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REVIEW ARTICLE

How to Achieve Near Zero Fluoroscopy During Radiofrequency Ablation of Atrial Fibrillation: A Strategy Used at Two Centers

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Abstract: Radiofrequency ablation for atrial fibrillation is currently the most effective rhythm control strategy. These procedures, although safe, pose a risk for potential exposure to radiation and can be time consuming. Radiation exposure during ablation can increase the risk of serious complications in both patients as well as physicians. The overall procedure time also increases with use of fluoroscopy. Advances in mapping technology, such as electroanatomic mapping, use of contact force technology, intracardiac echocardiography and use of versatile sheaths and catheters has vastly enhanced our ability to both shorten the procedure duration and minimize or even eliminate radiation exposure. Use of near zero fluoroscopy technique is increasingly gaining acceptance in electrophysiology centers. At this point, there is no uniform technique and various centers use individual techniques based on their expertise and availability of various tools. There is need for a uniform technique that is workflow friendly and widely accepted. There is a learning curve associated with this technique and efforts should be made to incorporate zero fluoroscopic technique for ablation as an essential part of electrophysiology training programs. In this paper, we present the strategy being practiced at two centers, that involves a series of steps, to either decrease or eliminate the use of fluoroscopy during atrial fibrillation ablation.

Keywords: Atrial fibrillation, radiofrequency, ablation, intracardiac echo, 3D mapping, zero fluoroscopy.

1. INTRODUCTION

Pulmonary vein isolation (PVI) has emerged as the most effective rhythm control strategy in patients with symptomatic Atrial Fibrillation (AF). Currently, there are almost 5 million patients who suffer from AF [1]. The number of patients that will undergo PVI is likely to increase in the near future. The procedure of AF ablation has evolved over time and the procedure has continued to become safer, more effective, and more efficient [1-3]. AF ablation procedure is performed using fluoroscopy in addition to three-dimensional mapping (3D) and intracardiac echocardiography (ICE). Over the years, there has been a substantial improvement in both the technology and expertise of physicians in acquiring 3D electroanatomic maps and the use of ICE. Physicians have learned to limit the use of fluoroscopy and rely more on 3D mapping and ICE during various electrophysiology procedures [1-3]. In the recent past, there are multiple reports on Radiofrequency Ablation (RFA) being performed with either minimal or completely without the use of fluoroscopy [4-12].

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2. BACKGROUND OF RADIATION DOSE IN EP LAB

Exposure to radiation during medical examinations and procedures results in a mean Effective Dose (ED) of 3.0 mSv per head per year. This corresponds to the radiation exposure of 150 chest X-rays and surpasses natural background radiation [13]. Large doses of ionizing radiation pose a multitude of risks to the patients and the medical staff, including malignancies, genetic disorders, and organ injury, among others [14]. Aside from radiotherapy, cardiologists account for nearly 40% of medical radiation exposure to the US population [13].

Fluoroscopy-guided procedures are routinely performed in cardiology. As a result, interventional cardiologists and electrophysiologists are more frequently exposed to ionizing radiation in comparison to other physicians. A typical radiofrequency ablation of an arrhythmia may require an ED of 1 to 25 mSv. In comparison, a typical chest x-ray requires an ED of 0.02 mSv [15]. In the laboratory, protective measures are taken to reduce radiation exposure. Personal protective devices such as lead aprons, leaded glasses, and thyroid shields are commonly utilized to mitigate radiation exposure. However, these protective measures are not entirely effective at absorbing scattered radiation and may also cause physical distress.

To address these issues, zero-fluoroscopy approaches to catheter ablation are being studied in clinical practice. Such approaches can significantly reduce exposure to harmful radiation during ablation procedures. Therefore, a feasible and effective zero-fluoroscopy approach to catheter ablation is desirable for physicians and patients alike.

3. NEGATIVE EFFECTS OF RADIATION

Cardiologists, nurses, and technical staff may be routinely exposed to hazardous doses of ionizing radiation. Furthermore, the risks of radiation exposure are of important concern to patients who undergo long and/or repeated procedures. These risks are exceptionally pertinent to vulnerable populations such as obese patients who may receive over twice the effective radiation dose of normal-weight patients during atrial fibrillation ablation procedures [16].

