CRYOABLATION FOR SIMULTANEOUS SURGICAL TREATMENT OF ATRIAL FIBRILLATION AND VALVULAR OR ISCHEMIC HEART DISEASES – OUR EARLY EXPERIENCE IN VARNA

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ABSTRACT

Atrial fibrillation (AF) is a problem with rising frequency and importance in developed countries. The consequences of that condition are a significant medical, social and economic problems: high risk of development of heart failure, ischemic stroke, decreased quality of life and lowered life expectancy. With the development of theoretical knowledge and technical means in medicine, new surgical methods have been established and validated for the treatment of AF, among them is cryoablation. We present our early experience with the concomitant treatment of AF with cryoablation for patients undergoing surgical treatment of coronary artery disease (CAD), mitral and aortic valvular pathology. The system used for cryoablation uses nitrous oxide (N₂O). The results from patient follow-up show high effectiveness of the procedure even in the initial phase of mastering the skill.

Keywords: AF, cryoablation, simultaneous surgical treatment, concomitant surgical treatment

INTRODUCTION

Atrial fibrillation (AF) is the most frequent heart arrhythmia affecting 1-2% of the population (5). It is characterized by chaotic electrical activation of the atrial myocardium. It has a frequency of 300-600 beats per minute (bpm). This leads to:

• Loss of effective mechanical contraction of the atria and reduction of the stroke volume of the heart;
• Ventricular tachycardia with a frequency of 100-160 bpm if there is normal atrioventricular conduction;
• Blood stagnation and aggregation in the atrium, thrombus formation, and embolization (9).

AF leads to hemodynamic disturbances, thromboembolic incidents, myocardial injury, lowered functional...
Mechanism of AF
External stressors like structural heart disease, hypertension, probably diabetes, but also AF itself induce slow but progressive process of structural remodelling of the atria (3). Two are the mandatory components for development of AF: induction of foci of ectopic excitation, called triggers, and a substrate, which supports the trigger. Anatomical areas from which the triggers most commonly start are the areas around: pulmonary veins, superior and inferior vena cava ostia, and coronary sinus. The premature activation, increased volume of the atria and changes in conduction speed of impulses increase the probability of occurrence and persistence of AF.

Arrhythmogenic circles are formed in the atria and their activity is self-maintained (“macro re-entry”). The condition slowly progresses from a single episode of arrhythmia to long-standing persistent AF (7).

Surgical Treatment of Atrial Fibrillation
Thorough and continuous experimental research at Washington University of Saint Louis, USA, under the guidance of J. Cox, in 1987, led to the introduction of the Maze procedure. The procedure is based on the „cut and sew“ technique by making multiple incisions through the atria. Created lines of scar tissue interrupt re-entry circles, prevent AF and atrial flutter by directing impulses from the sinus node to a specific path (maze). So called Cox-Maze procedure achieves

| AF Type               | Definition                                                                 |
|-----------------------|-----------------------------------------------------------------------------|
| Newly diagnosed       | AF, which has not been diagnosed until now                                  |
| Paroxysmal AF         | Episodes of AF stop spontaneously within 48 hours. Some episodes may take up to 7 days |
| Persistent AF         | AF lasting more than 7 days, including episodes terminated by cardioversion after 7 days or more |
| Long-standing persistent AF | Long-standing persistent AF for 1 year or longer when a rhythm control strategy is selected |
| Permanent AF          | AF, which is acknowledged and accepted by the patient (and the physician). Therefore, rhythm control interventions do not apply to patients with permanent AF |
Lечение на ПМ чрез криоаблация

В основата на успешната абляция на ПМ стои създаването на трансмурални микокарди лезии, които блокират пропагацията на вълните на ПМ. Криоабляцията постига това чрез охлаждане, като се прилага на предсърдия до температура около -80°C. Intracellular crystals are formed and destroyed in the cell membrane, interrupting cell metabolism and electrical conduction. Cells are completely destroyed, but not the intracellular matrix, so the cryolesion has minimal thrombogenicity (4). According to the literature, the effectiveness of the procedure is high - over 90% of patients are without AF on the sixth month. There is no increase in surgical mortality, and aortic cross-clamp time is significantly shorter than with the Cox-Maze III procedure.

OBJECTIVES AND TASKS

In 2015, surgical cryoablation for the treatment of AF was first applied at the Department of Cardiac Surgery, St. Marina University Hospital, Varna. In this article we present our initial experience with this procedure in patients undergoing elective operation for valvular or coronary pathology. We evaluate the benefits of the procedure based on its efficiency and safety. Indicators for this are the successful recovery of SR and the low mortality rate in 1-year follow-up.

