High-power, short-duration ablation of the atrioventricular node

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Abstract

Introduction Atrioventricular node (AVN) radiofrequency ablation is a highly effective treatment of atrial tachycardias resistant to other management modalities. There are limited studies that compare different radiofrequency ablation catheters. Our study aimed to compare the effectiveness of several types of ablation catheters in AVN ablation. **Methods** We identified patients who underwent AVN ablation for different indications at our institution. Data related to patients and procedures were collected through retrospective chart review. The radiofrequency catheters used were: plain non irrigated, externally irrigated (EI), and contact force sensing with 10-20 gm of force in two different settings: low power long duration (LPLD) (30W, 45°C, and 60 sec) and high-power short duration (HPSD) (50W, 43°C, and 12 sec). We compared the different catheters in terms of success rate using logistic regression and lesion time using linear regression. **Results** We identified 66 patients who underwent AVN ablation, out of which 31 were female (47%). The patients were elderly, with a mean age of 73.27 years. The indications were resistant atrial fibrillation in 74%, atrial flutter in 18%, and other atrial tachycardias in 8% of patients. Types of catheters used were plain non irrigated in 48%, EI in 2%, LPLD in 16%, and HPSD in 34% of patients. All ablation procedures were successful with no immediate post-procedure complications. Regarding lesion time, HPSD was significantly shorter compared to plain catheters by 403.42s[-631.67, -175.17]. **Conclusions** Radiofrequency ablation of AVN is a highly effective treatment modality for atrial tachyarrhythmias that failed other management methods. While plain catheter, LPLD, and HPSD were equally safe and effective, HPSD catheter had significantly shorter lesion time and thus procedure time.

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Declarations:

Ethics approval and consent to participate

Study have been performed in accordance with the Declaration of Helsinki. Informed consent was waived as the study is a retrospective chart review with minimal risk to the patients. A copy of the ethical approval is available upon request.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare no conflict of interest.

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Authors' contributions

Conceptualization: AB and AJ. Data Collection: MA, RA, and HC. Writing - Original Draft: MA, OR, and LF. Figure creation: OR. Writing - Review & Editing: LF, AB, and AJ. Supervision: AB and AJ.

Introduction

Atrioventricular node (AVN) radiofrequency ablation is a highly effective treatment of atrial tachycardias resistant to other management modalities. There are limited studies that compare different radiofrequency ablation catheters. Our study aimed to compare the effectiveness of several types of ablation catheters in AVN ablation.

Methods

We identified patients who underwent AVN ablation for different indications at our institution. Data related to patients and procedures were collected through retrospective chart review. The radiofrequency catheters used were: plain non irrigated, externally irrigated (EI), and contact force sensing with 10-20 gm of force in two different settings: low power long duration (LPLD) (30W, 45°C, and 60 sec) and high-power short duration (HPSD) (50W, 43°C, and 12 sec). We compared the different catheters in terms of success rate using logistic regression and lesion time using linear regression.

Results

We identified 66 patients who underwent AVN ablation, out of which 31 were female (47%). The patients were elderly, with a mean age of 73.27 years. The indications were resistant atrial fibrillation in 74%, atrial flutter in 18%, and other atrial tachycardias in 8% of patients. Types of catheters used were plain non irrigated in 48%, EI in 2%, LPLD in 16%, and HPSD in 34% of patients. All ablation procedures were successful with no immediate post-procedure complications. Regarding lesion time, HPSD was significantly shorter compared to plain catheters by 403.42s[-631.67, -175.17].

Conclusions

Radiofrequency ablation of AVN is a highly effective treatment modality for atrial tachyarrhythmias that failed other management methods. While plain catheter, LPLD, and HPSD were equally safe and effective, HPSD catheter had significantly shorter lesion time and thus procedure time.

Keywords: Atrial Fibrillation, Radiofrequency Ablation, AVN Ablation, High Power Short Duration

Introduction

In 1987, transcatheter ablation of cardiac arrhythmias via radiofrequency (RF) current was introduced to avoid the complications associated with direct current fulguration(1). In RF ablation, low voltage high-frequency electrical energy (30KHz – 1.5MHz) is delivered to the endocardial surface producing well-circumscribed lesions resulting in more accurate and focal tissue ablation(1). In 1995, RF ablation was further refined using saline irrigation to cool the catheter tip, making larger RF lesions possible and thus increasing its efficacy(2, 3).

