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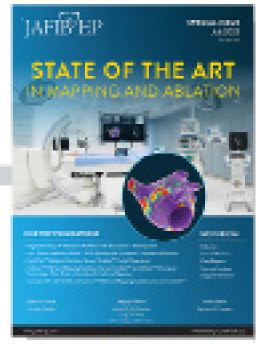

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High Efficiency Workflow During Atrial Fibrillation Ablation: Protocol and Experience with EnSite™ X EP System

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Abstract

Background: In recent years, there has been a dedicated focus to improve the tools, techniques, and technology for radiofrequency ablation (RFA) of atrial fibrillation (AF). Multi-electrode catheters paired with software enhancements for visualization and electrogram analysis have paved the way for more efficient mapping and anatomically accurate renderings of cardiac chambers. Contact force sensing catheters have been shown to be safe and effective tools for RFA, and software features have allowed for more accurate predictability of durable lesions. These factors combined can dramatically improve procedural outcomes.

Objective: The authors sought to demonstrate a safe and efficient workflow for AF RFA using the EnSite™ X EP System, TactiCath™ Ablation Catheter, Sensor Enabled™ and Advisor™ HD Grid Mapping Catheter, Sensor Enabled™ high-density mapping catheter.

Methods: Forty-nine patients undergoing paroxysmal AF RFA procedures were studied retrospectively to evaluate efficiency and safety of a workflow designed to optimize mapping and ablation conditions. Anesthesia considerations were made to ensure proper accuracy during mapping and catheter stability during ablation. All patients were paralyzed after the right phrenic nerve was tagged and ventilation was kept at 25 breaths/min and a tidal volume of 250cc throughout the procedure. After double transseptal access was obtained, the ablation catheter was used to build VoXels for the entire left atrium (LA), which ensured better mapping accuracy with the Advisor™ HD Grid Mapping Catheter, Sensor Enabled™. RFA was delivered using First Line Efficiency with EnSite™ X EP System (F.L.E.X.) protocol standards of power, time, impedance drop and AutoMark lesion tags.

Results: This workflow has enabled our center to perform RFA AF procedures with procedural times of 74.20±17.84 minutes, radiofrequency ablation times of 10.35±3.47 minutes, zero-fluoroscopy in 97.9% of patients and same-day discharge for 76% of patients. There were no anesthesia or other procedural related complications.

Conclusions: The recent enhancements of the EnSite™ X EP System with EnSite™ VoXel Mode magnetic navigation can be used with a detailed procedural workflow that optimizes mapping and ablation, yielding a safe and efficient RFA for AF.

Introduction

Radiofrequency ablation (RFA) of atrial fibrillation (AF) is performed routinely across the world to treat an ever-increasing number of patients. In recent years, there has been a dedicated focus to improve the tools, techniques, and technology for radiofrequency ablation (RFA) of atrial fibrillation (AF). Multi-electrode catheters paired with software enhancements for visualization and electrogram analysis have paved the way for more efficient mapping and anatomically accurate renderings of cardiac chambers. Contact force (CF) sensing catheters have been shown to be safe and effective tools for RFA, and software features have allowed for more accurate predictability of durable lesions[8]. These factors combined can dramatically improve procedural outcomes.

Workflow optimization of RFA for AF has been directly related with improvements in the following aspects of the procedure: a) fluoroscopy reduction[1], b) intracardiac echocardiography (ICE) guidance[2], c) general anesthesia (GA) optimization[3], d) three-dimensional (3D) electro-anatomic mapping (EAM)[4] and e) same-day discharge[5].

The EnSite™ X EP System (Abbott, Abbott Park, IL) is a novel electro-anatomic mapping system. EnSite™ X EP System offers two primary navigation modes, EnSite™ VoXel Mode and EnSite NavX™ Mode. EnSite NavX™ Mode is an enhanced version of the previous "Precision" platform with catheter localization based purely on impedance data, allowing direct visualization of all electrodes connected to the mapping system. The accuracy of impedance-based localization can be limited by local changes in thoracic impedance (lungs, sheath,

Key Words
Atrial Fibrillation; Ablation; Mapping; Efficiency

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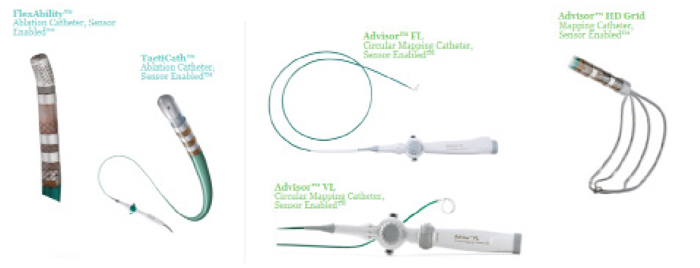

