Minimally invasive off-pump video-assisted endoscopic surgical pulmonary vein isolation using bipolar radiofrequency ablation – preliminary report

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Abstract

Background: Atrial fibrillation (AF) is the most common arrhythmia, having a strong impact on long-term stroke and heart failure prevalence and mortality. Nowadays, rapid development in the field of minimising the invasiveness of surgical ablation of AF can be observed.

Aim: To report on the feasibility and early results of the first Polish experience with a novel technique of minimally invasive video-assisted beating heart bilateral surgical ablation for lone paroxysmal AF using irrigated bipolar radiofrequency technique.

Methods: Between February and December 2006, 6 patients with highly symptomatic paroxysmal AF, resistant to pharmacological treatment, underwent video-assisted beating heart bilateral pulmonary vein isolation using irrigated bipolar radiofrequency combined with vein of Marshall dissection and left atrial appendage closure. In 2 patients at least 2 unsuccessful percutaenous ablations had previously been performed.

Results: There were no complications. Ablation time was on average 88±12.1 seconds. At least one recurrence of AF was observed in 4 patients in the early postoperative period; in 3 of them an electrical cardioversion was performed. All patients were discharged home in stable sinus rhythm. Three patients have exceeded 3 months' observation; one has reached 6 months of observation. All are in stable sinus rhythm and the follow-up course is uneventful.

Conclusions: Minimally invasive video-assisted beating heart bilateral surgical ablation for lone paroxysmal AF using irrigated bipolar radiofrequency is effective and safe. These promising results have to be confirmed by larger studies.

Key words: lone atrial fibrillation, surgical ablation, minimally invasive, off-pump, endoscopic

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Introduction

Atrial fibrillation (AF) is the most common arrhythmia, affecting 0.4% of the general population, with the prevalence rising rapidly with age, reaching 6% in subjects >65 years of age, and 9% in those >70 [1, 2]. The arrhythmia has a strong impact on long-term risk of stroke, heart failure prevalence and mortality [3-5]. It is believed that up to 45% of patients with AF have lone AF [6]. Nowadays, rapid progress towards minimising the invasiveness of surgical ablation of AF can be observed [7, 8]. Thoracoscopic approaches and new ablation tools capable of creating effective transmural lesions on a beating heart were developed [9]. Pulmonary vein isolation, both percutaneous and surgical, has become a standard therapy for paroxysmal AF and has been shown to be more effective than antiarrhythmic pharmacological therapy, which in addition is associated with significant adverse effects [10].

The aim of this paper is to report on the first Polish experience with the novel technique of minimally invasive video-assisted beating heart bilateral surgical ablation for lone paroxysmal AF using irrigated bipolar radiofrequency (RF) ablation.

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Methods

Patients

Between February and December 2006, six patients with highly symptomatic paroxysmal AF, resistant to pharmacological treatment, were admitted to our department. In two patients at least two unsuccessful percutaneous ablation procedures had been performed in the past. All patients were on prolonged antiarrhythmic drug treatment before hospitalisation. Patients' demographic and clinical data are given in Table I.

All patients underwent before surgery thorough clinical evaluation, chest X-ray, standard ECG, Holter ECG, echocardiography including transoesophageal echocardiography (TEE) in order to exclude intracardiac thrombus, and coronary angiography. Oral anticoagulation was stopped at least 5 days before surgery and the patients were switched to low molecular weight heparin. All patients were informed in detail about all the aspects of surgery and post-operative treatment and they signed an informed consent form for the procedure and the follow-up visits.

Ablation system

An irrigated bipolar RF ablation system (Cardioblate BP, Medtronic, Minneapolis, MN, USA) consists of a disposable handpiece and a power generator. The head can be rotated 300 degrees and angled up to 90 degrees, allowing proper adjustment and facilitating placement in the surgical field. The malleable jaws can be shaped so that they conform to the anatomy of the target tissue and the shape of the desired lesion. In two patients the pre-shaped low-profile "LP" model was used. During ablation, the surface of the tissue is continuously irrigated with saline through the porous polymer electrodes located within the 5 cm long jaws. Power is supplied by a stepwise-increasing algorithm until a plateau in the impedance, predicting transmurality of a lesion, is achieved.