Although AF ablation is relatively safe, the procedure still carries a risk of complications (4, 5). Several factors are taken into consideration to ensure the safety and efficacy of PVI, such as transmurality of lesions, necrosis of tissue and scar formation, and absence of excessive cardiac injury. These factors can be controlled by adjusting RF parameters such as power, duration, electrode, and lesion size(6-9). Currently, two broad ablation strategies are used: low-power, long-duration (LPLD) and high-power short-duration (HPSD)(10, 11). HPSD has been shown to lower time spent per lesion and reduce deep tissue heating and collateral injury(9-12).

While several studies compared different radiofrequency ablation catheters in AF ablation(13), few studies are available for atrioventricular node (AVN) ablation. This study aims to compare the effectiveness of various types of RF ablation catheters in AVN ablation.

Methods

Study Design

Our study assessed the effect of catheter type on the success rate and lesion time in patients who underwent AVN ablation. We used a retrospective cohort design for data collection.

Settings and Population

We included all patients who underwent AVN ablation at our institution, SUNY Downstate Medical Center, between 2007-and 2022. Procedures were performed by different operators at our institution.

Data Collection

We have classified the ablation catheters into the following categories: Unirrigated 8 and 10 mm, internally irrigated (Chilli II, Boston Scientific, Marlborough, MA), externally irrigated (Cool Path, Abbott, Minneapolis, MN), externally irrigated force sensing (TactiCath, Abbott, Minneapolis, MN). With force-sensing catheters, lesions were applied with force ranging from 10-20 grams. LPLD settings were power 30W, temperature 45°F, and 60 sec in duration, whereas HPSD settings were power 50W, temperature upper limit 43°C, and 12 sec in duration.

The exact details of the procedure are explained elsewhere(14). Besides procedure-related variables, we collected baseline demographic and patient-related data, including ethnicity, age, sex, and past medical history. Lesion time was defined as the duration of radiofrequency ablation. Successful ablation was defined by documenting the complete AV block.

Data Analysis

Our study compared different catheters in terms of success rate and lesion time. Continuous variables were reported as mean ± standard deviation(SD) in case of a normal distribution or median and interquartile range(IQR) in case of skewed distribution. We used logistic regression to compare the success rate between different catheters and linear logistic regression to compare lesion time. The plain catheter was the reference point. Results were reported as mean along with 95% CI. All statistical analyses were performed using statistical software R version 3.5.0 (R Foundation for Statistical Computing, Vienna, Austria)(15).

Results

We identified 66 patients who underwent AVN ablation, out of which 31 were female. The patient was elderly with an average age of 73 years. Each patient had several comorbidities with a median of 5 per patient IQR(4, 5). The general characteristics of patients are summarized in table 1.

The indications were resistant atrial fibrillation in 74%, atrial flutter in 18%, and other atrial tachycardias in 8% of patients. Figure 1 shows the types of catheters used. The main catheters used were plain and CF catheters.

All ablation procedures were successful with no immediate post-procedure complications. Regarding lesion time, HPSD was significantly shorter compared to plain catheters by 403.42s[-631.67, -175.17]. Table 2 shows the exact difference in lesion time between catheters used.

Discussion

To our knowledge, this is the first study to compare the different radiofrequency ablation catheters in AVN ablation. Patients were elderly with multiple comorbidities. The procedure was highly successful with no immediate complications. HPSD catheter was significantly shorter compared with the plain catheter.

The main current indication for AVN ablation is atrial tachyarrhythmias that are resistant to other treatment modalities, especially in the elderly population(16, 17). Two large trials assess the role of AVN ablation in resistant atrial tachycardia. In the ablate and pace trial, 156 with resistant atrial fibrillation had AVN ablation with permanent pacemaker placement. After the procedure, patients had improved quality of life and improved left ventricular function (18). In patients with heart failure and symptomatic AF, AVN ablation with cardiac resynchronization (CRT) reduced HF-related hospitalization and improved quality of life(19). As in previous research, our population was elderly with several comorbidities. The indication was atrial tachyarrhythmia resistant to medical therapy, mainly atrial fibrillation(74%). We assessed the short-term effectiveness of the procedure with no data on long-term effects.

The procedure is typically highly successful with a low complication rate. The overall success rate is above 97%(16). In our study, all procedures were successful with no immediate complications. We could not assess for factors associated with procedure success/failure as we had no failed ablation.