Figure 1: Abbott Electrophysiology Sensor Enabled Tools

The Sensor Enabled Tools utilized in this workflow were the TactiCath™ Ablation Catheter, Sensor Enabled™ and the Advisor™ HD Grid Mapping Catheter, Sensor Enabled™.

etc). The new EnSite™ VoXel Mode uses magnetic-based coordinates to provide accurate and linear visualization of tools within the heart. EnSite™ VoXel Mode relies upon sensor-enabled tools (Figure 1) to be located within a magnetic field and is not susceptible to inaccuracies due to thoracic impedance variability. The sensor-enabled catheters collect a cloud of VoXels (impedance fiducials), pairing this magnetic data with data from the impedance field to allow impedance-based (non-sensor catheter) electrodes to be shown in "high confidence." Without the collection of VoXels, non-sensor enabled catheters will display in a "low confidence" mode (Figure 2).

Magnetic-based navigation (EnSite™ VoXel Mode) is the primary procedural selection in our center during AF RFA. This mode allows for a consistent operator experience due to the magnetic-coordinate-based navigation and reconstruction of cardiac structures. Enhancement of respiratory compensation and rejection algorithms have facilitated accurate collection of data in various states of patient consciousness and anesthetic paralysis. EnSite™ Omnipolar Technology (OT) (EnSite™ X EP System, Abbott) has shown to be additive during mapping to highlight true voltage abnormalities and identify substrate regardless of electrode orientation and electrical vector directionality. Combining a multitude of these techniques, the authors sought to demonstrate ideal processes to maximize AF procedural success rates as well as safety profile for patients, operators, and laboratory staff.

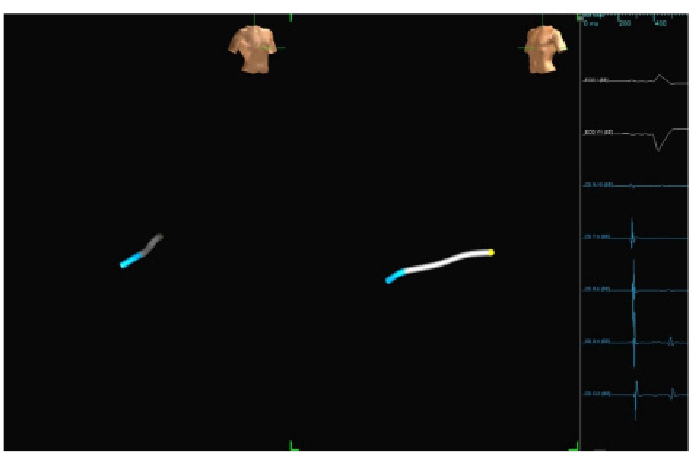

Figure 2: RAO and LAO views of the Decapolar CS Catheter displayed in "Low Confidence" in the absence of VoXels

Without the presence of a Sensor Enabled tool in the body and a sufficient cloud of VoXels, the decapolar catheter is displayed in its "Low Confidence" state.

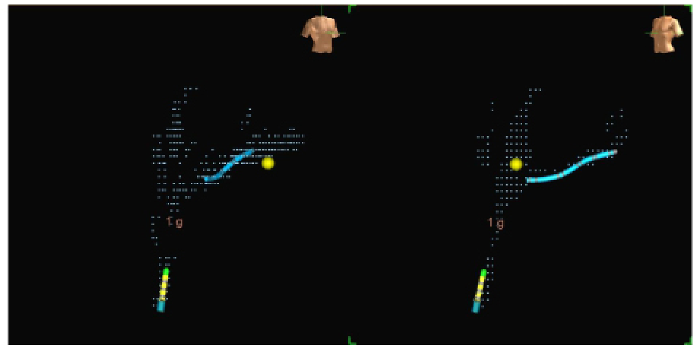

Figure 3: RAO and LAO views of the Decapolar CS Catheter displayed in "High Confidence" after sufficient VoXel collection

Following the introduction of the TactiCath™ Ablation Catheter, Sensor Enabled™ into the body, VoXels are collected in the Right Atrium and Coronary Sinus allowing the decapolar catheter to be displayed in "High Confidence."

Methods

Study Population and Protocol

From December 2021 to November 2022, 135 consecutive patients undergoing RFA for symptomatic paroxysmal AF (PAF) or persistent AF were prospectively studied as part of our internal quality improvement database. 49 patients who underwent initial ablation of paroxysmal AF were selected for this analysis, since this represents a more uniform population to describe procedural workflows.

Use of fluoroscopy, procedural duration, acute procedural success, PV RF delivery times, GA settings, lesion sets, discharge timing, and complications were recorded. Procedural duration was defined as the time from initial venous access until final sheath removal after the completion of the RFA procedure. Acute procedural success was determined by both entrance and exit electrical blocks of the pulmonary veins.

