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# Clinical Research on Ablation of Ventricular Arrhythmias Originating from Right Ventricular Outflow Tract via Above Pulmonary Valve

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## Abstract

**Objective: To evaluate the efficacy and safety of ablation of ventricular arrhythmias (VAs) originating from right ventricular outflow tract (RVOT) using innovative method of reversed U curve and conventional method with subvalvular approach. Methods: Electrophysiological study (EPS) and radiofrequency catheter ablation (RFCA) were performed on 143 patients with premature ventricular contractions (PVCs)/ventricular tachycardia (VT) in Changzhou first people's hospital from September 2017 to January 2019. Among them, 86 patients were diagnosed as PVC/VT originating from RVOT, and they were divided into two groups. One group including 55 cases were ablated with conventional method via subvalvular approach, and the other group including 31 cases just with the moulding of reversed U curve above the pulmonary valve. The differences in the activation mapping, results of ablation and the incidence of complications between two groups were observed. Results: The conventional ablation group had 4.3 ± 1.7 times of radiofrequency (RF) on average compared with 1.8 ± 0.6 times in the reversed U curve group ($P < 0.01$). After radiofrequency (RF) delivered, the PVCs in conventional group disappeared in 5.7 ± 3.4 seconds, while those in reversed U curve ablation group were gone in 2.8 ± 1.9 seconds ($P < 0.01$). The success rate of ablation in the reversed U curve ablation group was 96.77% (30/31), which was different from the other group, 85.45% (47/55) ($P < 0.01$). In the conventional group, ablation was failed in 8 cases, and then the failed cases were performed with reversed U curve ablation. As a result, ablation was successful in 7 cases. There was one case of cardiac tamponade in the conventional ablation group with the ablation target located in the free wall of the RVOT, and no complications occurred in another group. Conclusion: Contrasted with conventional ablation group, the times of RF in the reversed U curve group are fewer, the Time to Effect (TTE) of ablation is shorter, the success rate is increased, and the safety is higher.**

## Keywords

**Ventricular Arrhythmias, Outflow Tract, Radiofrequency Catheter Ablation**

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# 肺动脉瓣上消融治疗右心室流出道室性心律失常的临床研究

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## 摘 要

**目的：探讨肺动脉瓣上倒“U”法与传统肺动脉瓣下方法消融起源于右心室流出道(right ventricular outflow tract, RVOT)室性心律失常(Vas)的有效性及安全性。方法：常州市第一人民医院心内科2017年09月至2019年01月143例室性心律失常患者行电生理检查(EPS)及射频消融术(RFCA)，其中86例患者经标测明确为RVOT起源的室性早搏(室早，PVC)/室性心动过速(室速，VT)，分为两组，一组55例患者经传统肺动脉瓣下途径消融，另一组31例患者采用倒“U”法至肺动脉瓣上消融，观察两组之间电生理标测、消融结果及并发症发生率。结果：传统消融组需平均放电4.3 ± 1.7次，有效放电后室早在5.7 ± 3.4秒消失，倒“U”法消融组平均放电1.8 ± 0.6次，有效放电后室早在2.8 ± 1.9秒消失(P < 0.01)。传统消融组成功率85.45% (47/55)，倒“U”法消融组成功率96.77% (30/31)，成功率有显著差异(P < 0.01)。传统消融组8例瓣下消融未成功者同次手术中采用倒“U”法至瓣上消融后7例成功。传统消融组心脏压塞1例，倒“U”组无并发症发生。结论：与传统消融方法比较，经倒“U”法至肺动脉瓣上消融，放电次数减少，达效时间(Time to Effect, TTE)更短，成功率增加，安全性更好。**