Ablation catheters have advanced in the design to improve safety and effectiveness. Several new catheters were introduced, including irrigated and contact force catheters. Several studies and systemic reviews compared the safety/effectiveness of different catheters in atrial fibrillation ablation(20-22). Studies in atrial fibrillation favored HFSD in success rate and procedure time(23-25). Direct current energy was used in the early stages but was soon replaced by radiofrequency due to better safety and effectiveness (16). Few/no studies compared different radiofrequency ablation catheters in AVN ablation. In our study, a contact force catheter with HPSD settings was significantly associated with lower lesion time by 403.42s[-631.67, -175.17]. The success rate was similar to other catheters(all successful) with no immediate complications.

Current medical practice has increasing complexity with introducing new management modalities. Comparative effectiveness research is essential to improve the quality of care and guide policymakers, clinicians, and patients in deciding on their care(26). Our study has several limitations. First, procedures were done by different operators, which could confound our results. Differences in lesion time could be related to different expertise levels between different operators. Another limitation was the short follow-up time. There were no immediate post-procedure complications. However, no data regarding long-term safety and efficacy were available. We had no data regarding long-term patient outcomes such as morbidity, mortality, and quality of life. Complications are likely to occur in the immediate post-procedure time; as a result, we likely to document the severe complications that would happen. The main aim of the study was to compare different radiofrequency ablation catheters. Data regarding the long-term effect of AVN ablation is needed; however, that was not the focus of our research. It is unlikely that the long-term effects would be related to the type of catheter used.

Conclusion

Radiofrequency ablation of AVN is a highly effective method for resistant atrial tachycardias that failed other management methods. While plain catheters, EI, LPLD, and HPSD were equally safe and effective, HPSD catheters had significantly shorter lesion time.

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Table 1. General patient characteristics

	Total (N=66)
Age	
Mean (SD)	73 (± 10)
Sex	
Female	31 (47 %)
Male	35 (53 %)
Ethnicity	
Black	44 (67 %)
White	13 (20 %)
Hispanic	1 (2 %)
Unknown	8 (11 %)
DM	28 (42 %)
HTN	58 (88 %)
HLD	24 (36 %)
CAD	28 (42 %)
CKD	11 (17 %)
CHF	54 (82 %)
Afib	58 (88 %)
Aflutter	16 (24 %)
Stroke	9 (14 %)
COPD	4 (6 %)
OSA	2 (3 %)

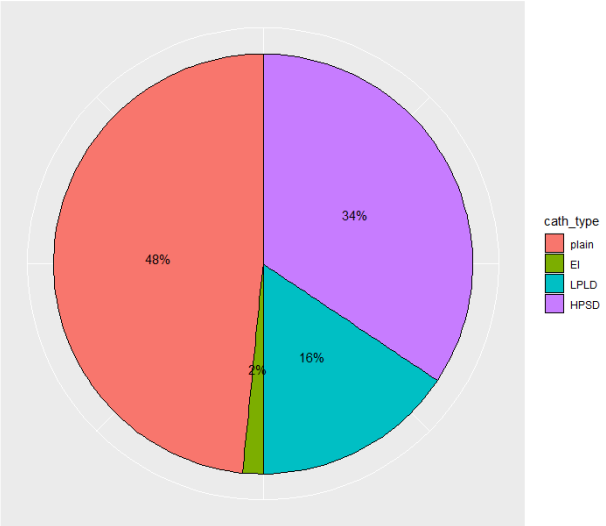
DM: diabetes mellitus, HTN: hypertension, CAD: coronary artery disease, CKD: chronic kidney disease, CHF: congestive heart failure, Afib: atrial fibrillation, Aflutter: atrial flutter, COPD: chronic obstructive pulmonary disease, OSA: obstructive sleep apnea.

Table 2. Lesion time difference

Catheter	Lesion time*	P-value	P-value
(Intercept)	556.32[404.15, 708.49]	0.00	0.00
EI	-436.32[-1212.23, 339.59]	0.26	0.26
LPLD	-293.75[-619.10, 31.60]	0.08	
HPSD	-403.42[-631.67,-175.17]	0.00	0.00

*Plain catheter as the reference point. EI: external irrigation, LPLD: low power long duration, HPSD: high power short duration

Figure 1. Types of catheters used



Plain: plain non irrigated catheter, EI: external irrigation, LPLD: low power long duration, HPSD: high power short duration