Surgery

The procedure begins with anaesthesia selectively ventilating the left lung. A 5 cm mini-thoracotomy is performed in the antero-lateral chest wall in the 4th intercostal space (ICS). The endoscopic port is inserted through the 6th ICS. A pericardial sack is transected over the phrenic nerve and stay sutures are placed. After dissection of pericardial reflections and eventually the interatrial groove, the bipolar device is clamped around the atrial cuff containing the inflow of the right pulmonary veins. The RF energy is delivered and an encircling ablation line created. Double application is always performed. After placing a pacing wire and drainage, the wound is closed in a typical manner (Figure 1).

Left pulmonary vein (PV) ablation involves single right lung ventilation, repositioning of the patient and 5 cm lateral mini-thoracotomy in the 4th ICS. The endoscopic port is placed through the 6th ICS. After opening the pericardial sack, left PVs encircling ablation, drainage and wound closure are performed as on the right side. The vein of Marshall is dissected and the left atrial appendage is permanently sewn at its base.

Conduction block validation is always performed by pacing the PV distally to the ablation site (Figures 2 and 3).

Follow-up protocol

In cases of peri-operative AF, medical therapy with amiodarone and/or beta-blockers or electrical cardioversion was instituted. If a patient experienced further rhythm instability (more than two AF episodes), amiodarone was continued but not longer than for

Table I. Demographic and clinical data of the studied patients

Parameter	Value
Number of patients	6
Age [years]	66.3±8.31
Gender (Male/Female)	2/4
AF duration [months]	54±28.14
Failed percutaneous ablation	2
History of electrical cardioversion	4
History of pharmacological cardioversion	6
Pre-operative use of antiarrhythmic drugs	6
Arterial hypertension	5
Diabetes	1
History of thrombo-embolic event	none
Left atrial diameter [mm]	44.5±0.5
Left ventricular ejection fraction [%]	62.5±5.5

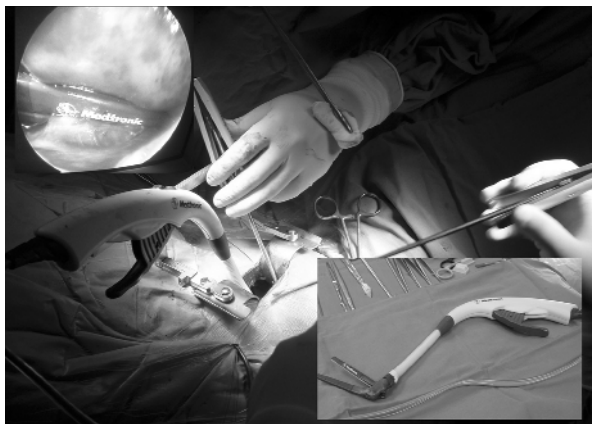

Figure 1. Endoscopic view of right pulmonary vein isolation with the bipolar radiofrequency device

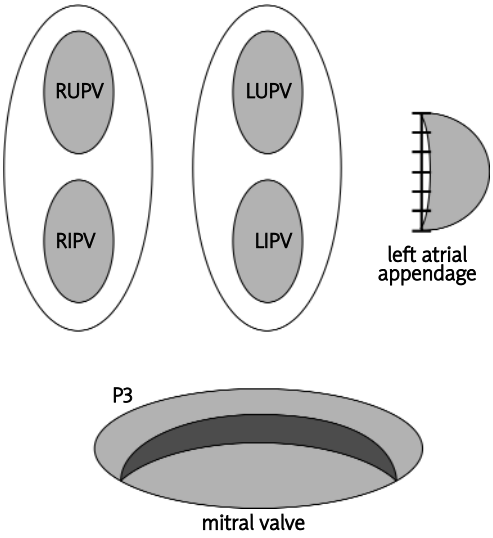

Figure 2. Ablation lines pattern

RUPV – right upper pulmonary vein, RIPV – right inferior pulmonary vein, LUPV – left upper pulmonary vein, LIPV – left inferior pulmonary vein

Figure 3. A patient 10 days after the procedure

three months. At discharge, 24-h Holter ECG and echocardiography were performed in all patients. All patients received anticoagulation therapy for a minimum of three months. Patients who remained in stable sinus rhythm without antiarrhythmic drugs three months after surgery were weaned from anticoagulants and received aspirin. At three and six months post-surgery, 24-h Holter ECG, echocardiography, physical examination and clinical evaluation were carried out.

