



Can hybrid procedure eliminate the gaps of experience in surgical ablation for atrial fibrillation and improve the sinus rhythm maintenance?

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Atrial fibrillation (AF) is a common arrhythmia encountered in clinical practice that contribute to hemodynamic abnormalities, thromboembolic events, cardiomyopathy, hospitalizations, and mortality (1,2). The prevalence of AF is around 1% in the general population, substantially increases with age and is estimated to reach 4% in 2050 (2,3). Haïssaguerre *et al.* (4) and Chen *et al.* (5) demonstrated the pathologic role of pulmonary vein (PV) triggers as being responsible for the arrhythmogenesis of AF. Because of this initial discovery, circumferential PV with electric isolation of all PVs as an endpoint was established as the cornerstone of catheter ablation of AF (1). Radiofrequency catheter ablation is considered as an effective and alternative treatment option for patients with symptomatic paroxysmal AF (1). On the other hand, surgical AF ablation was reserved as an adjunct to open-heart surgery for patients with structural heart disease. The most consistent predictor of late recurrence after catheter ablation is longer duration of AF and non-paroxysmal AF. Other predictors include hypertension, older age, larger left atrial size, diabetes, valvular heart disease, left ventricular dysfunction, the presence of non-PV triggers, and higher thromboembolic risk scores (1,6). Sinus rhythm maintenance after catheter ablation is an important predictor of better long-term outcome among patients with persistent AF and protective factor of late recurrence (7,8).

The surgical procedure was introduced for the treatment

of AF in 1987 by James Cox and the modified procedure has been performed for three decades. The development and innovation of new surgical ablation device and technologies benefited surgical AF ablation by making a technically difficult and time-consuming surgery with traditional cut-and-sew lesions easier for all cardiac surgeons to perform. The simplified Cox-Maze procedure currently provided the optimal long-term outcome in the patients with long-standing persistent AF with 60–73% single-procedure AF freedom rate (9). Additionally, the simplified Cox-Maze procedure lessened the procedural morbidity thus leading to wider adoption and extending its benefits to more patients. Nowadays, a growing number of patients with AF are treated with concurrent AF surgical ablation during cardiac surgery (10). Further incorporation of ablation technology allowed subsequent modifications to increase efficacy and decrease morbidity (11). Despite the clinical success of surgical ablation, with promising freedom from AF, it was seldom used to treat stand-alone AF, because of its technical complexity and surgical risk. At present, surgical ablation is reserved for patients with structural heart disease as an adjunct to open-heart surgery (1). Failure of surgical ablation was mainly dependent on the clinical documentation of atrial arrhythmia. With the increased efficacy and safety of surgical ablation strategies in preventing AF recurrences, recent studies evaluated the feature and electrophysiological characteristics of

recurrence after AF surgical ablation. In patients with post-surgical AF ablation, scar-related AT from the left atrium with macro-re-entry was the most common arrhythmia mechanism. Interventional catheter ablation was highly successful in eliminating the culprit AT with favorable long-term outcomes (12).

In this issue of *Journal of Thoracic Disease*, the study by Ad *et al.* (13) extended the enrollment period (January 2005 to June 2015) and follow-up duration of patients (up to 5 years) from the previous study evaluating the Cox maze procedure for AF (14). The study is unique in that the length of follow-up adds up as a major strength of the study considering the challenges in patient follow-up, the additional analysis of the importance of 1-year sinus rhythm maintenance, and the impact of surgeon experience. A total of 743 patients reached the 1-year time point after surgical ablation. In 68% of patients (503 of 743), no detected atrial arrhythmia was reported during the first one year of follow-up. After a median follow-up period of 48 [35–79] months, stable sinus rhythm was maintained up to 5 years in 52% of patients (388/743). After mixed model logistic regression, the arrhythmia recurrences during 1–5 years were associated with older age ($P < 0.001$), longer preoperative AF duration, detected atrial arrhythmia in the first year, and less-experienced surgeon (less than 50 cases experience).

Although the mechanism of early and late recurrence may be different, this study suggested that some of the variables associated with long-term (1–5 years) recurrence are also associated with 1-year atrial arrhythmia recurrences. Maintenance of sinus rhythm at discharge and 1-year follow-up after surgical ablation was found to be a predictor of favorable outcome. Ad *et al.* (13) reported that surgeon experience of more than 50 cases was associated with less 1-year recurrence and 1–5-year recurrence. Operator-experience related AF ablation outcome by using radiofrequency catheter ablation was less reported (15). The gap of experience between operators might be compromised by the clear ablation endpoint of electric PV isolation by electrophysiological study. Although the operator with less experience spend longer procedure time and more fluoroscopy radiation, the long-term AF recurrence was comparable.

Additional catheter ablation after surgical ablation is emerging as a critical adjuvant for patients who undergo surgical AF ablation yet still suffer from residual AF. Although the innovation of surgical ablation technology and device simplified the procedure and improved the overall outcome, the new technology also introduced an

area of vulnerability around the PVs, which emphasized the importance of hybrid procedure as an individualized approach to each patient. Halдар *et al.* (9) reported that the electrophysiologically-guided thoracoscopic surgical ablation strategy provided excellent single-procedure success rates as compared with those of catheter ablation alone, but with an increased risk of nonfatal complications. Conducting gaps in the roof or PV were not uncommon after surgical ablation and hybrid procedure with post-ablation electrophysiological study may be a potential solution to compromise the gap of both surgical lines and surgeon experience. Experienced operators may have less conducting gap and perioperative electrophysiological study with additional endocardial ablation may improve AF ablation outcome. Hybrid AF ablation hold several advantages because it combines the strengths of both surgical and catheter ablation. The main strengths of surgical ablation stems from the ability of the surgeon to visualize and create transmural linear lesions and direct access to the arrhythmogenic structures, which including ganglionic plexi, the ligament of Marshall, and the left atrial appendage. Post-surgical electrophysiological study and catheter ablation enable the electrophysiologist to confirm isolation of the PVs and the posterior wall box lesion and close any gaps in the surgical ablation lines. These information of surgical ablation gaps provide feedback to the surgeon to eliminate the impact of experience gap among surgeons and improve surgical techniques and outcome.

In summary, the detected atrial arrhythmia during the first 12 months following surgical ablation for AF has an important association with stable rhythm throughout follow-up and long-term success. Variables including the surgeon's experience associated with long-term recurrence are also associated with short-term atrial arrhythmia recurrences after surgical ablation. A hybrid procedure with post-surgical ablation electrophysiological study may be a potential strategy to eliminate the gaps of both the surgical ablation lines and the experience between the operators.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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