Radiofrequency ablation for common atrial flutter using an 8-mm tip catheter and up to 150W

R.J. Hillock*, I.C. Melton, I.G. Crozier

Department of Cardiology, Christchurch Hospital, Christchurch, New Zealand

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Abstract
The formation of bi-directional block in atrial flutter can be adversely affected by problems with the delivery of effective energy related to isthmus anatomy and contact. Higher energies can produce larger and more effective lesions. The optimum setting for power delivery using temperature controlled ablation has not been established, with the maximum reported being 100 W. This is a retrospective review of the first 50 new cases assessing the efficacy and safety of using temperature controlled (60–65 °C) flutter ablation with an 8 mm tip electrode catheter and up to 150 W. All cases had either typical flutter alone (34%) or predominant flutter as the indication, no combined procedures were included. Acute procedural success was 94% and long-term success of 88%. Median number of ablations required was 11 (interquartile range 10–19), median procedure time 120 min (IQR 102–164), fluoroscopy time 22 min (IQR 17–36), radiation dose 17 Gy cm² (IQR 10–27), median number of lines 1 (IQR 1–2). Six patients achieved 150 W, but 42 achieved >100 W (median watts 142 W, IQR 104–147). Patients (12%) experienced an uncomplicated pop during the procedure. None experienced a significant complication. There were three late relapses. The setting of 150 W maximum delivered energy in temperature regulated ablation allowed higher energies (>100 W) to be delivered in most patients. This resulted in acute and long-term success rates that compare well with the literature but is associated with a 12% rate of pop. Subsequent to this series our 54th patient sustained a pop due to high energy ablation that resulted in perforation and tamponade, from which there was survival.

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* Corresponding author. Department of Cardiology, Christchurch Hospital, Riccarton Avenue, Private Bag 4710, Christchurch 8000, New Zealand. Tel.: +64 3 3640 640; fax: +64 3 3641 415.
E-mail address: hillocks2005@yahoo.com.au (R.J. Hillock).
Introduction

Cavotricuspid isthmus (CTI) ablation is well established as a safe and effective therapy for common atrial flutter. Current techniques include 4-mm and 8-mm standard tip, single and dual sensors, closed and open irrigated tip catheters and newer energy sources.

Formation of a line of block across the CTI depends on delivering adequate energy causing thermal coagulation necrosis and dehiscence in a continuous line across the CTI from the tricuspid annulus to the inferior vena cava. Difficulties forming this line are often due to irregular isthmus anatomy causing poor contact and ineffective lesion formation. A common approach to deal with this is to deliver high energies to produce deeper lesions. The current method of doing this is to increase the power output using standard RFA generators, large tip catheters, and irrigated tip catheters.

Success rates are uniformly good, ranging from 80 to 100% [1], with complication rates for this form of ablation up to 5% [2]. However, it seems the methods that deliver higher energies through large tip catheters require fewer applications and shorten procedure time. Various ablation protocols with different power and temperature settings have been used.

However, the optimum setting for power delivery using temperature controlled ablation has not been established, with the maximum reported energy being 100 W [3]. Therefore, we wished to assess the efficacy and safety of using 8-mm-tip standard radiofrequency (RF) ablation catheter and up to 150 W during temperature controlled CTI ablation. We present a retrospective review of the first 50 cases using this approach.

Methods

A retrospective review of the first 50 new cases for a single operator (I.C.) from 1999 to 2003. Equipment included the EPT-1000XP RF generator (EP Technologies Inc, San Jose, CA, USA) and the EPT large curve 8-mm tip electrode catheter (EP Technologies Inc). Ablation temperatures were regulated to 60–65 °C but maximum delivered energy of up to 150 W was permitted for duration of 50 s per ablation. All cases were performed using the anatomical approach for CTI ablation from the right femoral approach by forming a line of radiofrequency ablations from the tricuspid valve annulus to the inferior vena cava. We used two cutaneous dispersive electrodes. Indications for the procedure were either typical atrial flutter alone or atrial flutter and occasional fibrillation. No combined procedures were included such as pulmonary vein isolation with an isthmus line. If there was no clear bi-directional block at the end of the first line then ablations were selectively placed in areas of residual conduction as indicated by the absence of split potentials during flutter or proximal coronary sinus pacing. Failing finding the gap, a new line or lines were placed. Demographic data were collected including the presence or absence of heart disease or hypertension (HTN).

Data were collected on indication, acute success, immediate complications, case duration, number of ablations performed, number of isthmus lines formed, fluoroscopy times, radiation dose, pop incidence, and maximal wattage achieved. In the first 11 cases the criterion for success was unidirectional block, termination of flutter and non-inducibility. After December 1999, bi-directional block was used as the criterion for success. Complications were defined as pops, pain, or other adverse events during the case. Catheter coagulum was not routinely checked during the ablation procedure. Fluoroscopy times and radiation dose were measured from an in-tube exit dose dosimeter. Case duration was the total time the patient spent in the laboratory. The patients were then cross-referenced with the angiography and angio-plasty database to look for evidence of right coronary artery disease or injury associated with the procedure. Descriptive statistics were applied for analysis. Mean and interquartile ranges are given for non-normal distributed values.