The damaging effects of ionizing radiation have been extensively studied in recent years. The risks of ionizing radiation are categorized into tissue reactions (formerly known as deterministic effects) and stochastic effects [10]. Tissue reactions vary in severity according to the dose of ionizing radiation. Examples of tissue reactions include skin injuries, cataracts, bone necrosis, and damage to the myocardium. Stochastic effects are not dose-dependent in severity and include radiation-induced cancer risk and heritable effects in offspring.

Among other risks, brain and neck tumors have been associated with chronic exposure to fluoroscopy. Cardiologists' annual head exposure to radiation is 20-30 mSv, which is 10 times higher than the rest of the body. This could very well explain the increased prevalence of brain cancer with more exposure to the left side of the brain as compared to the right side [17, 18]. In a study performed involving 31 interventional physicians from various countries with head and neck cancers, 23 interventional cardiologists, 6 interventional radiologists and 2 electrophysiologists developed cancer with latency periods ranging from 12 to 32 years [19].

The use of protective equipment, such as lead aprons, is essential in reducing exposure to radiation. However, the weight of protective lead apparel can cause spine, hip, neck and ankle problems, which can lead to functional disability over the course of time [20, 21]. In a study conducted at George Washington University, researchers determined the presence of a distinct occupational hazard termed "interventionalist's disc disease." In this study, 99.7 percent of surveyed cardiologists reported the use of a lead apron, with most wearing one-piece aprons averaging a weight of 17.9 lbs. The researchers reported a significant correlation between the usage of lead aprons and the frequency of back pain, sciatica, axial skeletal complaints, and cervical disk herniations [22]. Minimizing the use of radiation during procedures would reduce the need for protective equipment, thereby preventing the long-term skeletal consequences of lead aprons.

4. REDUCING RADIATION

Recent technical advances have resulted in the widespread use of three-dimensional (3D) electro-anatomic navigation systems in order to minimize radiation exposure during mapping and RFA of tachyarrhythmias [11]. Real-time intracardiac echocardiography may also be used to assist in the 3D reconstruction of the heart.

3D mapping systems have been improved in recent years and now enable contact force measurement as well as simultaneous visualization of multiple catheters. The use of 3D mapping systems in RFA procedures results in significantly reduced fluoroscopic times, thus minimizing the risks of ionizing radiation exposure to both patients and medical staff.

In this paper, we present the strategy used at two centers to achieve near zero fluoroscopy during RF ablation of AF.

5. TECHNIQUE USED AT MCLAREN GREATER LANSING

The procedure was performed after an overnight fast. All patients were instructed to continue their anticoagulation before and after the procedure. Anesthesia was involved in all cases. Patients were brought to the electrophysiology laboratory in the post-absorptive state.

General anesthesia was involved in all cases and patients were intubated. Three venous accesses were obtained on the right side and one venous access on the left side.

Step 1: Venous access and advancing Ultrasound catheter and long sheaths:

Two SL0 and one SR0 sheaths are inserted in the Right Femoral Vein (RFV) and one 11fr short sheath is inserted in the Left Femoral Vein (LFV) using the modified Seldinger technique.

The venous access is obtained using a microscopic puncture needle set and ultrasound guidance.

After obtaining the left femoral venous access, a cartosound Intracardiac Echo (ICE) mapping catheter is advanced through the vein using ultrasound guidance. If resistance is felt, the catheter is withdrawn and rotated to have a translucency ahead of the catheter.

The catheter is advanced without using any force into the Right Atrium (RA). Subsequently, the catheter is advanced into the right ventricle to perform respiratory gating. Once respiratory gating is completed, the catheter is turned clockwise to visualize the RV and subsequently LV.

Furthermore, the clockwise movement brings the aortic valve, the Left Atrial Appendage (LAA), Left Superior Pulmonary Vein (LSPV) and the left atrial ridge in view. After obtaining the cartosound map of the aortic valve, LAA and LSPV, the ICE catheter is withdrawn and placed in the RA and a home view is obtained. A complete clockwise sweep from the home view will sequentially bring coronary sinus, mitral valve, LAA, LIPV and LSPV in view. Further, clockwise rotation brings the left atrial posterior wall, LIPV, pulmonary artery and LSPV in view.

After obtaining the cartosound map of the left atrium, the ultrasound catheter is brought back to the home view. Furthermore, posterior and right-sided tilt will bring the SVC in view (Fig. **1**).