Results

There were no complications or conversion to the open-chest procedure. The procedure duration was approximately 2-2.5 hours, showing a steep learning curve. The mean ablation time was 88±121 seconds. Five patients were extubated within 2 hours from surgery whereas the remaining patient with pre-operative advanced circulatory failure required prolonged ventilation till the second post-operative day.

All patients were admitted to the intensive care unit in sinus rhythm. At least one episode of AF was observed in four patients in the early postoperative period; in three of them electrical cardioversion was performed and in one sinus rhythm was restored following low-dose amiodarone infusion. In these patients oral amiodarone in a dose of 200 mg per day for 3 months was administered. All the patients were discharged home in sinus rhythm.

A three-month follow-up was completed in four patients and one patient reached six months of observation. All patients remain in stable sinus rhythm and no major cardiac events were noted during this period.

Discussion

Atrial fibrillation is a disease strongly influencing long-term outcome, including morbidity and mortality, both in the general population and in patients after cardiac surgery [3, 10]. It is believed that over 2.2 million people in the US suffer from AF (160 000 new cases per year), which means that the number of AF patients in Poland exceeds 200 000 [1]. At the same time, only approximately 300 percutaneous procedures of AF ablation have been performed in Poland. Even in the richest countries like the US, the number of AF patients exceeds and will exceed many times the technical possibilities of the treatment, even if only some subgroups of patients are selected for ablation.

Surgery can offer an alternative solution for the treatment of lone AF, but only when the results will be equal or better than those achieved using less invasive percutaneous procedures. As far as the safety is concerned, surgery can give new quality in comparison to percutaneous procedures, where the complication rate remains relatively high and should be lower, having in mind the relatively harmless type of disease that is treated [11, 12]

On the other hand, the procedure presented in this paper through two small incisions is still an operation. So far, only two initial series of patients have been described, but the results are promising [8, 13]. First of all, it is an important step towards the complete elimination of surgical wounds, which remains, apart from efficacy and safety, one of the main goals of contemporary cardiac surgery. From the technical point of view, the procedure is rather difficult, but new devices soon to appear on the market hopefully will offer a less invasive and less complex approach to the surgical treatment of AF. In this way, the technique will become more popular.

The number of patients treated in our centre is obviously too small to discuss the efficacy of the

procedure; however, there are growing data from the literature showing superiority of the bipolar devices over the unipolar ones [14]. This finding may be particularly important for the beating-heart procedures as well as for percutaneous ablation, regarding lesion transmurality. The 20 years of surgical experience with different energy sources and techniques for AF treatment should not be underestimated. Numerous studies have shown that beating heart, off-pump ablation very often is not transmural, which has been proven to be one of the most important factors influencing success rates [15]. Until today, creating a contiguous, transmural line using percutaneous techniques remains challenging [16].

One of the strongest benefits of the presented procedure is left atrial appendage exclusion, which is a source of thrombogenic material in more than 90% of patients, and can have a potentially protective effect in patients with sustained AF [17]. Other potential benefits of the surgical procedure described in this paper include reduced procedural time, no need for repeated procedures, no fluoroscopy, no drug-related side effects, direct visualisation of the myocardium and the possibility for targeting of multiple potential mechanisms of AF such as autonomic ganglia, Marshall fold dissection or ectopic foci.

The presented technique in the current state is not going to replace the elegant and still improving percutaneous AF ablation; however, it uses the best energy source developed so far, which is bipolar radiofrequency ablation. It can be used safely and with minimal invasiveness in more and more patients with AF. Clinical implementation of this method is at the very beginning, but the indications for its usage should already be discussed between cardiologists and cardiac surgeons. One possible indication could be failed percutaneous AF ablation – in such cases surgery offers high efficacy, which is not always the case with redo percutaneous procedures.

Surgery is currently the most effective tool for the treatment of AF coexisting with other cardiac pathologies, reaching an efficacy of over 90% in patients with permanent AF [7, 18-20]. Maximal reduction of surgical invasiveness without compromising procedural efficacy is the main goal of this new, rapidly developing technique.