Pre-procedural description

Transesophageal echocardiography was performed to rule out intracardiac thrombus. Antiarrhythmic drugs were discontinued for approximately five half-lives except for amiodarone, which was discontinued for less than 2 weeks before the RFA procedure. All procedures were performed with uninterrupted oral anticoagulation.

Right Atrial Access and CS Catheter Placement

Using ultrasound guidance for vascular access, three 8-French sheaths are placed in the right femoral veins for mapping and ablation catheters, and one 11-French venous sheath is placed in the left femoral vein for the intracardiac echocardiography (ICE) catheter. A standard diagnostic quadripolar catheter is tied to an esophageal temperature probe which is advanced adjacent to the posterior wall of the left atrium (LA), allowing visualization on the mapping system.

The ICE probe is advanced without fluoroscopy under direct visualization of the anatomy along the path to the cardiac structures. First, the bladder is noted, followed immediately by the cross section of the iliac artery. Then a slight anterior tilt and clockwise rotation is utilized

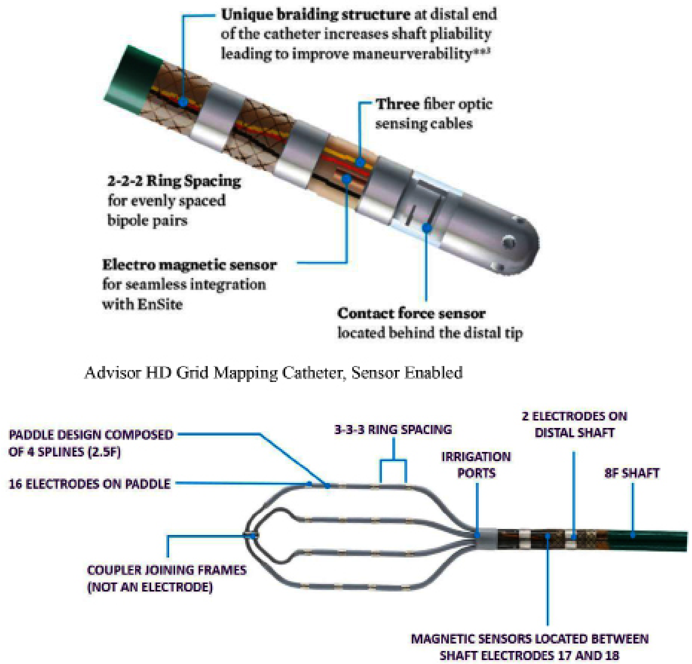

Figure 4: Location of the Magnetic Sensor on the TactiCath™ Ablation Catheter, Sensor Enabled™ and the Advisor™ HD Grid Mapping Catheter, Sensor Enabled™

Advisor™ HD Grid Mapping Catheter, Sensor Enabled™. Comparative magnetic sensor locations on the Advisor™ HD Grid Mapping Catheter, Sensor Enabled and TactiCath™ Ablation Catheter, Sensor Enabled™ tools. EnSite™ VoXel Mode relies on these sensors communicating accurate location information to the system to determine catheter and electrode locations. The creation of the VoXel fiducial cloud depends on the linking of magnetic and impedance data. Increasing the density of these fiducial points in the magnetic navigation mode improves the accuracy, navigation, and visualization of impedance based (non-sensor) catheters on the system. The sensor on the TactiCath™ Ablation Catheter, Sensor Enabled™ is located between the 2nd and 3rd electrode allowing for it to be visualized in "High Confidence" at all times, regardless of VoXel cloud density. This allows for efficient VoXel collection and is why this catheter is used to rove around the LA and PVs prior to mapping with the Advisor™ HD Grid Mapping Catheter, Sensor Enabled™. The sensor on the Advisor™ HD Grid Mapping Catheter, Sensor Enabled™ is located between the shaft electrodes which are more proximal than the paddle. Accurate visualization of the electrodes is dependent on sufficient VoXel density in the local area.

to engage the vein and advance to the IVC. The ICE probe is then placed in the right atrium.