MATERIALS AND METHODS

From November 2015 to date, cryoablation has been performed in 17 patients with AF simultaneously with another cardiac procedure. The information is col-
ЦЕЛ И ЗАДАЧИ
През 2015 г. за пръв път в България в Клиниката по кардиохирургия към УМБАЛ „Света Марина“ – Варна се прилага хирургична криоаблация за лечение на ПМ. В тази статия представяме нашия начален опит с тази процедура. За да оценим ползата от процедурата, най-важни критерии са ефективността и безопасността на метода. Показатели за това са успешното възстановяване на СР и смъртността.

МАТЕРИАЛИ И МЕТОДИ
След ноември 2015 до изготвянето на тази статия криоаблация е направена на 17 пациенти с ПМ едноетапно с друга сърдечна процедура. Информацията е събрана проспективно от „История на заболяването“ по време на вътреболничния престой и от следоперативни контролни прегледи.

Индикациите за оперативно лечение са поставени след клинично и инвазивно изследване на болниите. Противопоказания за проведение на криоаблация са размер на лявото предсърдие над 60 мм; тежко общо състояние, непозволяващо увеличаване обема на оперативната интервенция. След подписване на информирано съгласие, пациентът бива приведен в операционната зала. Стандартно се подготвя оперативното поле. Осъществява се срединна стернотомия и перикардиотомия. Пациентът се хепаринизира, канюлират се аортата и две празни вени, начало на екстракорпорално кръвообращение (ЕКК). Инфузира се кардиоплъгичен разтвор. Медиана на температурата е 34 - 32°C. Всяка абляция линия продължава 2 минути. Съществува риск за образуване на тромби на мястото на абляцията. За предотвратяване на тромбообразуването изолира се лявата атриовентрикуларна жлъчка и лявата атриовентрикуларна жлъчка след абляцията. В 15 пациенти е направена абляция на стеничната жлъчка. В 13 пациенти е направена абляция на стеничната жлъчка след аортната кръвозагуба и аортната кръвозагуба.

Изследванията се свързват с дълготрайни контроли на пациентите. Методи на изследване включват ехокардиография, автоматична ехокартография, магнитно-резонансна томография и кардиоинтермитентен контрол. Пациенти, излечени в рамките на операцията, имат подобни резултати на контролите от 1 до 48 месеца след абляцията. Основната цел на операцията е постигане на СР без необходимост от антиаритмични медикаментозни терапии.

Изходите от процедурата са отчитани в българските регистри на болници. Възстановяването на СР се определя чрез графично контролиране на сердечно-легените показатели. Резултатите са стабилни по време на месец след абляцията.

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trocardiography (ECG). A series of 12-channel ECG, a postoperative ECG with atrial epicardial electrode, and a 24-hour Holter ECG before discharge from the hospital were performed. ECG was recorded preoperatively, postoperatively, before discharge, and on the check-ups. The echocardiogram evaluated the structure and function of the atrium, the left atrial appendage and the presence of thrombi.

RESULTS
Cryoablation was performed in 17 patients, the data for whom are shown in Table 2. The indications for elective cardiac surgery are shown in Table 3. The type of AF was paroxysmal in 8, persistent in 8, and long-standing persistent in one, lasting from 1 month to 11 years.

The mean aortic cross-clamp time was 91 minutes (53 to 127 minutes). The mean CPB duration was 142 minutes (103 to 206 minutes). At the end of the operation, 14 patients had sinus rhythm. One patient died in the early post-operative period. Patient extubation was between 5 and 48 hours postoperatively (mean 9 h). The postoperative blood loss was 1324mL (760 to 2710mL) on average. Postoperatively, all patients received acenocoumarol therapy for at least 3 months, regardless of the rhythm. Amiodarone treatment was started in 10 patients - during the operation or in the ICU. Nine of the patients received inotropic support (dopamine - 7, adrenaline - 3, arterenol - 3, dobutamine - 1, milrinone - 1) postoperatively. The postoperative complications were as follows: pericardial effusion leading to drainage - 1; left pleural effusion - 1; bilateral pleural effusion - 1; reexploration for bleeding, hemorrhagic shock and lethal outcome - 1; ischemic stroke - 1; ventricular tachycardia - 1. The average hospital stay was 19 days.

Heart Rhythm Follow-Up
Conduction disorders observed in the post-operative period are summarized in Table 4. A permanent pac-
levopredstved се от лезии за криоаблация и е затворено ухото на ляво предсърдие. При 15 пациента е направен и деснопредсърден сет от лезии за криоаблация. Индикациите за операция са посочени в Табл. 3.

