位点消融可以提高非阵发性房颤患者的手术成功率及术后窦性心律的维持率。但这些辅助消融方法仍需要更多的随机化研究来证实其优势。老年人群中非阵发性房颤发生率较青年人群高，单纯使用PVI消融治疗效果欠佳，更多的老年患者需要加用辅助消融策略，从而提高消融成功率，但是否会增加手术风险，仍需要更多的临床研究加以证实。

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