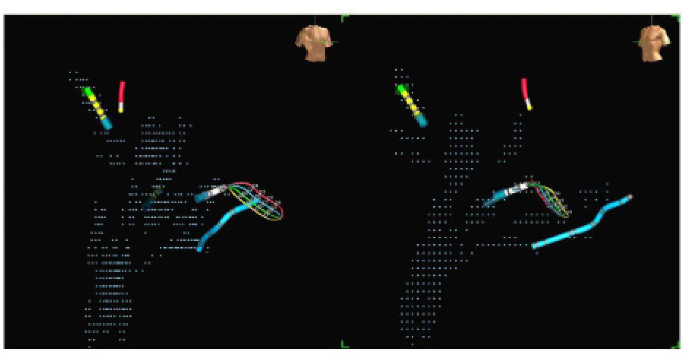

Figure 5: RAO and LAO views of the initial VoXel Cloud collected during placement of the TactiCath™ Ablation Catheter, Sensor Enabled™ and Advisor™ HD Grid Mapping Catheter, Sensor Enabled™ into the Left Atrium

The TactiCath™ Ablation Catheter, Sensor Enabled™ is positioned in the right superior pulmonary vein after gaining transseptal access to check for phrenic nerve capture. The Advisor™ HD Grid, Mapping Catheter, Sensor Enabled™ and the esophageal temp probe (Red) is displayed in "Low-Confidence" due to a relative lack of VoXel density in its immediate area.

The TactiCath™Ablation Catheter, Sensor Enabled™ contact force ablation catheter (Abbott) is "zero-ed" outside the patient body and then introduced through an Agilis™ NxT Steerable Introducer to the IVC, hereafter beginning the collection of VoXels for magnetic navigation. We continue to collect VoXels and the TactiCath™ Ablation Catheter, Sensor Enabled™ is observed along its superior course to the right atrium until electrograms are noted. A HIS potential is identified and tagged on the mapping system as VoXel collection continues in the right atrium as the catheter is roving. After a sufficient model is created of the right atrium, the catheter is inserted into the coronary sinus ostium under guidance of EAM and ICE. VoXels are collected with TactiCath™Ablation Catheter, Sensor Enabled™ in the coronary sinus structure for accurate visualization of the decapolar catheter (Figure 3).

The decapolar catheter is then inserted to the RA and then to the coronary sinus following the course afforded by the VoXel cloud collection and assisted with ICE.

Ultrasound GuidedTransseptal Access

After venous access has been obtained and prior to transseptal access, intravenous heparin is administered to maintain ACTs greater than 300 seconds for the remainder of the case. The fossa ovalis is observed with the ICE probe in the right atrium, from here a slight posterior and right tilt is slowly applied to visualize the SVC. The SL2 wire is then inserted under ICE visualization to the SVC. The SL2 sheath with dilator is then advanced over the wire to the SVC. The wire is then removed from the sheath and exchanged for the Brockenbrough transseptal needle just proximal to the tip of the dilator. The sheath and needle assembly are then dragged inferiorly until tenting of the fossa ovalis is visualized via ICE. A slightly anterior transseptal puncture is made; the dilator is advanced into left atrium and fixed; the needle is exchanged for the wire which is advanced to the left superior or inferior PV; its access to the vein and constant position is confirmed by ICE; then we safely advance the sheath into the left atrium. The sheath is pulled back into the IVC over the wire and using ICE guidance the ablation catheter and Agilis sheath are advanced into the LA using the wire as a guide. The SL2 is then readvanced into the LA and the Advisor™ HD Grid Mapping

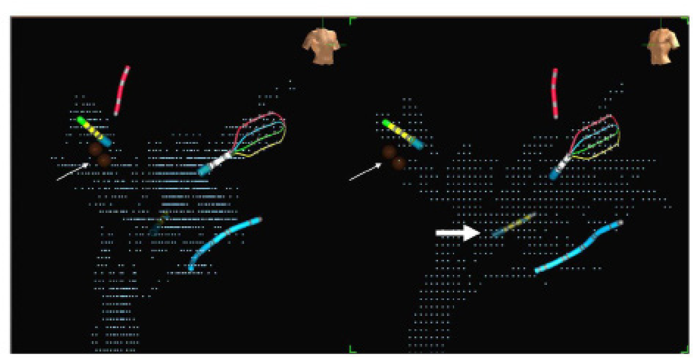

Figure 6: RAO and LAO views of the VoXel Cloud after roving around the chamber with the TactiCath™ Ablation Catheter, Sensor Enabled™ to collect additional VoXels before beginning the mapping process

The VoXel density in the left atrium has been greatly increased and has allowed for the Advisor™ HD Grid Mapping Catheter, Sensor Enabled™ and esophageal temperature probe (Red) to be displayed in their "High Confidence" states. Performing this exercise prior to mapping will increase the accuracy and efficiency of the resulting map and geometry. Phrenic nerve capture is represented by the brown tags in the RSPV (small arrows). A shadow of the ablation catheter was created to mark the transseptal access site (large arrow).

