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Initial Results of Routine Use of Atrial Fibrillation Ablation with High Power Short Duration Technique

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Abstract

INTRODUCTION: *Different results are described after atrial fibrillation (AF) ablation and multiples predictors of recurrence are well established. Objective: Evaluate and analyze the benefits of first atrial fibrillation (AF) ablation with high-power short-duration (HPSD).*

METHODS: *Observational, retrospective study, 212 patients submitted to High Power Short Duration AF ablation (HPSD). Ablation in left atrial posterior wall was performed with 45W with contact force of 3 to 10 grams during 4 to 6 seconds, in the anterior wall we used 50W with contact force of 5 to 20 grams during 4 to 6 seconds and a pump flow of 35ml/min. Males were 155 (73.11%), mean age 61.73 years, paroxysmal AF in 132 (62.26%), 126 (59.43%) hypertension, 96 (45.28%) obstructive apnea, 65(30.66%) arterial disease, 41(19.34%) Diabetes, and 16(7.55%) strokes. Mean time from AF diagnosis to ablation was 20.43 months* $CHADS_2VASC_2$ *2.51.*

RESULTS: *Mean left atrial time was 72.83 minutes, mean total procedure time 94.79 minutes, mean radiofrequency time of 1,723.8 seconds, 76 (35.85%) of esophageal temperature elevation, mean Xray time of 7.58 minutes, bilateral first-pass isolation effect in 168 (79.25%) patients and mean follow-up was 22.12 (4 to 36) months and recurrence rate after blanking period occurred in 33 (15.57%) patients. Complications were local hematomas in 62 (29.25%) patients, 2 (0.94%) femoral artery pseudoaneurysm, 2 (0.94%) pericardial effusions and 1 (0.47%) cardiac tamponade occurred after transeptal puncture.*

CONCLUSION: *HPSD showed a high rate of sinus rhythm during the follow-up. Also, we demonstrated a low rate of esophageal heating, a high rate of first-pass isolation effect and short left atrial, total ablation and radiofrequency times with HPSD technique.*

Keywords: *atrial fibrillation, esophageal temperature, recurrence rate, first-pass isolation, and atrial fibrillation ablation.*

Introduction

Since the late 90s, Haïssaguerre and his collaborators[1] concluded that ectopic beats from pulmonary veins were atrial fibrillation (AF) triggers and showed that ablation can be a treatment for these triggers. Since then, the electrophysiology community has discovered factors that limit the success of this procedure in conventional supraventricular tachycardias[2,3]. For example, as a central objective of the treatment interventions for AF, the left atrial anatomy and its surrounding organs are a limiting factor during pulmonary vein isolation (PVI)[4-7]. In addition to the anatomical limitations, questions have been raised regarding the biophysics of lesions induced by radiofrequency[8,9]. One of the solutions for these

limitations and for the achievement of better results is the adoption of new technologies, such as irrigated catheters and, more recently, catheters containing sensors that measure real time contact force[10-14] using higher power settings in the radiofrequency generators associated with short applications times.

Objectives

The objective of the present study was to evaluate the results of a routine use of the High-Power Short Duration (HPSD) technique in patients with atrial fibrillation submitted to a first intervention.

Methods

Study Population

We performed 212 consecutive first catheter atrial fibrillation ablations with routine use of the HPSD technique. This post-hoc analysis was performed with the first patients with HPSD, and data were collected between December 2017 and October 2020.

Among these patients, males' patients were 155 (73.11%), mean age was 61.73 years, 126 (59.43%) patients had hypertension, 96 (45.28%) had obstructive sleep apnea that needed treatment, 65 patients (30.66%) with any kind of arterial disease, 41 (19.34%) patients were treating Diabetes, and 16 (7.55%) had prior strokes. Mean $CHADS_2VASC_2$ score was 2.51 (from 0 to 8) (Table 1). Majority of AF was paroxysmal in 132 (62.26%) patients and the mean time from diagnosis to ablation was 20.43 months.

Table1. *Clinical features of patients.*

Clinical Features	Total patients: 212
Males	155 (73.11%)
Mean Age	61.73 years
Paroxysmal Atrial Fibrillation	132 (62.26%)
Hypertension	126 (59.43%)
Obstructive Sleep Apnea	96 (45.28%)
Arterial Disease	65 (30.66%)
Diabetes	41 (19.34%)
Stroke	17 (7.55%)
CHA_2DSVAC_2	2.51
Time from Diagnosis to Ablation	20.43 months

Pre-Ablation Investigation for Thrombus Exclusion

Patients underwent a transesophageal echocardiogram (TEE) and/or angiotomography of the left atrium and pulmonary veins prior to the procedure. Both exams for exclusion of the thrombus, diameter of the left atrium, and other measurements was performed on the day of the procedure or up to 48 hours before ablation.

