心房颤动高功率短时程消融的临床应用进展

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【摘要】 目前高功率短时程射频消融术是心房颤动消融领域的一项新技术。已有临床研究显示:与低功率长时程射频消融术相比,高功率短时程消融术能明显减少手术时间和相关并发症的发生率,但二者的手术效果相近,目前仍需大样本、前瞻性和多中心的临床研究去评估其对心房颤动的远期疗效。现主要从有效性、安全性、优势、局限性及展望等方面,对高功率短时程消融术的临床应用以及研究进展做一综述。

【关键词】 高功率短时程;心房颤动;射频导管消融术
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Clinical Application of High-power and Short-term Ablation for Atrial Fibrillation

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【**Abstract**】 At present, high-power and short-duration radiofrequency ablation is a new technology in the field of atrial fibrillation ablation. Clinical studies have shown that: "compared with low-power and long-duration radiofrequency ablation, high-power and short-duration radiofrequency ablation can significantly reduce the operation time and the incidence of related complications, but their surgical effects are similar." However, a large sample, prospective, multicenter clinical study is still needed to evaluate its long-term effect on atrial fibrillation. This article mainly reviews the clinical application and research progress of high-power and short-duration radiofrequency ablation from the aspects of effectiveness, safety, advantages, limitations and prospects.

【**Key words**】 High-power and short-duration; Atrial fibrillation; Radiofrequency ablation

近年来,经皮导管消融术已成为心房颤动(房颤)患者维持窦性心律的重要治疗手段之一,以肺静脉前庭隔离为基石的导管消融术也取得了确切的成就。但射频导管消融术为逐点消融,且目前国内外的多数中心均采用每个点以 25 ~ 35 W 功率消融 30 ~ 60 s 的低功率长时程(low-power and long-duration, LPLD)消融模式[1-2],这导致手术时间较长和相关并发症的风险较高。而冷冻球囊消融术虽为多点消融,明显缩短了手术时间,但其在持续性房颤和术后出现房性心律失常等方面的应用价值却有限[3]。近年来,少数研究者发现:相比 LPLD 消融模式,采用每个点 45 ~ 50 W 消融 5 ~ 15 s 的高功率短时程(high-power and short-duration, HPSD)消融模式,可明显缩短手术时间且并未增加相关并发症的发生率[4-5]。

1 房颤的流行病学、危害和发病机制

房颤是最常见的心律失常之一。有研究分析在 2010 年全世界约有 3 350 万人罹患房颤,校正年龄因素后,男性发病率为 0.78‰,女性发病率为 0.60‰,40 岁以上的人群中男性患房颤的终身风险为 26%,女性为 23%[6]。房颤的主要危害是增加缺血性脑卒中及体循环动脉栓塞的风险和增加心力衰竭的发病率。房颤使得心房收缩活动失去规律,心房内血流紊乱,导致血流淤滞于心房内,尤其易淤积在左心耳中。如果其血栓脱落则随着血液流至全身各处,可导致脑栓塞或体循环动脉栓塞,其年发生率分别为 1.92% 和 0.24%。房颤患者缺血性脑卒中的风险是非房颤患者的 4 ~ 5 倍[7-8]。心房的不规则活动还干扰了心房-心室的同步,影响心室的充盈,使其心输出量较正常人减

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少。房颤使得心力衰竭的患病率增加 3 倍且加重患者心力衰竭的症状[9]。房颤还易诱发快速的心室率并引发心悸、胸闷和晕厥等临床症状,严重影响房颤患者的生活质量。

房颤的电生理机制很复杂,临床虽有部分共识,但仍需深化研究。目前普遍认为异位触发和折返机制是房颤发生和维持的主要病理生理机制。房颤最常见的异位触发点位于肺静脉中,肺静脉肌袖内具有异常自律性的细胞,在某些特定情况下,可自发产生快速电活动导致房颤的发生。异常电活动的增加诱发心房结构及电生理的重构,造成心房基质的不均质,严重时发生纤维化,形成多个折返环,使得房颤得以维持[8]。肺静脉异常电活动触发和心房折返机制,奠定了肺静脉前庭隔离治疗房颤的理论基础。最近的一项荟萃分析也证实:肺静脉前庭隔离是射频导管消融治疗房颤的基石[10]。