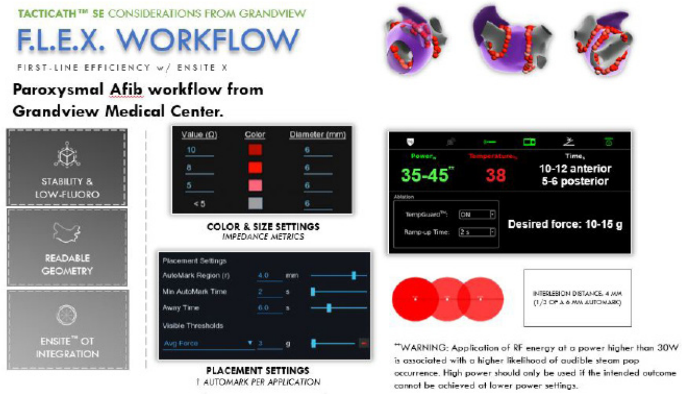

Figure7: First Line Efficiency with EnSite™ X EP System (F.L.E.X.) Workflow Standards

Catheter, Sensor Enabled™ is inserted (Figure 5). Intravenous heparin is administered before and after transseptal catheterization as necessary to achieve a target ACT of >300 seconds. The Agilis™ NxT Steerable Introducer remains in the right atrium until mapping is completed, when the SL2 is pulled back into the IVC.

Anesthesia considerations and workflow

In order to improve mapping and ablation conditions during the procedure, our center designed an anesthesia protocol for RFA of AF.

The protocol used with EnSite™ X Ep System guided procedures consists of:

1. Patient preparation, sedation, and paralysis
2. Maintenance of ventilation parameters during mapping and ablation phases
3. Recovery

Our complete anesthesia protocol has been previously published, with details on anesthetic agents used for each step of the ablation procedure[3].

1. Patient preparation, sedation, and paralysis

a. Patient instrumentation is minimized as the clinical needs of the patients allow. Foley catheters are rarely used. IV fluids used by anesthesia are limited to that needed for medication flushes and infusion and if clinically needed. Invasive blood pressure monitoring is not performed. ICE is used for every procedure.

b. Anesthesia induction/transseptal access: Anesthesia induction is performed with propofol and succinylcholine. Propofol is used as main anesthetic agent for induction (1-2 mg/kg titrated to effect; usual total induction dose of 100-200 mg) followed by an infusion (0.02-0.06 mg/kg/min).

c. Short acting neuromuscular blocking agent (NMBAs), succinylcholine (1-1.5 mg/kg), is used and additional boluses of 20-40 mg are given as needed (not to exceed a dose of 300 mg) to maintain proper paralysis up until the transseptal access is performed.

d. After transseptal access, we immediately insert the TactiCath™ Ablation Catheter, Sensor Enabled™ into the right superior pulmonary vein and attempt to identify the phrenic nerve with high-output pacing and tag it on the EAM. Only after this step are long-acting paralytic agents used.

2. Maintenance of ventilation parameters during mapping and ablation phases

a. It has been our experience that map shifts may occur if the patient is not properly paralyzed or if ventilatory changes are made during the procedure (from the mapping to the ablation phase). These could be secondary to patient motion and also changes in the lung volumes that may cause actual cardiac movements. Therefore, we try to maintain similar ventilation parameters throughout mapping and ablation.

b. After transseptal access, the ventilator is set at 25 breaths/min and a tidal volume of 250cc. At that point respiratory compensation training is performed. End tidal CO_2 is monitored and hyperventilation may be performed if levels increase above 47mmHg.

c. If clinically possible we will not make any changes to the ventilation until ablation is completed.

3. Recovery

a. After ablation we start an infusion of isoproterenol which is maintained for 15-20 minutes.

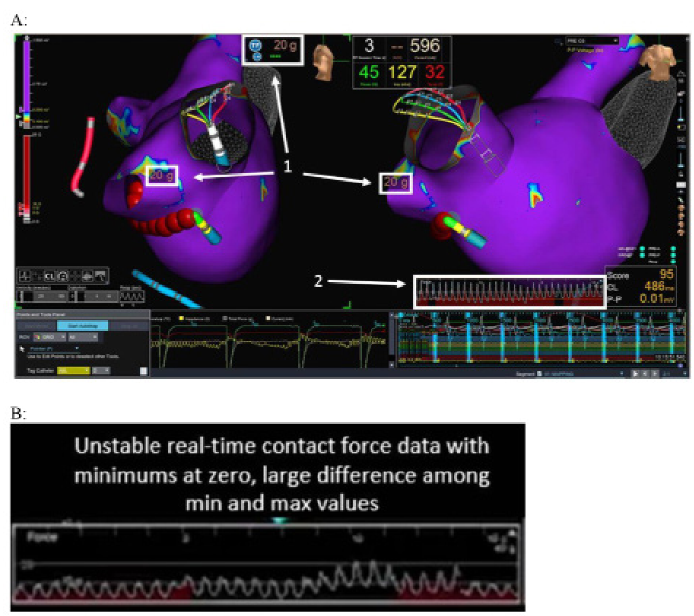

Figure 8: Right Pulmonary Vein Ablation Example Highlighting Contact Force Information