## 关键词

**室性心律失常，流出道，射频消融**



## 1. 引言

特发性室性心律失常(ventricular arrhythmias, Vas)包括室性早搏(室早，PVC)和室性心动过速(室速，VT)，常发生于无器质性心脏病患者[1]，心室流出道为其最常见的好发部位[2]。射频消融对频发、症状严重并且药物无效 VAs 的疗效已得到证实[3]。消融右心室流出道(RVOT)室早/室速，传统方法是经肺动脉瓣下途径，Liao 等[4]提出 RVOT 室早/室速绝大多数起源于肺动脉瓣上即肺动脉窦内，使用倒“U”法至肺动脉窦内标测及消融达到 100%成功率。陈海敏等[5]提出消融 RVOT 起源室早/室速，倒“U”方法比传统方法更具优势。本文回顾性分析了 86 例 RVOT-VAs 患者的临床资料，剖析和对比倒“U”方法与传统途径的有效性和安全性，以提高标测消融成功率，降低消融风险。

## 2. 资料和方法

### 2.1. 研究对象

常州市第一人民医院心内科 2017 年 09 月至 2019 年 01 月 143 例室早/室速患者行 RFCA，其中 86 例患者经标测明确为 RVOT 起源的 PVC/VT，男 39 例，年龄 15~73 (52.61 ± 16.82)岁。术前均行 24 h 动态心电图检查，PVC 总数 l0,048~41,852 (22,584 ± 11,721)次/24h。所有患者均符合快速性心律失常消融适应证[6]。入选标准：1) 无器质性心脏病，室早频发(>10,000 次/24 h，室早负荷 > 10%)或持续性室速；2) 心电图提示 RVOT 起源：II、III、aVF 导联 QRS 波呈高大 R 波。胸导联为左束支阻滞图形，胸导联移行 ≥ V3；3) 症状明显，口服抗心律失常药物治疗无效。排除标准：1) 严重心肺、肝肾功能不良及凝血功能障碍不能耐受手术；2) 合并病毒性心肌炎或心肌梗死 < 6 个月；3) 胸廓严重畸形；4) 高龄(>85 岁)。消融术前停服抗心律失常药物至少 5 个半衰期，签署知情同意书后接受电生理检查及射频消融术。该研究符合 2013 年修订的《赫尔辛基宣言》的要求。

### 2.2. 电生理检查和消融

穿刺右股静脉，送入 3.5 mm 冷盐水灌注导管(NaviStar ThermoCool, Biosense Webster)至 RVOT，在 Carto3 系统下行激动标测，如局部靶点电位较 VAs 的 QRS 波提早 25 ms 以上，为试消融靶点。功率控制消融，消融功率 30 W，盐水灌注 17 mL/min。传统组先于瓣下标测消融，若多次尝试消融无效，则将消融导管倒“U”至肺动脉窦内进一步标测。倒“U”组经初步标测判断为 RVOT 起源的 VAs 后直接至肺动脉窦内标测消融(见图 1、图 2)。判定靶点在肺动脉瓣上的指标：1) X 线影像学位置；2) 三维解剖模型；3) 靶点图可见小 A 波和大 V 波。成功标准[7]：即刻成功标准：术后基线状态下及异丙肾上腺素静脉滴注后，观察半小时 VAs 消失；远期成功标准：术后 3 月复查动态心电图，VAs 负荷减少 75%以上。根据随访结果，比较分析两组之间电生理标测、消融结果及并发症发生率。

## 3. 统计学处理

计量资料采用(x ± s)表示，使用 t 检验分析是否存在差异。计数资料以例数和百分率(%)表示，组间比较采用 r 检验或 Fisher 确切概率法直接计算概率。P < 0.05 为差异有统计学意义。

## 4. 结果

### 4.1. 消融结果(见表 1)

1) 放电次数：传统消融组需平均放电 4.3 ± 1.7 次，倒“U”法消融组平均放电 1.8 ± 0.6 次(P < 0.01)。

2) 达效时间(Time to Effect, TTE)：定义为射频电流发放后至 VAs 消失或终止的时间。传统消融组 TTE 为 5.7 ± 3.4 秒，倒“U”法消融组则为 2.8 ± 1.9 秒(P < 0.01)。