2　HPSD 治疗房颤的原理

射频导管消融是通过心内导管释放一定的物理能量,产生可控的热效应造成局部细胞外液蒸发和脱水,导致细胞不可逆的局限性凝固坏死,从而实现肺静脉前庭的电隔离。射频导管消融的过程中,有两个主要的加热阶段:阻抗式加热和传导式加热。阻抗热会直接导致局部心肌组织不可逆的损伤和心肌细胞的死亡,形成透壁损伤。传导热则被动传导至更深的心肌组织层,由于其局部温度降低而造成深层组织的潜在可逆损伤(水肿)。房颤的复发原因主要是未能形成透壁损伤而仅导致心肌组织水肿,待组织水肿消退后,肺静脉与左心房的电位重新连接[11-12]。研究表明 HPSD 通过提高射频功率使射频能量以阻抗热为主,心内膜损伤灶表面积相对大,易形成透壁损伤;通过缩短放电的时间使射频能量传导热的占比降低,损伤灶深度相对浅,从而减少对周围组织(如食管和膈神经)造成不必要的损伤[13-14]。动物体内实验也证实:与传统的 LPLD 相比,HPSD 的病灶宽度更大而深度更浅,且病灶间的线性连接更好[15-16],这是 HPSD 消融可能提高肺静脉隔离效率和减少相关并发症发生率的理论基础。

3　HPSD 治疗房颤的有效性和安全性评价

3.1　HPSD 的有效性

众多的临床研究证实了 HPSD 射频导管消融术治疗房颤的有效性和安全性。Vassallo 等[4]的单中心和回顾性研究纳入 76 例房颤患者(HPSD 组 $n=41$ vs LPLD 组 $n=35$),结果显示:HPSD 组的手术时间、左房内操作时间和消融时间与 LPLD 组相比均明显减少[手术时间:(106±23) min vs (148±33.6) min, $P=0.0001$;左房内操作时间:(70.7±18.5) min vs (110±29) min, $P=0.0001$;消融时间:(1 909±675.8) s vs (4 558±1 998) s, $P<0.00001$];而两组的 X 线曝光时间无统计学差异[HPSD 组 vs LPLD 组:(8.52±3.5) min vs(8.8±6.6) min, $P=0.221$]。HPSD 组在第 6 个月和第 12 个月的房颤复发率较 LPLD 组降低,但无统计学差异(第 6 个月:12.19% vs 25.71%, $P=0.231$;第 12 个月:17.07% vs 31.42%, $P=0.14$)。Berte 等[17]的单中心、非随机和前瞻性研究在消融指数指导下对 174 例房颤患者(HPSD 组 $n=80$ vs LPLD 组 $n=94$)行射频导管消融术,研究显示 HPSD 组的手术时间和消融时间与 LPLD 组相比均明显减少[手术时间:(82±18) min vs (100 ±22) min, $P<0.0001$;消融时间:(23±5) min vs (36±11) min, $P<0.0001$]。而两组的无房颤复发率(HPSD 82% vs LPLD 83%, $P=0.93$)和主要并发症发生率(HPSD 1% vs LPLD 3%, $P=0.39$)无统计学差异。王炎等[18]的单中心、前瞻性和随机性研究纳入 92 例房颤患者(HPSD 组 $n=46$ vs LPLD 组 $n=46$),研究显示:HPSD 组的消融手术时间较 LPLD 组明显减少[HPSD(139.4±50.7) min vs LPLD(173.6±53.3) min, $P<0.05$];而两组的无房颤复发率(HPSD 80.0% vs LPLD 76.1%, $P>0.05$)、一般并发症、严重并发症和即刻肺静脉隔离成功率均无统计学差异。Baher 等[5]的单中心、回顾性和非随机性研究纳入 687 例房颤患者(HPSD 组 $n=574$ vs LPLD 组 $n=113$),研究示:HPSD 组的手术时间较 LPLD 组明显缩短[(149±65) min vs (251±101) min, $P<0.001$];而在平均 2.5 年的随访期内,两组的房颤复发率相似(42% vs 41%, $P=0.571$)。Ücer 等[19]的单中心和前瞻性研究对 25 例房颤患者行 HPSD 射频导管消融术,研究显示 HPSD 的急性肺静脉有效隔离率低于预期。在腺苷激发试验中 32% 的患者(8/25)肺静脉电位重新连接,但所有的重新连接都是暂时的,并且随着腺苷效应的停止而消失。综上所述,HPSD 消融术可明显缩短手术时间和消融时间,甚至可能提高手术成功率,但其远期随访结果尚需更多研究证实。