Two SL0 and one SR0 sheaths are inserted in the right femoral vein (RFV) and one 11fr short sheath is inserted in the left femoral vein (LFV) using the modified slinger technique. The long wires are advanced gently into the SVC under direct ultrasound guidance (Fig. **2** and Supplementary Video **1**).

Step 2: Advancing Ablation and coronary sinus catheter:

A smart touch irrigated catheter is advanced into the right atrium under direct visualization. A fast-anatomical map (FAM) of the right atrium, His region and coronary sinus is created. Subsequently, under electroanatomic map guidance, a decapolar deflectable catheter is advanced and placed in the coronary sinus using the FAM for anatomic guidance (Supplementary Video **2**). A multi-sensor esophageal temperature probe is placed under fluoroscopy with two to three sensors placed inferior to the coronary sinus ostium. The total fluoroscopy time is kept less than 30 seconds. The fluoroscopy is disabled at this point.

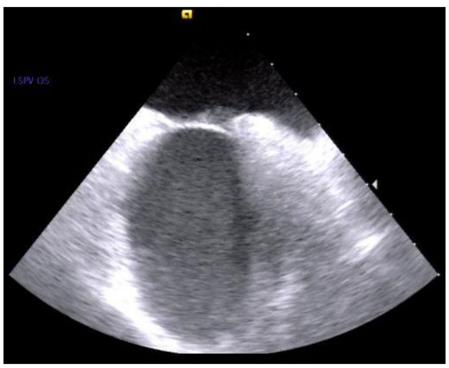

Fig. (1). Baseline ICE image showing superior Vena Cava View. (*A higher resolution / colour version of this figure is available in the electronic copy of the article*).

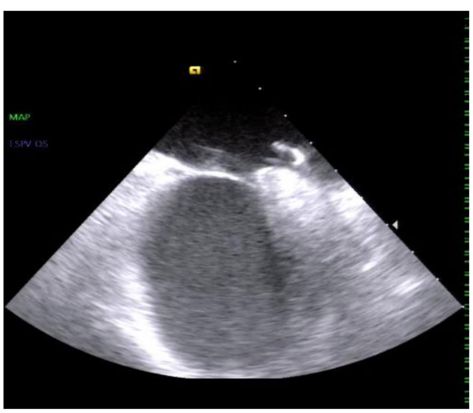

Fig. (2). Intracardiac echo showing wire being advanced in SVC. (*A higher resolution / colour version of this figure is available in the electronic copy of the article*).

Step 3: Obtaining Trans-septal Puncture:

The long wires are again placed in the SVC under ICE guidance. The sheaths with dilators are advanced over the wires under direct ICE visualization (Fig. **2** and Supplementary Video **1**). The wire is subsequently removed, and placement of sheath-dilator assembly is confirmed by injecting saline through the dilator and visualizing bubbles in the SVC. The transseptal needle is now advanced through the dilator and the needle dilator-sheath assembly is withdrawn as a unit under direct ICE visualization. The engagement of the fossa ovalis with the dilator is noted and the transeptal puncture is performed with the tip of the dilator tenting the Interatrial Septum (IAS) (Fig. **3**) towards the left atrium. Entry into the left atrium is confirmed by injecting saline into the left atrium (Fig. **4** and Supplementary Video **4**). Sheath exchange can be performed by placing a wire in the left atrium (Fig. **5**). Subsequently, the needle and the dilator are withdrawn while advancing the sheath. The procedure is repeated for the second transeptal puncture. Throughout the procedure, the Activated Clotting Time (ACT) is maintained between 350-400 seconds using heparin boluses.

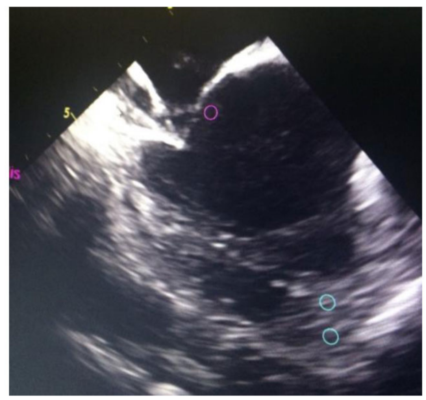

Fig. (3). ICE image showing trans-septal needle tenting the fossa ovalis. (*A higher resolution / colour version of this figure is available in the electronic copy of the article*).