**Table 1.** Comparison of ablation results between conventional method and reversed U curve method
**表 1.** 传统法及倒“U”法的消融结果比较[n (%)]

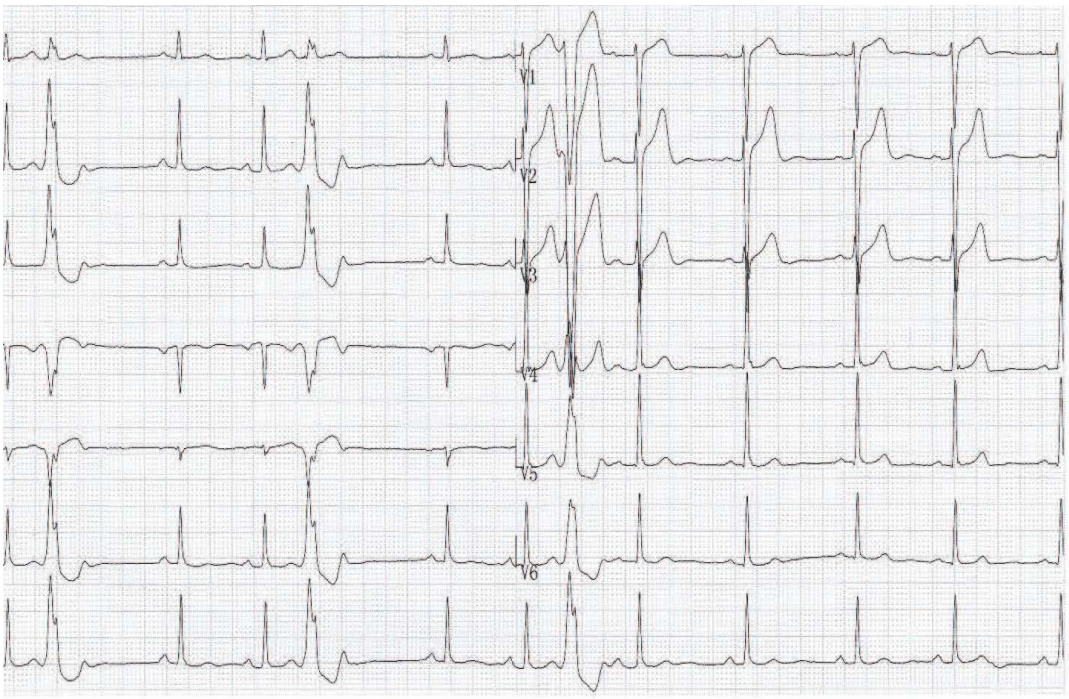
| 项目 | 传统法消融组 | 倒“U”法消融组 | P 值 |
|---|---|---|---|
| n | 55 | 31 | |
| 放电次数(次) | 4.3 ± 1.7 | 1.8 ± 0.6 | P < 0.01 |
| 达效时间(秒) | 5.7 ± 3.4 | 2.8 ± 1.9 | P < 0.01 |
| 成功率 | 47 (85.45%) | 30 (96.77%) | P < 0.01 |
| 并发症 | 1 (1.8%) | 0 | |

3) 成功率：随访时间为(4~20)月，传统消融组成功率 85.45% (47/55)，倒“U”组成功率 96.77% (30/31)，倒“U”组成功率显著高于传统组($P < 0.01$)。传统消融组 8 例瓣下消融未成功者同次手术中采用倒“U”法至瓣上消融后 7 例成功。