Catheter Ablation

All patients underwent ablation using an uninterrupted oral anticoagulation protocol (OAC). Most common ACO drug prescribed was Dabigatran in 97 (45.75%), followed by Rivoraxaban in 56 (26,42%), 33 (15.57%) with Apixaban, 13 (6.13%) with Edoxaban and 13 (6.13%) using Warfarin. Patients also had their antiarrhythmic drugs suspended for 5 half-lives prior to the procedure, with the exception of amiodarone, which was maintained for the procedure. The main objective was to isolate the antral portion of the pulmonary veins[2,15]. In cases of patients with previously diagnosed atrial flutter, the tachyarrhythmia was also ablated at the end of the PVI, time for this ablation and radiofrequency were not included in the data. Procedures were performed in sinus rhythm, and patients who were in atrial fibrillation or flutter underwent electrical cardioversion immediately before the ablation.

For all patients, the EnSite Velocity mapping system version 5.0 was used with a TactiCath™ contact force sensing catheter, Agilis™ deflectable sheath, Viewflex™ intracardiac echocardiography probe, and Ampere™ radio frequency generator (St Jude Medical - USA / Abbott – USA).

The HPSD ablation technique consisted, in the posterior wall, atrial roof, and atrial flutter (if indicated), we set the power of radiofrequency generator to 45 Watts for no more than 4 to 6 seconds. On the anterior wall, we increased the power to 50 Watts with an estimated pressure of 5–20 grams of contact force for the same short periods of time[16] as in the posterior wall. The irrigation pump was always programmed for 35ml/min regardless of the power setting. For LPLD, the RF

applications lasted no more than 30 seconds, we use an irrigation set of 17ml/min for pump flow, a contact force between 10 to 30 grams and applied 20 Watts in the posterior wall and 30 Watts elsewhere including in the cases of atrial flutter (Table 2). At the end of the procedure, all patients were given a challenge of 12 mg of adenosine for each antrum of the pulmonary veins in order to unmask any dormant veins and assess the need for re-ablation of their reconnection[17,18].

In addition to analyzing the real-time contact force values across all radiofrequency applications, we evaluated the impedance measurements in the EP recording system looking for gradual falls that might indicate lesion formation[8-11]. We used a dragging technique for catheter ablation (CA) and made all efforts to avoid catheter jumps. If a catheter jump did occur, the radiofrequency application was immediately interrupted, and we returned to the spot before the jump to continue the ablation[19-23].

We did not use other features provided by the contact force catheter, such as the lesion index (LSI) and force-time integral (FTI)[24]. All patients received esophageal temperature monitoring, as described previously[25].

Table2. *High Power Short Duration catheter ablation characteristics.*

	Radiofrequency Power (Watts)	Contact Force (g)	Local Time of Radiofrequency Application (seconds)	PumpFlow (ml/min)
Anterior Wall	50W	3-10g	4-6 sec	35ml/min
Posterior Wall	45W	5-20g	4-6 sec	35ml/min

Informed Consent and Ethical Considerations

All patients signed the informed consent form according to the standards of ours Institutions, which follows national and international standards[26,27]. The study was approved by the Research Ethics Committee of the Institution.

Post-Ablation Follow-up Protocol

Patients who were more than 75 years old or had multiple comorbidities remained in the intensive care unit after ablation for one day, those without these characteristics stayed at an apartment and were discharged from the hospital on the day after only if clinical evaluation, vascular punctures, chest X-ray, and electrocardiogram (ECG) were normal. Patients received a prescription of Sucralfate for 2 g per day and Pantoprazole for 40 mg twice daily for 4 weeks after the procedure. Same antiarrhythmic drugs were reintroduced after the procedure.

Antiarrhythmics were maintained for 60 days and then suspended. Anticoagulants were interrupted at this time for patients with a $CHADS_2VASC_2$ score less than or equal to 3[28], with the exception of patients who had a previous stroke and/or were 75 years old or more. In cases of atrial arrhythmia, amiodarone was the drug of choice to reestablish the normal sinus rhythm. If this approach was successful, the drug was used for 30 more days and then suspended. Direct current cardioversion (DC) was done in patients after the amiodarone challenge or if they achieved day 60th with atrial tachyarrhythmias.

All patients were evaluated after 7 days, 1, 2, 3, 6, 12 months and every 12 months thereafter with a medical appointment and ECG. At 3, 6, 12 months and every year thereafter they also were submitted to 24 hours of Holter monitoring.

Statistical Analysis

All tests were performed using BioStat statistical software (AnalystSoft Walnut, CA, USA). Continuous variables were expressed as mean-standard deviation.