In Figure A, the contact force number displayed at the tip of the ablation catheter [1] is an average value derived from the real-time data displayed graphically in the bottom right of the screen [2]. The real-time force graph is a powerful tool for assessing the stability of the catheter. In this example, the catheter remains in constant contact with the tissue, never dropping below 10 grams of force. In Figure B, peak-to-peak variations in force without stable baseline contact may result in an acceptable "average" force reading; however, in actuality, there is intermittent tissue contact which may lead to poor lesion formation.

b. After 10 minutes we start to decrease the propofol infusion rates and assess neuromuscular blockade and the need to use reversal agents.

Left Atrial Model and Map Creation

Once transseptal access is obtained, the ablation catheter is advanced to the right superior PV; guided by EAM while pacing at 20 mA output at 500 msec, the right phrenic nerve is identified and marked throughout its course near the anterior antrum of the right PVs. Only then is the patient paralyzed, and we can modify the ventilation settings to facilitate a stable environment for mapping and ablation. Anesthesia will set a breath rate of 25/min with a tidal volume of 250cc. Left atrial pacing is performed from the coronary sinus decapolar catheter at a cycle length of 500 msec. If the patient is in atrial fibrillation at this stage of the procedure, external cardioversion is performed to restore sinus rhythm. After both of these physiologic conditions are met, we perform a respiratory compensation measurement on the EnSite™ X EP System. This order of operations is essential for maximum stability and locational accuracy during our AF procedure.

Before mapping is performed with the Advisor™ HD Grid Mapping Catheter, Sensor Enabled™ high-density mapping catheter, it is vital to understand the relationship of the VoXels to the chamber being mapped. Whereas the TactiCath™Ablation Catheter, Sensor Enabled™ magnetic sensor is located between electrodes 2 and 3 near the distal tip of the catheter, the Advisor™ HD Grid Mapping Catheter, Sensor Enabled™ magnetic sensor is located between the 2 electrodes on the shaft of the catheter (Figure 4). One will notice that VoXels are rather sparse in the distal portions of the pulmonary veins, causing the Advisor™ HD Grid Mapping Catheter, Sensor Enabled™ paddle to display in its low-confidence mode. We routinely rove about the left atrium and PVs with the TactiCath™Ablation Catheter, Sensor Enabled™ prior to mapping with the Advisor™ HD Grid Mapping Catheter, Sensor Enabled™ to observe a dense VoXel cloud, particularly in the pulmonary veins. This is accomplished safely by monitoring contact force readings as well as utilizing ICE imaging to confirm placement into each pulmonary vein. The higher density of VoXels throughout the chamber and the veins facilitates a quicker and more accurate mapping process with the Advisor™ HD Grid Mapping Catheter, Sensor Enabled™ (Figures 5-6). The Advisor™ HD Grid Mapping Catheter, Sensor Enabled™ is then maneuvered throughout the left atrium to create a complete LA anatomy. Local activation timing and voltage data are collected and utilized to better understand the patient's substrate and plan the lesion set. During mapping, care is taken by the mapping specialist to edit geometry as required to eliminate artifact of catheter tenting or "push-out" model data.

Ablation for PVI

Once mapping is complete, we pull the SL2 sheath back into the right atrium, while leaving the Advisor™ HD Grid Mapping Catheter , Sensor Enabled™ securely positioned in the right pulmonary veins. We then advance the Agilis™ NxT Steerable Introducer into the left atrium over the shaft of the TactiCath™ Ablation Catheter, Sensor Enabled™, affording maximal control of the ablation catheter during ablation. We prefer to begin our wide antral circumferential lesion sets around the right pulmonary veins, due to the relative greater difficulty level and to allow more time to observe potential reconnection. On the recording system, we utilize a unipolar electrogram from the distal recording electrode of the ablation catheter to observe elimination of the terminal 's' wave, suggesting successful lesion creation[6]. We focus on catheter stability above all else.

Table 1: Ventilatory management during each phase of Radiofrequency Ablation of Atrial Fibrillation using EnSite™ X EP System

1. Respiratory Compensation	2. Mapping	3. Ablation	4. Recovery
• •	Long-acting neuromuscular blockade given after transseptal access, identification and tagging of the phrenic nerve on the EAM Ventilator settings changed to 25 breaths/min, 250cc tidal volume		SIMV 8 breaths/min until spontaneous ventilation then pressure support and propofol stopped when indicated
	Rationale		
	Faster respiratory rate with lower tidal volume minimizes transthoracic impedance changes and respiratory-related cardiac motion yielding improved mapping conditions and catheter stability during ablation		Expedite patient recovery and extubation after the procedure is completed