Step 4: Mapping and Ablation:

The Pentarray catheter and the ablation catheters are advanced through the transeptal sheaths into the left atrium. An extensive FAM, voltage, and activation map of the left atrium, left atrial appendage, esophagus and the pulmonary veins are obtained using Penta array multipolar mapping catheter (Fig. **6**).

Pulmonary vein isolation is performed by circumferential ablation around each pulmonary vein. Additional ablation, including the roof, floor, mitral isthmus or left atrial tachycardia ablation, is performed depending on the clinical scenario in each patient. Pulmonary vein isolation is confirmed by entrance block (electrical silence in each vein) and exit block (pacing in pulmonary vein) in each pulmonary vein. A voltage map is also performed in each pulmonary vein. After pulmonary vein isolation and additional ablation, dormant conduction in each vein is confirmed by placing a Penta array catheter in each vein and injecting adenosine 12 mg IV for each vein. After completing the left atrial ablation, the catheters are withdrawn from LA and placed in the right atrium. The Cavo tricuspid isthmus ablation is performed with confirmation of bidirectional block across the isthmus. After completing the ablation, an ICE catheter is used to rule out any pericardial effusion. Heparin is reversed using protamine. The sheaths are removed once the ACT is < 200 secs. Hemostasis is achieved using manual compression.

Fig. (4). ICE image showing trans-septal needle across the FO. (*A higher resolution / colour version of this figure is available in the electronic copy of the article*).

6. TECHNIQUE USED AT WALTER REED NATIONAL MILITARY MEDICAL CENTER, BETHESDA, MD

Femoral venous access is obtained using the modified Seldinger technique and two 8F short sheaths are inserted into each vein (the right and left femoral veins). Therefore, a total of four venous sheaths are introduced. Intravenous unfractionated Heparin bolus is given (calculated according to body weight) after placement of the groin sheaths.

6.1. Catheters, Sheaths and other Apparatus Used During the Procedure

- Swartz Braided Transseptal Guiding introducer, SLO, 8.5 F sheath, 0.032-inch guidewire, 63 cms sheath usable length, 67 cms dilator usable length (St. Jude Medical).
- NRG Transseptal Needle, CO curve, 71 cm length, 0.032-inch dilator capability (Baylis Medical Company, Inc.).
- ProTrack Pigtail Wire, 175 cm, 0.025-inch outer body diameter (Baylis Medical Company, Inc.).
- Mobicath sheath, 11.5 F, 72 cm usable length, 8.5F inner diameter, 30 mm curve size (Biosense Webster, Inc.). This was later replaced by the Carto Vizigo Sheath.
- Carto Vizigo Bi-directional guiding sheath, medium curve, 11.5 F, 71 cm, 22 mm curve size.
- Carto Thermocool Smart touch SF, Bi-directional with curve visualization, 8F, DF curve (Biosense Webster).
- CARTO PENTARAY eco Catheter, 7F, F curve.
- Esophageal temperature probe with a Webster Quadripolar deflectable Catheter.

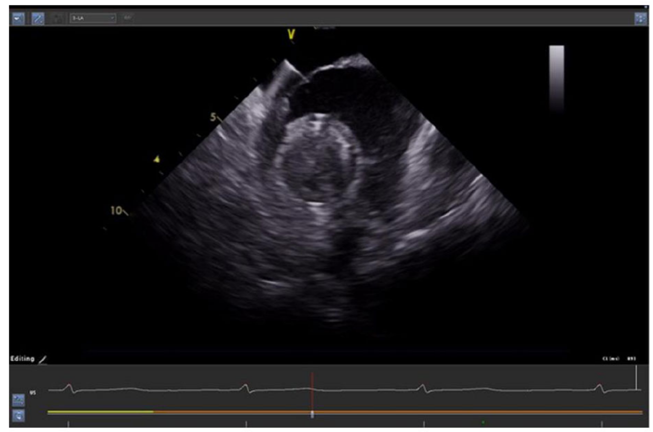

Fig. (5). ICE image showing ProTrack Pigtail Wire in the left atrium. (*A higher resolution / colour version of this figure is available in the electronic copy of the article*).

The technique (Serial steps):

Step 1: One of the right femoral short sheaths is exchanged with the Swartz Braided Transseptal SLO Guiding introducer and the STSF ablation catheter is advanced to the Right Atrium (RA) using the SLO sheath. A 3D shell of RA and Coronary Sinus (CS) is created using Fast Anatomic Mapping (FAM). The superior vena cava-RA and the inferior vena cava-RA junctions are delineated using the electrograms and the FAM.