Results

At the mean 22.12 (4-36) months follow-up analysis, 33 (15.57%) patients showed atrial arrhythmias after the 3 months blanking period (Table 4). Of the 33 recurrent patients in 20 (60.61%) the arrhythmia observed was atrial flutters and in 13 (39.39%) others patients the mechanism of recurrence was AF.

Mean left atrial time was 72.83 minutes, mean total procedure time 94.79 minutes, mean radiofrequency time of 1,723.8 seconds, in 76 (35.85%) patients we observed a rise of esophageal temperature more than 2 Celsius degrees, while the mean Xray time was of 7.58 minutes. An interesting finding with the routine use of the technique was a high rate of bilateral first-pass isolation effect (FPI), observed in 168 (79.25%) patients demonstrating the high efficacy of the lesions produced by the HPSD approach (Table 3).

Table3. *Catheter ablation results at 22.12 months follow-up analysis.*

Ablation Results	Total patients: 212
Mean Follow Up Time	22.12 (4-36) months
Mean Left Atrial Time	72.83 minutes
Mean Total Ablation Time	94.79 minutes
Mean Radiofrequency Time	1,723.8 seconds
Esophageal Temperature Elevation	76 (35.85%)
Mean Xray Time	7.58 minutes
Bilateral First-Pass Isolation Effect	168 (79.25%) patients
Recurrence Rate	33 (15.57%) patients

We had a low complications rates with local puncture and compressive dressing hematomas in 62 (29.25%) patients being the most common minor complication. The major complications were observed in 2 (0.94%) patients with femoral artery pseudoaneurysm, 2 (0.94%) with pericardial effusions fixed by pericardial puncture and drainage and 1 (0.47%) patient with cardiac tamponade occurred after transeptal puncture requiring cardiac surgery with a good evolution (Table 4).

Table4. *Minor and Major complications in catheter ablation.*

Catheter Ablation Complications	Total of Patients: 212
Local Hematomas	62 (29.25)
Femoral Artery Pseudoaneurysm	2 (0.94%)
Pericardial Effusion	2 (0.94%)
Cardiac Tamponade	1 (0.47%)

Discussion

In this retrospective, observational study, we observed a high rate of sinus rhythm at a mean 22.12 months of follow-up with a routine use of HPSD technique. In our first report[16] comparing two techniques, HPSD with Low-Power Long Duration (LPLD), in 76 patients we do not saw a clear benefit in terms of better outcome in maintenance of sinus rhythm comparing the two groups. With a recurrence rate of 17.07% in the HPSD group and 31.42% in LPLD the P value was .14 but we observed that this could be a bias and if we follow these patients for a longer time or compare a higher number of patients in both groups result could be distinct favoring a better outcome for HPSD patients (Figure 1). In a second report from our own lab, we saw a clear superiority in the maintenance of sinus rhythm in the group of patients submitted to the HPSD technique compared to the LPLD[29]. Our results suggest, in a retrospective analysis of theses 144 patients, that patients submitted to HPSD ablation had at 12 months 87.32% of patients in sinus rhythm, while in LPLD only 67.12% with a P value of .0039 showing a superiority of HPSD. Another important observation of this routine use of HPSD approach is a high rate of achievement of first-pass isolation effect. In a previous report[30] we showed that this effect is associated with a higher rate of sinus rhythm maintenance comparing HPSD and LPLD techniques. This manuscript with 144 patients with 71 in the HPSD and 73 in the LPLD group with a recurrence observed in 33 patients (22.92%) of 144 patients at 12months follow-up. In the HPSD group only 9 (27.27%) patients showed atrial tachyarrhythmias while in the LPLD group 24 (72.73%) patients. Higher rate of bilateral FPI were observed in HPSD patients with 62 of 71 patients comparing to 17 of 73 patients in LPLD with a P value of < .00001 (Figure 2).

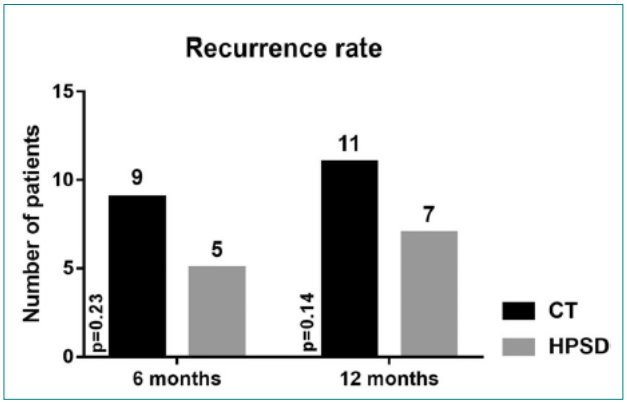

Fig1. *Comparison of recurrence rate between HPSD and LPLD (CT) ablation techniques (reproduced with permission of the author).*