Our strategy for lesion application has been formalized in our First Line Efficiency with EnSite™ X EP System (F.L.E.X.) workflow (Figure 7). Lesions are completed using AutoMark lesion tag (EnSite™ X EP System, Abbott) criteria as follows: 6mm lesion diameter, 4mm intra-lesion spacing (measured center-to-center), away time of 6 seconds, and minimum AutoMark time of 2 seconds. The color of the lesion is displayed utilizing impedance drop criteria, with lesion AutoMark progressively becoming a darker shade of red, until the darkest shade is reached at 10 ohms impedance drop. Lesions are delivered at a goal of 10 grams of force, with 40-45 W power setting. Power is titrated to maintain a current value around 600-650 mA, particularly in patients that have lower circuit impedance (less than 100 ohms). 5-6 seconds of ablation is preferred on the posterior wall, while 10-15 seconds is used on the anterior wall of the left atrium. Meeting these criteria for each lesion is of high importance for each operator during this workflow.

During ablation, it is notable that the contact force indicated visually at the tip of the catheter is an average. It is imperative for the operator to also observe the contact force graph that displays a real-time reading of the force data (Figure 8). If the force reading drops to zero consistently or a high amplitude variability of contact is shown, this will indicate a relative lack of stability during lesion application. Efforts can be made to stabilize the waveform such as repositioning the approach to the tissue or advancing the steerable sheath closer to the distal electrodes of the ablation catheter. The distal pair of electrodes must be uncovered to accurately observe the location of the TactiCath™Ablation Catheter, Sensor Enabled™.

After completion of the right pulmonary vein isolation, attention is directed toward the left pulmonary vein isolation. In order to ideally demonstrate the anatomy of the ridge of Marshall for ablation, the TactiCath™ Ablation Catheter, Sensor Enabled™ is inserted into the left superior pulmonary vein and anterior flexion and counterclockwise

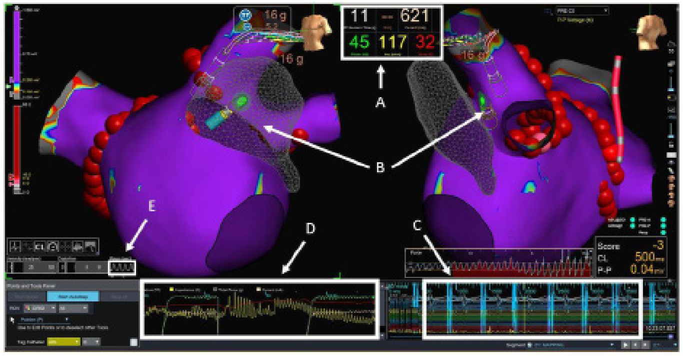

Figure 9: Left Pulmonary Vein Ablation Example Highlighting Important Ablation Information and Left Atrial Appendage Segmentation

The generator metrics [A] can be displayed anywhere on screen for easy reference by the operator during ablation. RF Session time, Impedance Drop, Current, Power, Impedance, and Temperature are displayed in this example. Segmentation of the Left Atrial Appendage is performed allowing for enhanced visualization of the ridge [B] when ablating in that area. Real-time EGMs [C] are shown in the bottom right of the screen to monitor the veins for isolation. Real-time ablation metrics [D] are displayed in the bottom left and updated at a frequency of 50 Hz. This allows for a greater appreciation of trends over time compared to the averaged values displayed on the recording system and generator metrics box [A]. The respiratory waveform [E] allows for respiratory changes to be monitored and will turn red when irregularities are sensed by the system.

rotation is applied on the tip of the catheter. There is minimal force indicated initially, as the true catheter-vein contact is on the shaft of the catheter. The catheter then is slowly withdrawn until force increases, indicating catheter-vein contact at the distal tip of the catheter. The operator may observe dropping off from the vein anteriorly to the LAA this is confirmed by sudden loss of CF and ICE correlation. Manual lesion markers can be created at the point of catheter drop, indicating the endocardial venous border of the appendage ridge. This process facilitates ideal positioning of lesions to apply adequate CF for pulmonary vein isolation lesions. Wide antral circumferential lesion set ablation of the left veins is completed similarly to the right pulmonary veins (Figure 9).

Validation of PV isolation is performed using adenosine boluses, isoproterenol infusion at doses up to 20 mcg/min, and pacing maneuvers when appropriate. When necessary, the Advisor™ HD Grid Mapping Catheter, Sensor Enabled™ is used to confirm the PV isolations via LAT and peak to peak voltage mapping. If PV reconnections were seen with adenosine, isoproterenol, or during waiting time, further ablation with similar parameters is done until veins are re-isolated.

Catheters are removed at the end of the procedure, and venous hemostasis is obtained with figure of 8 sutures around the venous access sites followed by a pressure dressing that remains in place for 2-3 hours.