Step 2: A Decapolar CS catheter is advanced into the CS *via* one of the short 8F sheaths using the previously created 3D shell as a guide and confirming with CS electrograms (Supplementary Video **3**).

Step 3: The ICE catheter is advanced to the right heart and different views of LA and Pulmonary Veins (PVs) are obtained. Using a previously obtained CT-angiogram of the LA and Pulmonary Veins (PVs), a CARTO Merge map is created using Cartosound. The ICE catheter is advanced by rotating and deflecting the catheter such that the long axis of the venous lumen is continuously visualized.

Step 4: STSF ablation catheter is used to tent the Fossa Ovalis using real-time ICE visualization (Fig. **3**). Fossa Ovalis (FO) was mapped and a landing zone for transseptal puncture is identified and tagged using the conventional Carto mapping.

Fig. (6). Ablation performed near the left inferior vein. (*A higher resolution / colour version of this figure is available in the electronic copy of the article*).

Step 5: A Mobicath vascular access sheath is placed *via* the remaining 8F sheath using right femoral venous access. The guidewire is secured after the placement of the Mobicath. After the availability of the Vizigo sheath, the Mobicath vascular sheath was replaced by the Vizigo sheath.

Step 6: The STSF catheter is removed from the SLO sheath and inserted into the Mobicath and advanced to RA, and the landing zone on FO is again confirmed and tagged on the Carto map. The tip of the trans-septal sheath cannot be visualized. However, on the FAM/electroanatomic map, it can be indirectly tracked by advancing and retracting the sheath over the ablation catheter. With the CARTO mapping system, there are remote electrodes located on the ablation catheter shaft. Each of the electrodes emits a signature current that is processed by system patches. If the catheter is covered by the end of the sheath and the electrodes on the catheter shaft are covered, the two ring electrodes on the catheter are visualized as turning to black color. The FO is again touched by the tip of the ablation catheter and the distal end of the MOBI sheath, now approximated close to the FO, using both CARTO and ICE visualization.

Step 7: At this point, the position of the proximal end of the MOBI sheath outside the body is marked on the drape using a marker to draw a line. This is an essential landmark, also used at the time of transseptal puncture.

Step 8: The STSF catheter is taken out of the Mobicath sheath and using the guidewire and dilator, the Mobicath is positioned into the high RA near the SVC junction.

Step 9: Using Mobicath, a Baylis needle is inserted and advanced close to the distal end of the Mobicath. The whole transseptal assembly is slowly withdrawn to the level of the FO. ICE guidance is used. The FO tenting is visualized using real-time ICE imaging. The position of the hub and the pointer on the trans-septal needle are also marked on the drape, and FO is punctured by ICE guidance (Fig. **4**).

Step 10: After puncturing FO, a ProTrack Pigtail Wire is advanced and parked into the LA (Fig. **5**). The Mobicath is moved back and forth along FO to achieve optimal dilatation of FO. The ACT level of 350-400 seconds is achieved immediately prior to performing the transseptal puncture. Subsequent periodic heparin boluses are given to maintain an activated clotting time of 350 - 400 seconds.

Step 11: With the ProTrack wire securely parked into the LA, the Mobicath is withdrawn into the RA. ProTrack wire location is visualized on real-time ICE imaging.

Step 12: The STSF catheter is re-introduced *via* the SL sheath and advanced into the LA using the previously marked landing zone site on FO. The STSF catheter is slid alongside the ProTrack wire entrance point on the FO.

Step 13: The Mobicath is threaded into the LA using the ProTrack wire parked into the LA. The STSF catheter is pulled out of the SLO sheath and re-introduced through the Mobicath into the LA.

Step 14: A Pentaray catheter is introduced *via* the SLO sheath into the LA.

Table 1. Summary of published fluoroless atrial fibrillation ablation studies.

Study Source	Mean Procedure Time (Minutes)	Number of Fluoroless AF Ablations	Zero Fluoroscopy (%)	Complication Rate (%)
Bulava *et al.* [4] 2015	92.5	40	97.5	0
Sanchez *et al.* [5] 2016	148	56	100	0
Percell *et al.* [6] 2016	210	20	95	5
Razminia *et al.* [7] 2017	194	186	99.5	1.6
Liu & Palmer [8] 2018	106	200	100	1
Lyan *et al* [9] 2018	108.8	245	98.8	1.2
Haegeli *et al.* [10] 2019	130	28	54	3.6
Jan *et al.* [11] 2020	175	144	100	8.3
Salam *et al.* [12] 2020	134	325	100	0

Step 15: After completing the ablation procedure, the ICE catheter is used to rule out pericardial effusion. Heparin effect is reversed using protamine. The sheaths are removed once the ACT is < 200 secs. Hemostasis is achieved using manual groin compression.