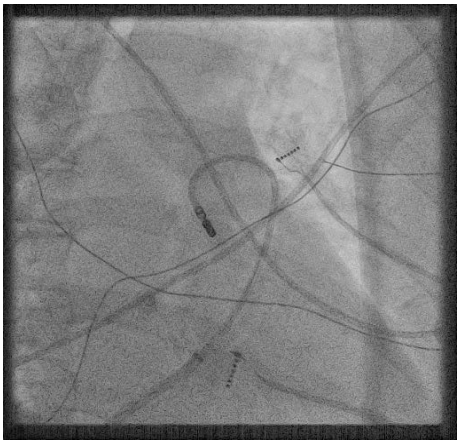
### 4.2. 并发症

传统消融组心包填塞 1 例，于右室流出道游离壁反复消融时发生。倒“U”组无并发症发生。

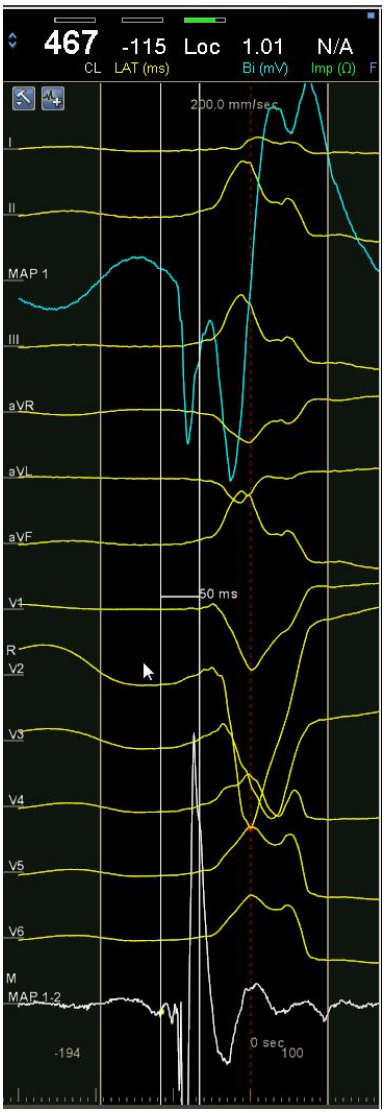
患者，男，28 岁，因“反复心悸 2 年，加重 1 月”入院。(a) 体表心电图：V1 导联呈 rS 型，胸前导联 R 波在 V3~V4 移行，I 呈 r 型，II、III、aVF 导联均为高大 R 波，AVR 及 AVL 导联为 QS 型。(B) RAO 30°消融影像。(c) 腔内图：早搏时靶点局部 V 波前有一碎裂低幅电位，领先体表 QRS 波 50 ms。(d) (e) 分别为 RL 及 RAO 体位三维影像，粉红点代表靶点，提示位于肺动脉右窦。黄色点为希氏束 RL = 右侧位；RAO = 右前斜。




(a)



(b)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Loc
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CL
LAT (ms)
Bi (mV)
Imp (Ω)
200.0 mm/sec
I
II
MAP 1
III
aVR
aVL
aVF
50 ms
V1
R
V2
V3
V4
V5
V6
M
MAP 1-2
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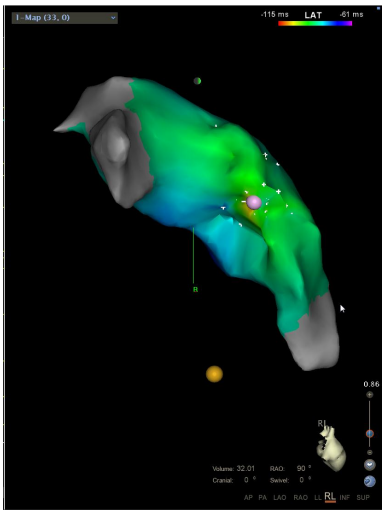
0 sec
100

(c)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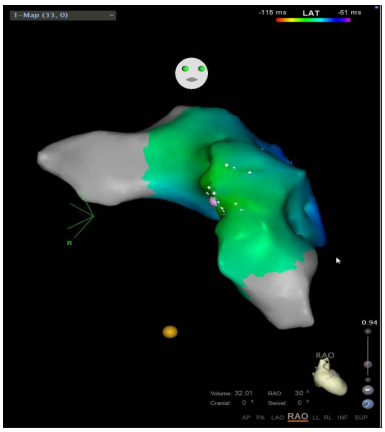
LAT
-61 ms
0.86
AP PA LAO RAO LL RL INF SUP