3.2　HPSD 的安全性

Winkle 等[13]的多中心和回顾性研究共对 10 284 例房颤患者行 HPSD 射频导管消融术,它是目前关于 HPSD 最大的临床研究,该研究发现 HPSD 的并发症发生率极低:33 例心脏压塞(0.24%),2 例肺静脉狭窄(0.014%),2 例膈神经损伤(0.014%),6 例在 48 h 内出现脑卒中(0.043%)。在消融左心房后壁时,HPSD 导致心房食管瘘 1 例(0.008 7%),而 LPLD 导致心房食管瘘 3 例(0.12%)。一项单中心和双向性

研究[20]通过在射频导管消融术后对患者行上消化道内镜检查,评估患者术后食管糜烂的情况。该研究发现消融术后患者食管糜烂发生率在 30 W 组(13/47, 28%)、50 W 组(4/18,22%)和 60 W 组(0/30,0%)有统计学差异($P=0.007$),提示 HPSD 消融模式可能降低食管损伤的风险。但该研究的病例数较少,且缺乏患者术前上消化道内镜检查的结果,无法排除部分患者术前已存在食管糜烂的情况,这可能造成统计分析的误差。Baher 等[5]的研究通过无创性的食管磁共振来评估 HPSD 组和 LPLD 组术后食管热损伤程度,发现两组术后食管热损伤发生率相近(HPSD vs LPLD)(无热损伤:64.8% vs 57.5%;轻度热损伤:21.0% vs 28.3%;中度热损伤:11.5% vs 11.5%;重度热损伤:2.8% vs 2.7%)($P=0.370$)。综上所述,HPSD 消融可能降低房颤消融手术相关并发症,特别是食管损伤的发生率,但尚需更多的研究证实。

4 HPSD 治疗房颤的优势

与传统的 LPLD 消融模式相比,HPSD 消融模式可能存在以下优势:(1)明显缩短手术时间和消融时间;(2)术中液体灌注量明显减少,可能降低术后心力衰竭的发生率;(3)手术时间明显缩短,可能降低与手术时间过长相关的脑血管缺血事件的发生率;(4)短时程的放电,可减少因疼痛引起的呼吸变化造成的导管移位;(5)HPSD 的病灶更宽和病灶间线性连接更好,可减少补点操作及提高手术成功率;(6)HPSD 的病灶深度更浅,可减少对周围组织(如食管和膈神经等)的热损伤,降低相关并发症发生率。

5 HPSD 治疗房颤的局限性及展望

虽然大量研究已证实 HPSD 消融术可明显缩短房颤消融手术时间,且安全有效,但目前的研究多为小样本和单中心的临床研究,该技术仍需大样本、多中心、随机对照研究和更长时间的随访观察来进一步证实其有效性和安全性。其次,目前国内外学者对 HPSD 的消融功率和持续时间的设置尚未达成共识,多数研究是采用 45 ~ 50 W 的高功率,也有部分研究采用 70 W 甚至 90 W 的超高功率。Kottmaier 等[21]的研究用 70 W的功率对病灶消融 5 ~ 7 s,结果示:70 W 的超高功率可明显缩短手术时间,而无房颤复发率和并发症发生率无明显差异。Reddy 等[22]的研究对 52 例房颤患者用 90 W 的超高功率对病灶消融 4 s,结果显示 94.2% 的患者(49/52)在 3 个月后仍保持窦性心律。然而该研究中,26.9% 的患者(14/52)术中出现肺静脉的重新连接,需补充消融,但未出现心脏压塞、心房食管瘘和肺静脉狭窄等严重并发症。何种功率和时间设置才是最优的消融模式仍需进一步探讨。再者,HPSD 消融的安全窗口期很窄,因而术中如何确定有效而安全的消融终点至关重要。研究者们[23-24]提出通过应用整合消融功率、贴靠压力和消融时间三个消融损伤变量为一体的量化消融参数,包括压力-时间积分、消融指数和损伤指数等,来指导房颤射频导管消融术。Yazaki 等[25]的研究则提出通过阻抗下降来指导消融可能更安全和有效。何种参数为最佳的消融参数仍需更多的临床研究验证。

6 总结

与 LPLD 消融模式相比,HPSD 消融术可明显缩短房颤消融手术时间和消融时间,同时提高手术成功率和减少手术并发症的发生率。但该技术在临床上仍有很多问题待解决,如:何种消融功率和持续时间为 HPSD 最佳消融模式? 术中如何确定有效而安全的消融终点? 缺乏大样本、多中心和随机对照的临床试验等。未来仍需大样本、多中心、随机对照研究和更长时间的随访观察来进一步证实 HPSD 消融的有效性和安全性。

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