Using this technique, double transseptal access is obtained without the use of fluoroscopy by utilizing a series of well calculated steps. This hands-on technique has been validated thoroughly in our EP lab over the past two years and fine-tuned to reduce the procedure time, enhance safety, and improve the workflow.

This information is critical when ablating on the posterior left atrial wall. At this point, this modified esophageal probe is an alternative to a future esophageal probe with an in-built sensor for the CARTO mapping.

During the study, Carto Vizigo bi-directional guiding sheath became available and was used in place of the Mobicath.

Contact force technology is one of the critical factors during the zero fluoroscopic procedure. It allows consistent movement in response to contact forces using precision spring as it allows measurement of stable contact force and catheter tip direction. Contact force monitoring acts as a surrogate for the fluoroscopic visualization of catheter movement against the chamber wall, thereby preventing inadvertent push against the wall.

The four distal electrodes on the Vizigo sheath enable real-time steerable sheath visualization. This aids in understanding the spatial relationship between the catheter and the sheath during navigation and understanding the orientation during catheter manipulation. In addition, smooth tip-to-dilator transition allows for optimal transseptal access.

The ablation technique used for pulmonary vein isolation was similar for both centers (see the "Technique used at McLaren Greater Lansing").

7. CREATING A 3D MAP OF LA AND ITS APPENDAGES

Carto Pentaray catheter mapping, real-time ICE imaging and CT angiogram imaging are used to create the 3D map of LA and identify and map the left atrial ridge and pulmonary veins and the antrum of each vein.

8. DISCUSSION

A review of the existing literature indicates that zero-fluoroscopy ablation of atrial fibrillation is feasible with a combination of electroanatomic mapping, intracardiac echocardiography, and/or contact-force technology [4-12]. Table **1** summarizes the results of published studies on fluoroless AF ablation. All studies have utilized radiofrequency energy for AF ablation. In comparison to traditional fluoroscopy-based ablation of AF, zero-fluoroscopy approaches often yield similar procedural duration and efficacy while maintaining similar complication rates.

The risk of ionizing radiation is reduced as a result of minimal fluoroscopy exposure, thereby enhancing patient and operator safety [4-12]. Chronic exposure to fluoroscopy places physicians, nurses, and technical staff at a higher risk of cataracts, dermatitis, congenital defects and brain/neck tumors [19, 23-26]. Due to such risks, occupational health policies have been adopted for minimizing the radiation during interventional procedures [24, 27]. Moreover, zero fluoroscopy is an especially important mode of radiofrequency ablation in the most vulnerable groups to ionizing radiations, including children and pregnant patients [28-32].

Bulava *et al.* [4] conducted a randomized study on fluoroless radiofrequency ablation for atrial fibrillation. Pulmonary vein isolation was performed for eighty patients with paroxysmal atrial fibrillation either with fluoroscopy (X+) or without fluoroscopy (X-). Patients were randomly assigned to either group in a 1:1 ratio. Total procedure duration was comparable in both the X- and X+ groups. Major complications related to the procedure did not occur in any of the patients and arrhythmia-free survival at 12 months was comparable in both groups.

In a retrospective study of 107 patients who underwent fluoroless catheter ablation for an atrial or ventricular arrhythmia, Sanchez *et al.* [5] determined that fluoroless ablation can be performed safely and effectively with minimal change in procedural duration.

In a retrospective single-center study, Percell *et al.* [6] concluded that fluoroless RF ablation of AF is safe and feasible using the CARTO 3-D mapping system and contact force-sensing catheters. Razminia *et al.* [7] analyzed data from 500 consecutive patients who underwent fluoroless endocardial cardiac ablations. The authors concluded that a fluoroless approach is feasible for all endocardial ablations without compromise in procedure times, efficacy, and safety.

