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Review article – *Special issue: Surgery treatment of atrial fibrillation*

**The current technical options for minimally invasive surgical treatment of atrial fibrillation**

V. Kurfirst <sup>a,\*</sup>, A. Mokráček <sup>a</sup>, P. Budera <sup>b</sup>, Z. Straka <sup>b</sup>, M. Pojar <sup>c</sup>, J. Harrer <sup>c</sup>

<sup>a</sup> Department of Cardiac Surgery, Hospital of České Budějovice, Czech Republic

<sup>b</sup> Cardiocenter, Clinic of Cardiac Surgery, 3rd Faculty of Medicine, Charles University, and University Hospital Kralovske Vinohrady, Prague, Czech Republic

<sup>c</sup> Clinic of Cardiac Surgery, Charles University, Faculty of Medicine and University Hospital in Hradec Kralove, Hradec Kralove, Czech Republic

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ABSTRACT

Minimally invasive surgical treatment of AF as well as technical tools and instruments are still evolving. The most suitable patients for this method are the patients with persistent and long-persistent AF. This article describes mini-invasive surgical methods and tools for treatment of atrial fibrillation available on the Czech market nowadays.

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\* Corresponding author at: Department of Cardiac Surgery, Hospital of České Budějovice, Boženy Němcové 54, České Budějovice 37001, Czech Republic.

E-mail address: [vojtech.kurfirst@post.cz](mailto:vojtech.kurfirst@post.cz) (V. Kurfirst).

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## Introduction

The Cox-maze procedure was developed by James Cox, M.D. as an open-heart cardiac surgery procedure to eliminate atrial fibrillation (AF) in 1987. It consisted of specific series of surgical incisions arranged in left and right atria that terminate in incisional scars after couple of weeks [1]. These scars can electrically block atrial macroentry circuits resulting in elimination of AF, but with preservation of atrial contractility and atrio-ventricular conduction. This original and genius concept is so called Cox maze III or the “cut and sew maze” or the “maze” and its idea has been projected to all present non-conservative treatments of AF.

Since all of the lesions were originally made by surgical incisions and the procedure needs to be done from full sternotomy and by using cardiopulmonary bypass this approach was practically excluded from treatment options of lone AF. Further efforts have been therefore made to reduce surgical complexity and invasiveness of the procedure. In late 1990s, radiofrequency, cryoenergy, microwave and other energy sources were developed to simplify the cut and sew maze. These energies have enabled to make specific scars in both atria by epicardial approach and to shift cardiac surgery toward modern minimally invasive AF ablation surgery. The main goals were to avoid sternotomy and the use of cardiopulmonary bypass by using thoracotomy or thoracoscopic off-pump epicardial approaches.

In 2003, Saltman reported a totally endoscopic microwave ablation procedure using bilateral access in patients with paroxysmal AF [2]. In 2004, Loulmet and coworkers firstly reported off-pump robotic endoscopic pulmonary vein isolation using microwave energy in patients with chronic AF [3]. In 2005, Wolf published his initial experience with bilateral video-assisted minithoracotomy AF surgery [4]. In the next period efforts of many surgical teams were leading to improve and develop these firstly described approaches. Surgeons used to operate from sternotomy had to deal with new types of complications such as postoperative pneumonia, hemothorax, left atrial injury requiring conversion to open thoracotomy/sternotomy or phrenic nerve injury.

Nowadays, the terms minimally invasive surgical treatment of atrial fibrillation or mini-maze should be used in following conditions:

1. Thoracoscopic or minithoracotomy access.
2. Avoidance of cardiopulmonary bypass.
3. Ablation lines are made epicardially by using radiofrequency energy, cryoablation, microwave energy of high-intensity ultrasound, usually with use of specially intended devices and catheters.

In general, minimally invasive surgical procedures for AF treatment usually consist of:

1. Isolation of pulmonary veins.
2. Creating a “box lesion” (i.e., isolating all pulmonary veins together with posterior left atrial wall).
3. Creating of other lesions in left (or also right) atrium, such as mitral line, line to LAA, cavotricuspid line, intercaval line,

caval veins isolation etc.; importantly, such lesion are usually reported with lower success rates than PVI, therefore, they may be checked, completed or created by subsequent catheter, endocardial ablation (hybrid approach).

4. Occlusion of the left atrial appendage.

The purpose of this article is to describe devices and catheters used in minimally invasive treatment of AF, that are currently accessible and used on Czech departments of cardiac surgery and also the courses of surgical procedure are covered.

## Devices and procedures

Descriptions of three mostly used types of procedures (and used devices) are presented in the following section.

### AtriCure

Surgery is performed under general anesthesia with a double lumen endotracheal tube for selective lung ventilation and external defibrillation pads are placed on intended positions. The procedure starts on the right side with placement of endoscopic tools: a 10-mm camera port in the right fifth intercostal space mid-axillary line, a 5-mm working port placed in the third intercostal space anterior axillary line and a 10-mm working port placed in the seventh intercostal space mid-axillary line. Using single-lung ventilation, the pericardium is opened anterior to the phrenic nerve from the superior vena cava to the diaphragm and gently pulled with three stitches. The interatrial groove is dissected with endoscopic scissors as well as the access to the oblique sinus between the inferior vena cava and the right lower PV. An articulating and illuminating dissector (LumiTip Dissector, AtriCure, OH, USA) is used to surround the right PVs with a rubber tourniquet which is subsequently utilized as a guide for the insertion of the ablation clamp (Isolator Synergy, AtriCure, OH, USA) (Fig. 1). A series of ablations (minimally five times) of the right PVs is performed for electrical isolation, and entry block is verified. A roof line (connecting superior right-sided and left-sided PVs) and bottom (or floor) line (connecting inferior right-sided and left-sided PVs) are made using a linear pen device (Bipolar Linear Pen, AtriCure, OH, USA) (Fig. 2). In our series, an

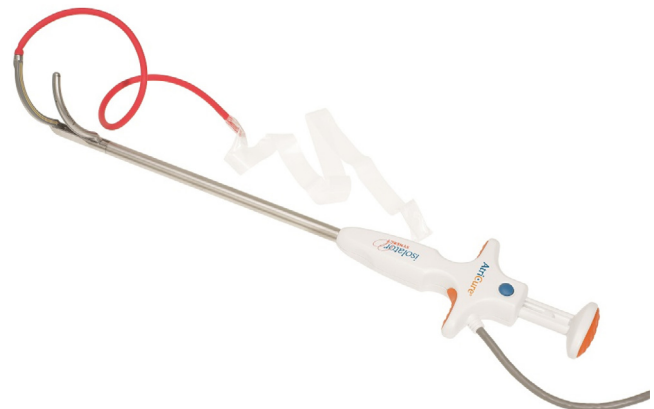


Fig. 1 – AtriCure bipolar clamps.

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