

Impact of Surgical Left Atrial Appendage Closure on Left Atrial Mechanical Function and Compliance: Pharmacological Strategies to Prevent and Mitigate Fibrotic Remodeling

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Abstract

Background: Surgical ablation combined with left atrial appendage (LAA) closure is widely performed to manage atrial fibrillation (AF) and reduce stroke risk. While LAA closure's effectiveness for stroke prevention is well established, its impact on left atrial (LA) mechanical function and compliance remains incompletely understood.

Methods: We reviewed current evidence on LA mechanical and compliance changes following surgical LAA closure during AF ablation. Particular focus was given to pharmacological interventions

aimed at preventing or mitigating adverse fibrotic remodeling.

Results: Surgical LAA exclusion can reduce LA compliance and transiently impair mechanical function, potentially affecting diastolic filling and atrial contractility. Pharmacological agents with antifibrotic properties—including mineralocorticoid receptor antagonists, angiotensin-converting enzyme inhibitors, angiotensin receptor blockers, and emerging agents such as pirfenidone—show promise in modulating atrial remodeling. Optimal timing for

intervention appears to be perioperative and early postoperative phases.

Conclusions: Comprehensive management of patients undergoing surgical LAA closure should include strategies to preserve LA function. Targeted antifibrotic pharmacotherapy may represent a valuable adjunct to surgical treatment, warranting further clinical investigation.

Introduction

Atrial Fibrillation (AF) is the most common sustained cardiac arrhythmia, significantly increasing the risk of ischemic stroke. Surgical ablation remains a cornerstone for rhythm control in selected patients with AF, often combined with surgical Left Atrial Appendage (LAA) closure to reduce embolic risk. While the stroke-preventive benefit of LAA closure is well documented, its effects on Left Atrial (LA) mechanical function and compliance are less clearly defined. The LAA contributes substantially to atrial reservoir function and modulates LA compliance, acting as a volume buffer during the cardiac cycle. Surgical exclusion of the LAA alters atrial geometry and mechanical properties, which may influence atrial hemodynamics and diastolic ventricular filling. Understanding these functional consequences is critical, as adverse LA remodeling and fibrosis can predispose to arrhythmia recurrence and heart failure symptoms postoperatively. This review examines the impact of surgical LAA closure on LA mechanical function and compliance and explores pharmacological strategies to prevent or mitigate fibrotic remodeling in the perioperative period.

Methods

A comprehensive literature search was conducted in PubMed and other scientific databases up to May

2025. Keywords included "left atrial appendage closure," "surgical ablation," "atrial compliance," "left atrial function," "atrial fibrosis," and "antifibrotic therapy." Relevant clinical studies, experimental data, and reviews focusing on surgical LAA closure effects and pharmacological interventions were analyzed.

Results

Impact on Left Atrial Function and Compliance
Surgical LAA closure reduces the atrial volume reservoir by eliminating the LAA chamber, potentially decreasing overall atrial compliance. This may increase LA pressure and impair diastolic function. Studies report transient impairment of LA strain and reservoir function postoperatively, with variable recovery over time. These changes may contribute to postoperative atrial arrhythmias or symptoms of diastolic dysfunction. Pharmacological Strategies for Fibrotic Remodeling Fibrosis plays a key role in adverse atrial remodeling following surgery. Several pharmacologic agents have demonstrated antifibrotic effects and may be beneficial adjuncts post-LAA closure:

- Mineralocorticoid Receptor Antagonists (MRAs): Spironolactone and eplerenone have shown to reduce myocardial fibrosis and improve diastolic function by blocking aldosterone-mediated collagen deposition.
- ACE Inhibitors and ARBs: These agents inhibit the renin-angiotensin Aldosterone system, decreasing profibrotic signaling and attenuating atrial fibrosis.
- Pirfenidone: An antifibrotic agent targeting TGF- β pathways, with emerging evidence for cardiac fibrosis modulation. Optimal administration is hypothesized during the

perioperative and early postoperative periods, aimed at limiting acute inflammatory responses and fibroblast activation.

Discussion

Surgical LAA closure, while effective in stroke prevention, can alter LA compliance and mechanical function, with potential clinical consequences. Recognizing these effects highlights the need for integrated management beyond surgery alone. Pharmacological modulation of atrial fibrosis is a promising strategy to preserve LA function and improve patient outcomes. Although clinical evidence specific to surgical LAA closure is limited, extrapolation from heart failure and AF studies suggests that MRAs, ACE inhibitors, ARBs, and novel antifibrotics could play a significant role. Future prospective studies and randomized clinical trials are required to define optimal antifibrotic treatment protocols and confirm their efficacy and safety in this setting [1-6].

Conclusions

Surgical LAA closure impacts LA mechanical properties, necessitating careful postoperative monitoring. Adjunctive antifibrotic pharmacotherapy may represent a valuable approach to mitigating adverse remodeling and preserving atrial function.

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Integration of surgical and medical strategies could enhance outcomes for patients with AF undergoing LAA closure.

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