Results

A total of 49 patients with PAF with first time procedure were included in this analysis. The baseline characteristics of the enrolled patients are summarized in Table 2. Procedure time and pulmonary vein RF time was 74.2(±17.84) and 10.35(±3.47), respectively. Lesion sets consisted of pulmonary vein isolation only in 61% of patients, pulmonary vein isolation and cavo-tricuspid isthmus ablation in 20.4% of patients and substrate modification was added to these targets in 18.3% of patients. 97.9% of patients received zero fluoroscopy during the procedure. In the single patient where fluoroscopy was necessitated, a total of 1 min was used. Return of conduction in the pulmonary veins occurred in 18.3% and 26.0% of patients by means of adenosine and isoproterenol administration, respectively. Same-day discharge was possible in 76% of patients in this population. There were no acute procedural complications in this group.

Discussion

We report that a structured workflow utilizing the EnSite™ X EP System for AF RFA procedures can contribute to enhanced procedural outcomes, EP lab efficiency, and a high safety profile for patients while reducing fluoroscopy in these procedures. General anesthesia ventilation profiles can be tailored to maximize catheter stability in the cardiac structures.

AutoMark criteria applied to RFA lesion markings were utilized to ensure each attempted application received adequate time, CF and impedance drop. These criteria were tailored to our workflow and derived from anecdotal experiences as well as the published catheter data[7,8].

The utilization of general anesthesia is paramount during AF RFA

Table 2: Baseline Patient and Procedural Characteristics

Variable	Sample (N= 49)
Age (mean ±SD)	66.3±10.8
Sex- Female (n, %)	27 (63%)
BMI (mean ±SD)	30.7±8.1
CHADS2Vasc (mean ± SD)	3.08±1.87
HASBLED (mean ± SD)	1.93 ±1.31
LV EF (mean± SD)	57.3±6.1
Procedure Characteristics	
Zero Fluoroscopy (n, %)	48 (97.9%)
Fluoroscopy Time in Minutes (total for 1 patient)	1.0
Procedure time in minutes (mean± SD)	74.20±17.84
PV RF Time in Minutes (mean± SD)	10.35±3.47
Return of conduction	
• Adenosine	9 (18.3%)
• Isoproterenol	13 (26.0%)
High Frequency-Low tidal volume ventilation	49 (100%)
Lesion Set	
Pulmonary Vein Isolation only	30 (61.2%)
Pulmonary Vein Isolation and Cavo-Tricuspid	10 (20.4%)
Isthmus	
PVI and CTI and Substrate Modification	3 (6.1%)
PVI and Substrate Modification	6 (12.2%)
Same-Day Discharge	55 (76%)
Acute Procedural Complications	
•Cardiac Tamponade or Effusion	0
• Stroke / TIA	0

to optimize the ablation procedure. Our anesthesia protocol has been previously described[3]. We developed this protocol as a joint effort between the EP and anesthesiology teams, and each step considers the specific aspects of each phase of the AF RFA procedure. Stability of the respiration cycle and paralysis of the patient are factors that greatly increase the reliability of EAM and localization of the catheters. With EnSite™ X EP System we routinely employ a respiration strategy of 25 breaths per minute at a tidal volume of 250cc. These criteria have enabled a highly cohesive environment in the EP lab amongst operators and anesthesiology.

Low or zero-fluoroscopy AF RFA has been instrumental in increasing safety profile for patients, operators, and EP lab staff. Fluoroscopy-guided catheter ablation can expose all in the EP lab to significant, and potentially deleterious, doses of ionizing radiation. Employing 3D EAM systems and ICE in ablation procedures can completely obviate the need for fluoroscopy. Utilizing a workflow minimizing fluoroscopy, we have not seen additional patient complications or procedural delays.

A limitation of this workflow is that the description has been focused on results from our center alone, with the experience of only three operators described. Our exposure to trainees and students is limited at our center, of which can be associated with relatively longer procedural times. The patients in this series had paroxysmal AF, and PV isolation was the primary concern of the procedure. For persistent AF, one may commonly employ additional lesions or ablation strategies. This can add time and additional considerations to the procedure. Additionally, there was no control group in our present work; however, a comparison with alternative EAM systems could be warranted in the future.

Conclusion

The integration of the EnSite™ X EP System has proven to be of great benefit to our practice and the safety of our patients. The magnetic based navigation (EnSite™ VoXel Mode) in this generation of the mapping system has been instrumental in our confidence of the reliability of anatomic reconstruction as well as the reproducibility in an efficient AF RFA workflow. Combining this process with our anesthesia parameters has enabled a reproducible, efficient, and safe procedure for pulmonary vein isolation in patients with PAF.

Disclosures

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