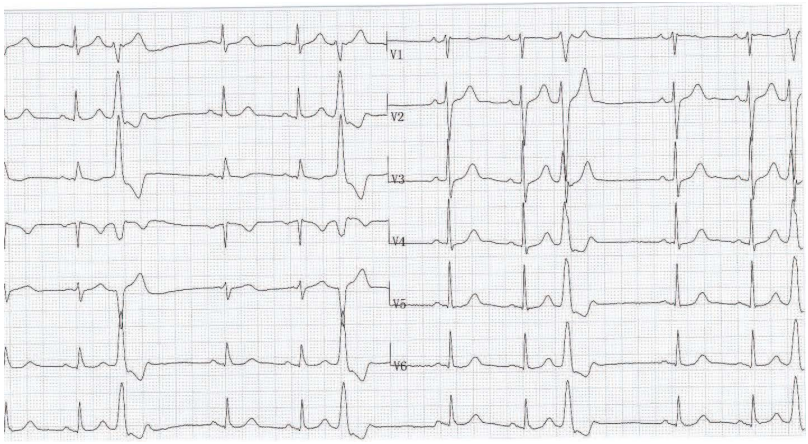
(d)



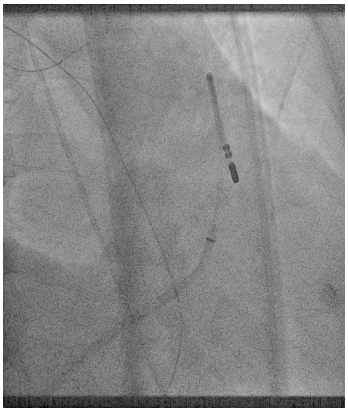

(e)

**Figure 1.** One case of PVC originating from right pulmonary sinus was ablated with reversed U curve ablation
**图 1.** 倒“U”法消融 1 例起源于肺动脉右窦的室性早搏

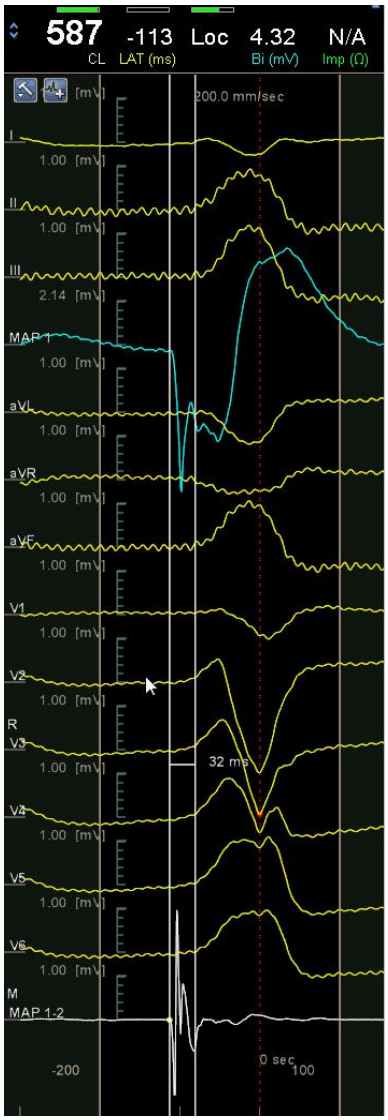
患者，男，66 岁，因“心悸半年”入院。(a) 体表心电图：V1 导联呈 rS 型，胸前导联 R 波移行于 V3，I 呈 rS 型，II、III、aVF 导联均为高大 R 波，AVR、AVL 导联为 QS 型。(b) RAO 30°X 线影像。(c) 腔内图：早搏时靶点局部 V 波领先体表 QRS 波 32 ms，单极导联呈 QS 型。(d) (e)分别为 LL 位及 PA 位三维影像，粉红点代表靶点，提示位于肺动脉左窦。蓝色点为希氏束 RAO (右前斜)；LL (左侧位)；PA (后前位)。