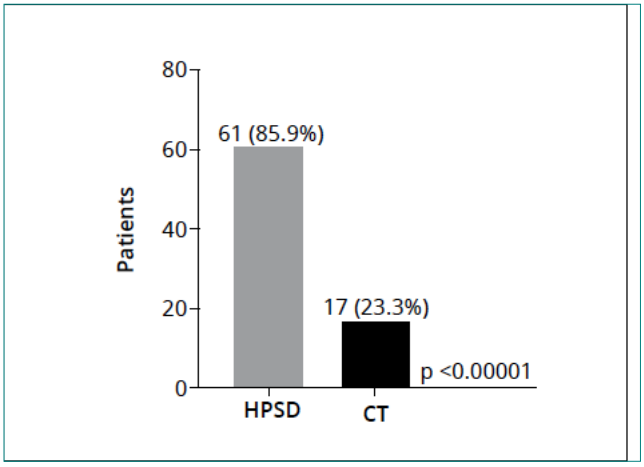

Fig2. *Comparison of first-pass isolation effect between HPSD and LPLD (CT) ablation techniques (reproduced with permission of the author).*

The first report from our knowledge was that from Bunch et al.[31] comparing also the results for long term outcome, with 3 years of follow-up, showed no superiority of the HPSD ablation compared to the LPLD approach. Another report from Winkle et al[32], with a huge number of patients summitted to HPSD ablation protocol, the authors described in a total of 13.974 procedures a very low rate of complications showing the security of the technique. The complications were death in 2 (0.014%; 1 due to stroke and 1 due to atrioesophageal fistula), pericardial tamponade in 33 (0.24%; 26 tapped, 7 surgical), strokes ,48 hours in 6 (0.043%), strokes 48 hours–30 days in 6 (0.043%), pulmonary vein stenosis requiring intervention in 2 (0.014%), phrenic nerve paralysis in 2 (0.014%; both resolved), steam pops 2 (0.014%) without complications, and catheter char 0 (0.00%). There was 1 atrioesophageal fistula in 11,436 ablations using power 45–50 W on the posterior wall and 3 in 2538 ablated with 35 W on the posterior wall (P 5 .021), although 2 of the 3 had no esophageal monitoring during a fluoroless procedure. Their conclusion was that AF ablations can be performed at 45–50W for short durations with very low complication rates. High-power, short-duration ablations have the potential to shorten procedural and total RF times and create more localized and durable lesions. Our results, obviously more modest with only 212 patients, showed a very low rate of complications reinforcing the security of the HPSD ablation technique.

Qiu et al.[33], in a review article of the HPSD technique, concluded that despite advances during the past decade recurrence of AF after PVI is unsatisfactory. Current technologies improved our knowledge regarding the association between RF lesion creation and ablation parameters (power and duration), which trigger the development of HPSD. In addition to reducing procedures and fluoroscopy times, a series of studies have also proved the feasibility, safety and efficacy of the HPSD settings for PVI, and suggest the need to consider HPSD as a standard PVI protocol.

However, the best set of HPSD parameters, which should be required to minimize the risk of major complications while maintaining maximal procedural efficacy, remains controversial. Therefore, more robust data from large scale clinical trials are still needed.

In a recent article from Yavin et al.[34], authors analyzed the impact of the HPSD ablation approach on the impact on long-term durability of lesion durability. The manuscript with use the HPSD ablation (45 to 50 W, 8 to 15 s) with contact force-sensing open irrigated catheter in a group of 112 patients. A control group with the same number of patients underwent ablation using moderate power moderate duration (MPMD) ablation (20 to 40 W, 20 to 30 s) with similar technology. Chronic PV reconnection was examined in patients who required a redo procedure, HPSD ablation with 18patients and MPMD ablation with 23. In the results section the rate of PVI at the completion of the initial encirclement was similar between the HPSD and MPMD ablation strategies (90.2% vs. 83.0%; p .006). In the HPSD strategy they required shorter radiofrequency time (17.2±3.4 min vs. 31.1±5.6 min; p < .001). The incidence of chronic PV reconnection was lower with HPSD ablation (16.6% vs. 52.2%; p .03). These results can be compared to our own and maybe the marker of this long-term lesion durability is the FPI effect observed in the HPSD ablatio protocol.

Study Limitations

This was a retrospective, observational, small sampled size study that practiced non-continuous cardiac rhythm monitoring through the use of ECGs and 24-hour Holter monitoring to document the recurrence of atrial tachyarrhythmias. A larger sample size or continuous monitoring may produce in future different findings.

Conclusion

This study showed a high success rate of sinus rhythm maintenance for HPSD first technique. Besides this result patients in HPSD ablation had short procedure times, lower esophageal heating and radiofrequency times.

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