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ORIGINAL ARTICLE

Electroanatomic Mapping and Transoesophageal Echocardiography for near Zero Fluoroscopy during Complex Left Atrial Ablation

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Background We evaluated Carto 3, transoesophageal echocardiography (TOE) and contact force (CF) sensing catheter in atrial fibrillation (AF) ablation.

Methods Unselected consecutive ablations performed under general anaesthesia (GA) were studied with modified protocol (cases, n=11) and compared to retrospective consecutive controls (n=10). Patent foramen ovale (PFO) or single transseptal puncture enabled left atrial (LA) access; ablation strategy was stepwise approach. Modified protocol utilised right atrial (RA) electrograms, CF and TOE to localise SmartTouch and create RA and CS electroanatomic map (EAM) without fluoroscopy. Transseptal puncture was performed with fluoroscopy in absence of PFO. Fluoroless pulmonary vein and LA EAM was created using TOE to locate circular-mapping catheter.

Results Mean age of cases was 57±11 years with 64% male compared with 60±11 (70% male) for controls. Patent foramen ovale was identified in four cases (36%) and two controls (20%). No early complications occurred. Shorter fluoroscopy time (median 36 vs 390 seconds; p=0.038) and trend to lower radiation dose (median 17 vs 165 cGym2; p=0.053) was seen in cases, with no increase in total procedure time (p=0.438).

Conclusions General anaesthesia, TOE and CF mapping catheters facilitate minimised fluoroscopy for catheter ablation of LA arrhythmias. Zero fluoroscopy is possible in a majority of cases with PFO.

Keywords Fluoroscopy • Radiation dosage • Catheter ablation • Atrial fibrillation • Foramen ovale • Patent

Introduction

Conventional radiofrequency ablation of left atrial (LA) arrhythmias, such as atrial fibrillation (AF) or atrial tachycardia (AT), depends upon fluoroscopy for catheter localisation. Electroanatomic three-dimensional (3D) multi-catheter tracking systems, such as Carto 3 (BioSense Webster, California, USA) permit reduction of radiation dose during ablation [1,2]. However, transseptal access into the LA and creation of the electroanatomic shell remain largely fluoroscopy-dependent in most centres.

Minimising radiation exposure is recommended by the American College of Cardiology, who have promoted the ''As low as reasonably achievable'' policy for invasive cardiac procedures for many years [3]. Notably, one hour of fluoroscopy carries up to 0.1% fatal malignancy risk

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[4]; the additive lifetime risk for multiple cardiac and non-cardiac procedures requiring radiation exposure is significant and warrants minimisation on a case-by-case basis.

The recognised ideal of zero fluoroscopy has previously been reported in ablation procedures. Clinical experience series report excellent outcomes in right-sided ablations in patients presenting with supraventricular tachycardias [5], and particular importance is placed on the benefits of zero fluoroscopy in paediatric patients [6]. Concerns regarding transseptal access have, however, limited zero fluoroscopy LA procedures. Nonetheless, successful zero fluoroscopy left-sided accessory pathway ablations have been reported in a paediatric population utilising transoesophageal echocardiography (TOE) to guide the transseptal needle into the LA [7]. Complex LA ablation for AF has also been performed without fluoroscopy in adults; intracardiac echocardiography (ICE) was used for transseptal guidance in these series [8,9]. A variety of alternative non-fluoroscopic modalities to locate catheters and guidewires alongside 3D mapping systems have been used: ICE [8,9]; intracardiac electrograms; and contact-force measurements [10]. Registration of pre-procedural computed tomography (CT) images of the LA with a 3D electroanatomic map has been used for the majority of complex LA ablations performed with zero fluoroscopy thus far [8,9].

At our centre, we have combined experience of over 300 LA ablation procedures in adults with Carto utilising TOE with fluoroscopy for transseptal access under general anaesthesia (GA). Recently, we developed and introduced a modified protocol to minimise fluoroscopy time and dose by optimal use of existing TOE expertise alongside electrograms and catheter contact force sensing as an alternative to fluoroscopy for safe catheter localisation and manipulation, in the absence of pre-procedural LA imaging. We describe here our early experience with this protocol.

Patients and Methods

Clinical Setting

Unselected consecutive clinical cases (n=11) performed by a single senior operator (MW) for complex left atrial ablation of paroxysmal (PAF) or persistent (PsAF) atrial fibrillation, or re-entry AT in the context of prior LA ablation, undertaken with Carto over a six-week period (July to September, 2014) were studied with the modified protocol (Modified Protocol Group) in whom fluoroscopy was minimised. The beginning of the study period represents routine implementation of the Modified Protocol, with no other modifications. The reference comparison cohort (Conventional Protocol Group, n=10) represents an equivalent six-week consecutive clinical case series (April to June, 2014), ending six weeks prior to the protocol change. All reference ablation procedures were performed by MW as primary or sole operator on uninterrupted warfarin with international normalised ratio between 2.0 and 3.0.

Procedural Details

All procedures were performed under GA with intra-procedural TOE, as per standard practice at our institution, with rhythm, oesophageal temperature and invasive radial arterial pressure monitoring throughout. Transoesophageal echocardiography manipulation and image acquisition was performed by a specialist cardiac physiologist accredited by the British Society of Echocardiography following oesophageal intubation by the anaesthetist; TOE confirmed absence of LA appendage thrombus in all cases. Right femoral venous access was gained for 3.5 mm Thermo-Cool SmartTouch (BioSense Webster) irrigated radiofrequency ablation catheter with contact force measurements in addition to variable duodecapole Lasso circular-mapping (BioSense Webster) and IBI deflectable decapole catheters (Irvine Biomedical Inc, St Jude Medical, Minneapolis, USA). Fluoroscopy was performed using a single plane unit.

Conventional Protocol Group: Fluoroscopy was used for placement of the IBI decapole catheter into the coronary sinus (CS). When a PFO was identified on TOE, fluoroscopic guidance was used to cross into LA with SmartTouch catheter. In all other cases, a single transseptal puncture was performed with Brockenbrough (BRK0) needle via 63 cm SR0 sheath (St Jude Medical) using fluoroscopic and real-time TOE guidance, with the additional use of LA contrast injection and pressure monitoring to confirm the position in the LA. A Lasso catheter was passed through the long sheath into the LA. The SmartTouch catheter was advanced under fluoroscopic guidance via the existing transseptal puncture into the LA through a second SR0 sheath; a second transseptal puncture was only performed where it was not possible to advance two sheaths through a single puncture, or catheter manoeuverability was restricted in the LA. Carto 3D fast anatomical map (FAM) with respiratory-gating of the LA was created with a Lasso catheter using minimal fluoroscopy to identify the catheter location in the pulmonary veins, prior to completion using the Carto system alone. If either SR0 sheath and/or catheters were withdrawn into the RA during procedure, fluoroscopic guidance was used to regain LA access.

Modified Protocol Group: The SmartTouch catheter was advanced until electrograms were identified that confirmed endocardial contact from a position in the RA; SmartTouch contact force was zeroed in the body of the RA as assessed by electrograms. A Carto FAM RA map (Figure 1) was created using a SmartTouch catheter, during which electrograms were used to identify the vena cavae and tricuspid annulus, without use of fluoroscopy; additional TOE localisation was utilised when necessary. The CS was engaged by clockwise torque and withdrawal from a position within the right ventricle until characteristic atrial (A) and ventricular (V) electrograms confirming the position within the CS body were seen (A>V in amplitude); this was visualised with left and right anterior oblique projections of the RA map during manipulation. Contact force and electrogram data were interpreted to safely identify chamber boundaries; contact force of