(a)



(b)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CL
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Bi (mV)
Imp (Ω)
200.0 mm/sec
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II
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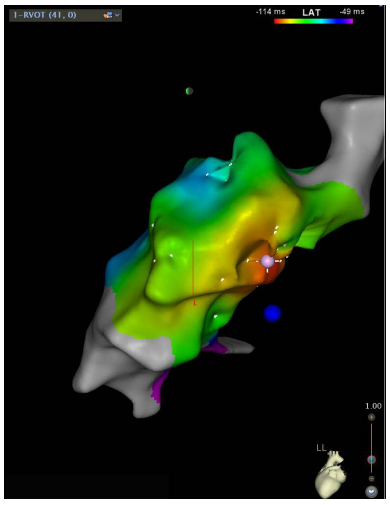
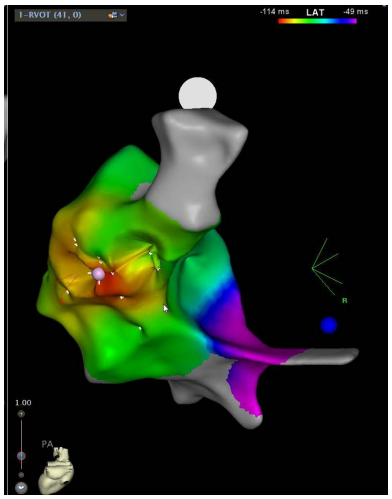
MAP 1
aVL
aVR
aVF
V1
V2
R
V3
V4
V5
V6
M
MAP 1-2
32 ms
-200
0 sec
100

(c)


LAT

(d)




(e)

**Figure 2.** One case of PVC originating from left pulmonary sinus was ablated with reversed U curve ablation
**图 2.** 倒“U”法消融 1 例起源于肺动脉左窦的室性早搏

## 5. 讨论

心肌与血管的交界处组织相互移行，电生理基质不均一，使心脏流出道容易发生心律失常。多个研究显示，延迟后除极所致的触发活动为该部位的 PVC/VT 的机制[8] [9] [10]。虽然曾有肺动脉窦起源 VAs 的报道[11]，但既往观点认为 RVOT-VAs 起源于肺动脉瓣下。事实上，传统采用肺动脉瓣下途径使得一部分 RVOT-VAs 的标测消融显得较为困难。Liao 等[4]提出 RVOT-VAs 绝大多数起源于肺动脉窦内，并首次提出使用倒“U”法至肺动脉窦内标测消融，消融成功率可达 100%。陈海敏等[5]验证了倒“U”法消融有效性和安全性均优于传统瓣下消融。

本研究发现，因采用倒“U”法，消融导管与组织的贴靠异常稳定，因而在理想靶点处消融，倒“U”法组在平均放电次数、消融达效时间、成功率等指标上均优于传统消融组，有统计学差异。8 例传统消融方法失败的患者同次术中继之使用倒“U”法后有 7 例消融成功，这提示 RVOT-VAs 的真正起源及最佳消融靶点在肺动脉窦区域，传统流出道仅是 VAs 传导的出口部位[12]。同时肺动脉窦区域空间相对较小，缩小了标测范围，避免了在流出道大范围操作导管标测时引起的心肌穿孔风险，增加了手术安全性。本文 1 例心包填塞即是在流出道游离壁标测消融时发生的。

本研究因解剖的定位主要依据 X 线影像、三维模型及靶点图特征，未应用腔内超声明确，故在解剖定位上有不足之处。本文另一局限性在于系小样本回顾性研究，需行较大样本量的前瞻性研究进一步确认本文结论。

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