Results

The mean age of the patients was 52.9 ± 14.3 years, male 88%, 46% had HTN, and 52% had minor structural heart disease on echocardiography such as left atrial enlargement, none had major functional impairment. One patient had a previous heart transplant. The indications for ablation were pure atrial flutter in 34% and predominantly flutter with at least a single episode of fibrillation or atrial tachycardia in 66%. Acute procedural success rate was achieved in 94% with the three failures occurring in the first 11 patients and no acute failures in the last 39. Three cases had late relapse (6%) and returned for repeat flutter ablation. One case was before bi-directional block became established, one was in AF at the completion of the procedure and bi-directional block could not be proven, and the third had proven bi-directional block at the end of the first procedure. Therefore,
the long-term success rate for a single treatment for flutter is 88% for all patients in this study, but 95% (37/39) in those with proven bi-directional block at the end of the procedure. The median maximum energy delivered was 142 W, only six reached 150 W, but 42 (84%) achieved greater than 100 W during the ablation. The median energy at the time of pop was 113 W (range 49–300), tip temperature 56 °C (52–64), impedance 82 Ω (71–96), and duration of the ablation before the pop was 25 s (18–30). All the pops occurred at the ventricular end of the line or in the mid-isthmus. None experienced a significant complication such as cardiac perforation or tamponade, and there were no other complications such as a cutaneous burn or myocardial infarction. Only one patient required a coronary angiogram after the procedure for chest pain that pre-dated his flutter ablation, which demonstrated no significant coronary stenosis or thrombus in the region of the cavotricuspid isthmus.

### Discussion

Successful ablation of typical atrial flutter requires the formation of a continuous RF line across the CTI forming bi-directional block. The cavotricuspid isthmus has a highly variable anatomy with ridges and valleys. Isthmus length is an average of 30–35 mm in most patients [4,5] and intracardiac echocardiography shows the isthmus to be thicker anteriorly than mid or posteriorly and with more marked pouching septally, and more trabeculations laterally [4]. This inhomogeneity can make it difficult to maintain good endocardial contact and deliver effective energies when forming a continuous line during radiofrequency ablation. Higher energies can be used to affect a more effective isthmus line of block by forming larger and deeper lesions [6].

Our acute success rate and recurrence rate of 94% and 6% is similar to published rates of 85.8%–93% with a recurrence rate of 14.7% [3,7]. Other studies of 8-mm tip have a similar success rate of 92% [8]. The three acute failures occurred very early in our series and may reflect the learning curve experience of any new procedure. Other ablation technologies have been applied to the ablation of atrial flutter most noticeably irrigated catheters. The use of irrigated tip catheter is associated with equal efficacy as 8-mm tip conventional catheters but requires fewer applications and shorter procedure times [9–11]. Recently cryotherapy has been used to ablate flutter [12] but experience is limited.

Higher energies are also potentially associated with a higher risk of complications that can include coronary artery injury [13,14], pops, and cutaneous burns via incorrectly adhered RF patches [15]. In this series, there was a high incidence of the pop phenomenon with 12% of patients experiencing an uncomplicated pop. Excessive tissue temperatures over 105 °C cause “Pops” which are audible explosions due to the vapourisation of intracavity blood or myocardium. This produces barotrauma and tissue disruption that is usually clinically benign but may cause rupture of thin-walled structures with subsequent pericardial tamponade, usually requiring emergency pericardiocentesis, and/or surgical repair. Few papers on ablation of atrial flutter report the incidence of pop, those that do give an incidence of 0–5% [9,16]; however, a recent paper reports a rate of 10–15% with cooled catheters and standard power [17]. Though some report the incidence of coagulum in ablation with 8-mm tips, which is also associated with temperatures in excess of 100 °C, as 2–8% [9,10,18]. Without mapping or intracardiac echo guidance the anatomical model of ablating CTI dependant flutter can cause difficulties knowing the exact location of the ablation catheter at all times, especially around the midpoint of the line and at the IVC end. The risk of pop around the coronary sinus remains high when ablating near the os.

### Conclusion

Performing CTI ablation with an 8-mm tip electrode and setting of 150 W maximum delivered energy in temperature regulated ablation allowed
higher energies (>100 W) to be delivered in most patients. This resulted in good acute and long-term success rates that compared well with the literature. The use of high-watt temperature controlled ablation appears safe in regions of thick and trabeculated myocardium to achieve deeper lesions in areas such as the anterior isthmus and may be an alternative to other, more expensive, technologies while utilising standard equipment. It is no more effective than irrigated catheter technology and is associated with a similar pop incidence. Care should be taken to reduce temperature and power output near thin-walled structures to minimise the risk of vapourisation and pop.

Addendum

The 54th case of our atrial flutter series sustained a pop that caused perforation and pericardial tamponade requiring emergency thoracotomy and repair. It occurred while revising a line of ablations near the septal border of the isthmus and the pop was found to have caused a rupture near the coronary sinus os. The patient survived and is free of atrial flutter.

References