Клампажното време на аортата средно е 91 мин (53 до 127 мин). Продължителността на ЕКК средно е 142 мин (103 до 206 мин). В края на операцията 14 пациенти са били в синусов ритъм. В ранния следоперативен период един пациент екзитира. Екстубацията на пациентите е осъществена между 5 и 48-и следоперативен час (медиана 9 ч.). Постоперативната кръвозагуба, отчетена от дреновете до отстраняването им, е средно 1324мл (760 до 2710мл). Постоперативно всички пациенти получават терапия с аценокумарол за период поне 3 месеца, независимо от ритъма. Насищане с амиодарон е започнат при 10 пациенти. Девет от пациентите са получили инотропна поддръжка (допамин-7, адреналин-3, артеренол-3, добутамин-1, миринон-1) следоперативно. Постоперативни усложнения: перикарден излив, наложил дренаж – 1; левостранен плеврален излив – 1; левостранен и десностранен плеврален излив – 1; ревизия на медиастинума, хеморагичен шок и екзитус леталис – 1; изхемичен мозъчен инсулт – 1; камера тахикардия – 1. Средният болничен престой е 19 дни. Проследяване на сърдечния ритъм. Наблюдаваните следоперативно нарушения на проводността са обобщени в Табл. 4. При един пациент вследствие на пълен атриовентрикуларен блок преди дехоспитализацията е поставен пейсмейкер. Останалите 15 пациенти са изписани със синусов ритъм. Ритъмът, регистриран при проследяването на пациентите, е представен в Табл. 3. До третия

Table 4. Early postoperative conduction anomalies during in-hospital stay

| CONDUCTION ANOMALIES | NUMBER OF PATIENTS |
|-----------------------|--------------------|
| Right bundle branch block | 3 |
| Left bundle branch block | 1 |
| I degree AV block | 2 |
| III degree AV block | 1 |

AV – atrioventricular

Table 5. Follow-up time postoperatively & rhythm

| POSTOPERATIVE PERIOD (days) | NUMBER OF FOLLOWED-UP PATIENTS | SINUS RHYTM | PACE |
|-----------------------------|---------------------------------|-------------|------|
| 0-30                        | 16                              | 15          | 1    |
| 31-60                       | 15                              | 14          | 1    |
| 61-90                       | 15                              | 14          | 1    |
| 91-120                      | 15                              | 14          | 1    |
| 120+                        | 14                              | 13          | 1    |

It is worth mentioning the fact that two patients with a 10-year AF before surgery had sinus rhythm during the 1 year follow-up after the operation.

DISCUSSION

AF is a socially significant problem associated with high treatment costs and serious health consequences. Increased life expectancy and cardiovascular treatment options are a prerequisite for the increase of the number of patients with AF. Surgical methods have proven their effectiveness and their place in the treatment stated in the guidelines of the European and American Associations for Cardiology and Cardiac Surgery (2,3).

Our experience shows positive results in the early and midterm postoperative period. In the period of accumulation of experience, we find it necessary to stick to clear indications of combining cryoablation with basic cardiac surgery for ischemic or valvular heart disease. There are no clear criteria whether isolated left atrial or biatrial cryoablation should be used. Biatrial ablation may be associated with fluid retention postoperatively. Future perspectives include the possibility of minimally invasive procedures combined with ablation for AF (7,13).

Continuous patient follow-up is needed to determine the duration of the effect of the procedure, also the incidence of cardiovascular events and long-term results. The establishment of additional annual medical examinations and 24-hour Holter ECG monitoring would provide more complete information on the patients’ condition and also provide the possibility of timely response to arrhythmia resumption. Trans-thoracic echocardiography helps to evaluate the atrial function (contraction) when there are no clear ECG criteria for sinus rhythm.
CONCLUSION

The most important conclusion from our experience is that cryoablation is a safe and effective procedure for simultaneous treatment of AF in combination with operative treatment of other heart diseases (coronary heart disease, mitral valve and aortic valve disease). Based on the literature and our experience so far, we believe that in all patients with AF who are undergoing cardiac surgery, the Heart Team should discuss the possibility of a simultaneous cryoablation.

Successful treatment of AF gives a chance for a better quality of life as it achieves more effective cardiac function and avoids the need for lifelong use of anticoagulants and antiarrhythmic medications (15).

Some important issues are still being discussed. It is proven that LV dilatation is a poor prognostic factor and an LV diameter above 60 mm is an exclusion criterion for ablation. However, different centers around the world have published that they have successfully solved this problem by combining left ventricular reduction plasty with ablation (6,14). The solution to this problem allows more patients to benefit from ablation treatment.

The duration of AF is another important prognostic criterion. Our experience shows success in the treatment of persistent and long-standing persistent AF by cryoablation.

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Cryoablation for Simultaneous Surgical Treatment of Atrial Fibrillation and Valvular or Ischemic Heart Diseases –
Our Early Experience in Varna

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