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Review article – Special issue: Acute Ischemic Stroke

Cardiac surgery interventions for stroke prevention in patients with atrial fibrillation

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ABSTRACT

Atrial fibrillation (AF) is the most frequent cause of stroke. Surgical ablation of AF presents a rapidly evolving area in cardiac surgery. Concomitant procedures and operations for stand-alone AF have been considered safe and effective in sinus rhythm restoration. Their clinical effect in stroke prevention, as well as the effect of elimination of the left atrial appendage, is less clear. In this article we summarize current cardiac surgery procedures for AF treatment and LAA elimination with special regard to their efficacy in stroke prevention.

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Introduction

Atrial fibrillation (AF) is the most common sustained cardiac arrhythmia with overall prevalence of 1.5–2% in general population [1]. Cerebral vascular events and thromboembolism in general present its most feared complications for patients. The risk of stroke is approximately five times higher with AF compared to patients with sinus rhythm (SR) and its rates are similar in paroxysmal and sustained AF [2]. AF-related stroke is associated with worse outcomes than those occurring in the absence of AF [3], concretely with higher 30-day mortality, worse residual neurological defects, more frequent recurrences and more fatal cases. According to clinical and imaging studies, over 70% of strokes in patients with AF are of cardio-embolic etiology originating from the left atrium. Importantly, more than 90% of left atrial thrombi are found in left atrial appendage (LAA) [4]. In a subgroup of patients with rheumatic mitral valve disease, about 60% of thrombi are localized in LAA, while the risk of stroke is 17 times higher in those patients [5]. Absence of contractions of LAA at AF leads to its imperfect emptying and to stasis of blood in the LAA. Moreover, presence of AF activates coagulation system as well as other processes such as apoptosis or inflammation [6]. Together this underlies thrombi formation with LAA being an ideal spot of origin due to its irregular shape and the trabeculae within.

There are three main approaches to stroke prevention in AF: (1) prevention of clot formation by antithrombotic therapy, (2) physical elimination of LAA as the site of clot formation and (3) elimination of AF, itself. Oral anticoagulant therapy (OAC) is recommended for stroke prevention in patients with AF who have risk factors for stroke, with warfarin reducing the relative risk of stroke by more than 60%. Group of new oral anticoagulants has been shown to have some important advantages in efficacy, and especially in safety and convenience compared to warfarin and should be considered for most patients with AF as a treatment of choice [1]. However, an increased risk of bleeding remains an inherent limitation of any OAC. In past decades, an interventional treatment has greatly evolved in both treating AF itself and also in separate LAA elimination. Furthermore, thanks to technical progress, many of these procedures can be performed through minimally invasive approaches, with smaller operation stress for patients. The aim of this article is to summarize current cardiac surgery procedures for AF treatment and LAA elimination with regard to their efficacy and safety itself and mainly their efficacy in stroke prevention.

Surgical ablation of atrial fibrillation

A supposed solution of eliminating the risk of stroke in AF is elimination of the AF itself. Pharmacological treatment still has its serious limitations in relatively low efficacy and high rates of side effects. The milestone experimental work and publications of Prof. J.L. Cox have started up a rapid expansion of surgical AF ablation and his Cox maze III procedure still presents the most effective method in SR restoration [7] and also the reference standard for other procedures. Some other

important findings were presented in 1998 by Haissaguerre, who highlighted the significant role of pulmonary veins in paroxysmal AF initiation [8]. Thenceforth the pulmonary veins isolation (PVI) is a cornerstone of most existing catheter and surgical ablation techniques, but fortuitously it already has been a part of the original Cox maze lesions 10 years earlier. In last decade, the original cut-and-sew technique has been mostly replaced by alternative energy sources for creating lesions, which made the procedures easier and safer. The most recent modification, Cox maze IV procedure, is performed with usage of bipolar and unipolar radiofrequency (RF), cryo-energy or combination of energies for most lesions. According to data from the most experienced centers, its efficacy in SR restoration and maintenance is very high and persist even in the long-term. Henn et al. have published results of 576 patients who underwent the Cox maze IV procedure between 2002 and 2014. After 5 years, overall freedom from AF was 78% with no difference between paroxysmal and non-paroxysmal AF or between stand-alone or concomitant procedures [9]. Weimar et al. have prospectively followed 100 patients who underwent Cox maze IV procedure with 90% of patients being free from AF after 2 years [10].

Importantly, quality of the postoperative rhythm monitoring strategy is an important issue, when reporting or evaluating data of AF ablation success. It has been repeatedly proven that more precise monitoring reveals more AF paroxysms, which impairs the ablation results. Current HRS/EHRA/ESC guidelines further recommend at least 1 year of the follow-up and a minimum of 24–72 h Holter monitoring or alternatively trans-telephonic monitoring, 30-day auto-event triggered monitoring or outpatient telemetry for reporting outcomes of surgical AF ablation [7].

Concomitant surgical ablation

The Cox maze IV procedure consists of a strictly defined lesions set in both left and right atrium and of LAA resection. It can be performed as a concomitant procedure or also separately for isolated AF, usually through a right minithoracotomy. Both procedures have excellent results [10], but for majority of surgeons, the on-pump stand-alone procedure with cardioplegic arrest is usually considered too invasive. In past decades, many modifications of the maze procedure have been evolved with different lesions sets and energies used, mainly in order to make it more simple but same effective. In a large comparative, retrospective study, Stulak et al. have reviewed a long-term efficacy of different concomitant procedures with usage of different methods for creating lesions in 1540 patients. On multivariate analysis, the cut-and-sew maze procedure was independently associated with less risk of recurrent AF at a follow-up period of 1–5 years and also of more than 5 years, for all patients [11]. However, cryo-energy (Fig. 1) and bipolar RF energy currently represent the most widely used techniques for concomitant AF ablation.

The PVI represents the simplest AF ablation procedure; pulmonary veins can be isolated in pairs, or with a connecting line added in-between the pairs, or all together with a posterior left atrium wall (so-called “box-lesion”). According to some authors, PVI is sufficient for treating paroxysmal AF,

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