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Małoinwazyjna wideoskopowa izolacja żył płucnych z zastosowaniem irygowanej dwubiegunowej elektrody prądu częstotliwości radiowej bez użycia krążenia pozaustrojowego w leczeniu samoistnego napadowego migotania przedsionków

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Streszczenie

Wstęp: Migotanie przedsionków (AF) to najczęstsza klinicznie istotna arytmia serca, występująca u 0,4% populacji ogólnej. Obecnie obserwuje się szybki rozwój w dziedzinie minimalizacji inwazyjności w kardiochirurgii, w tym ablacji AF. Wynaleziono bardzo skuteczne urządzenia ablacyjne w układzie dwubiegunowym, mające unikatowe systemy kontroli ablacji i obiektywnego potwierdzenia „przezścienności" powstałej blizny, a także techniki torakoskopowe umożliwiające ich zastosowanie w sposób mało inwazyjny. Izolacja żył płucnych stała się procedurą standardową w leczeniu napadowego AF z zastosowaniem zarówno technik przezskórnych, jak i chirurgicznych. Wykazuje ona znaczną wyższość nad leczeniem farmakologicznym, które wiąże się z istotnym obciążeniem efektami ubocznymi.

Cel: Zaprezentowanie pierwszych polskich i jednych z pierwszych na świecie doświadczeń w mało inwazyjnej wideoskopowej izolacji żył płucnych z zastosowaniem irygowanej dwubiegunowej elektrody prądu częstotliwości radiowej bez użycia krążenia pozaustrojowego w leczeniu samoistnego napadowego AF.

Metoda: Pomiędzy lutym a grudniem 2006 r. u 6 pacjentów z wysoko objawowym, opornym na leczenie farmakologiczne, napadowym AF wykonano mało inwazyjną wideoskopową izolację żył płucnych z zastosowaniem irygowanej dwubiegunowej (bipolarnej) elektrody prądu częstotliwości radiowej bez użycia krążenia pozaustrojowego, chirurgiczną dyssekcję więzadła Marshalla oraz zaszycie uszka lewego przedsionka. U 2 pacjentów wykonano wcześniej co najmniej 2 nieskuteczne przezskórne ablacje AF. Zabieg polegał na wykonaniu dwóch 4–5 cm minitorakotomii bocznych, a następnie – po otwarciu worka osierdziowego – wprowadzeniu urządzenia do dwubiegunowej ablacji prądem częstotliwości radiowej Medtronic Cardioblate BP2 lub Cardioblate LP w okolicę żył płucnych. Urządzenie umieszczano epikardialnie, tak aby odpowiednio prawe, a następnie lewe żyły płucne znalazły się pomiędzy jego branszami, by ablacja następowała możliwie daleko na mięśniówce przedsionka. Zawsze potwierdzano blok przewodzenia z żył płucnych. Następnie wykonywano dyssekcję chirurgiczną więzadła Marshalla i zaszycie uszka lewego przedsionka.

Wyniki: Nie zanotowano powikłań, nie zaistniała potrzeba konwersji dostępu przez sternotomię ani użycia krążenia pozaustrojowego. Czas ablacji wynosił 88±12,1 s. Całkowity czas zabiegu wynosił 2–2,5 godz. ze stromą krzywą uczenia. W okresie okołooperacyjnym u 4 na 6 chorych wystąpił napad AF, u 3 z nich wykonano kardiowersję elektryczną, u 1 pacjenta rytm zatokowy powrócił samoistnie. Wszyscy pacjenci zostali wypisani ze szpitala ze stabilnym rytmem zatokowym. Trzech pacjentów osiągnęło 3-miesięczny okres obserwacji, 1 osoba okres 6-miesięczny. U wszystkich utrzymuje się stabilny rytm zatokowy (bez typowych leków antyarytmicznych). Nie zanotowano niepożądanych zdarzeń sercowo-naczyniowych.

Wnioski: Mało inwazyjna, torakoskopowa izolacja żył płucnych z zastosowaniem irygowanej dwubiegunowej (bipolarnej) elektrody prądu częstotliwości radiowej w leczeniu objawowego, opornego na terapię farmakologiczną, samoistnego napadowego AF jest metodą powtarzalną i bezpieczną. Zachęcające wyniki wstępne muszą być potwierdzone na większej grupie chorych w obserwacji odległej.

Słowa kluczowe: migotanie przedsionków, mało inwazyjna ablacja chirurgiczna, ablacja endoskopowa

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