Liu and Palmer [8] analyzed the results of 200 consecutive fluoroless AF ablations (55% paroxysmal). The results were then compared to a control group of 50 patients who underwent traditional, fluoroscopy-guided AF ablation. The mean total procedure time in the fluoroless ablation cohort was reduced in comparison to the control cohort (106.2 ± 23.2 minutes *vs* 127.9 ± 38.2 minutes, $P < 0.01$). A success rate of 76% at a mean follow-up of 11 months was obtained for the fluoroless ablation cohort. Similarly, a 74% success rate at a mean follow-up of 12 months was obtained in the control cohort.

Lyan *et al.* [9] analyzed data from 481 patients with paroxysmal AF who underwent radiofrequency PVI with the CARTO 3 system. 245 patients underwent ICE-guided PVI without fluoroscopy and 236 patients underwent traditional fluoroscopy-guided PVI. PVI without fluoroscopy resulted in similar procedure duration, safety, and long-term efficacy.

Haegeli *et al.* [10] performed a single center study in which fluoroless ablation procedures were attempted in 34 consecutive patients with various tachyarrhythmias, including 28 patients with AF. When required, fluoroscopy use was restricted to transseptal puncture. The results indicated the zero or near zero fluoroscopy is feasible in the setting of a tertiary care center. Jan *et al.* [11] concluded that a zero-fluoroscopy approach for the treatment of paroxysmal AF is both effective and safe in a single center study of 144 patients. Salam *et al.* [12] discuss a zero-fluoroscopy approach for transseptal puncture and catheter ablation for atrial fibrillation. The authors analyzed the results of a large case series and concluded that a zero-fluoroscopy approach is safe and effective with minimal change in procedure time and outcomes.

Three-dimensional electroanatomic mapping, intracardiac echocardiography and electrography are important tools for successful Zero Fluoroscopic RFA in both the pediatric and elderly populations [28-30]. Minimizing exposure to radiation becomes extremely important in pediatric patients with congenital heart defects as they undergo numerous radiographies throughout their life span. While RFA in patients with congenital heart defects can be challenging, RFA for supraventricular tachycardia without fluoroscopy and through 3D electroanatomic mapping has been reported in patients with congenital heart defects [28, 33, 34].

Flourless intervention, in general, may also be feasible in patients in whom these procedures are deferred or avoided, such as pregnant patients. Nearly all antiarrhythmic medications have teratogenic effects on the fetus and catheter ablation is simultaneously avoided due to radiation exposure. As a result, management is often deferred until after the delivery of the newborn. Per ACC/AHA guidelines, ablation may be considered in drug refractory poorly tolerated supraventricular tachycardia during the second trimester [35]. Appropriate screening of both the patient and the fetus would be important and zero fluoroscopy is deemed to be an appropriate and feasible choice with minimal risk [36].

There are certain elements which are vital to having a successful zero fluoroscopy program without complications. One of the important things for physicians to understand is that the transition to zero fluoroscopy should be slow. The physicians must learn the technique in a stepwise fashion.

As there is a learning curve associated with this technique, physicians should have a low threshold of using fluoroscopy when they think it is needed and/or when in doubt. The idea is to minimize the risk of radiations without increasing the procedure related risk to the patients.

Also, the tools and technology for having a successful zero-fluoroscopy ablation program are already available in almost every electrophysiology laboratory performing AF ablations, however, a change in mindset and motivation of the team is required for having a successful program. As was eluded previously, there is a learning curve associated with incorporating this technique in the workflow, however, over a period when the physicians are comfortable, the procedure times may shorten.

8.1. Experience at McLaren Greater Lansing

In a retrospective analysis, we found 100 patients who underwent AF ablation using the technique as described above. Ninety-five patients also had uninterrupted anticoagulation as well. All patients had successful pulmonary vein isolation and additional ablation performed. There were no cardiac perforation, vascular complications, strokes, or esophageal fistula. All but one patient was discharged home the next day. One patient had to stay for an extra day for minor bleeding [37].

CONCLUSION

There is enough evidence that RF ablation of AF can be performed with minimal use or complete elimination of fluoroscopy. A stepwise approach to learning zero fluoroscopy AF ablations and the motivation of the electrophysiology team to learn this technique is key to having a successful program.

CONSENT FOR PUBLICATION

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FUNDING

None.

CONFLICT OF INTEREST

Dr Kanjwal is the consultant for St Jude Medical and Biosense Webster.

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SUPPLEMENTARY MATERIAL

The supplementary material is available on the publisher's website along with the published work.

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