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Efficacy and safety of surgical ablation for atrial fibrillation in elderly patients – state-of-the-art review

Skuteczność i bezpieczeństwo ablacji chirurgicznej migotania przedsionków u pacjentów w podeszłym wieku – przegląd aktualnego stanu wiedzy

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Abstract

Introduction. *Surgical ablation (SA) is an emerging rhythm control strategy for atrial fibrillation (AF) in elderly patients, a group with the increasing prevalence of AF and unique clinical challenges. SA achieves sinus rhythm maintenance rates of 58%-80%, particularly when combined with major cardiac surgeries. However, it carries procedural risks and lacks direct comparisons with catheter ablation (CA) in elderly populations.* **Aim.** *This review aims to evaluate the efficacy and safety of SA for AF in elderly patients, assess its long-term outcomes, and highlight research gaps, particularly in comparison to CA.* **Material and Methods.** *A non-systematic literature review was conducted using PubMed, Web of Science, and Google Scholar, focusing on studies from 2019 to 2024. Keywords included "atrial fibrillation," "surgical ablation," and "elderly." A total of 25 studies relevant to populations aged ≥60 years were analyzed.* **Results.** *SA is effective in maintaining sinus rhythm and improving survival in elderly patients, especially when combined with other cardiac procedures. While Cox-Maze IV achieves high success rates, it is associated with increased pacemaker implantation rates and longer surgical times. Minimally invasive techniques reduce risks while maintaining efficacy. However, the absence of direct comparisons between SA and CA remains a key limitation.* **Conclusions.** *SA offers significant benefits for rhythm control and survival in elderly AF patients, particularly when integrated with cardiac surgeries. Further randomized trials are needed to refine treatment strategies and address the comparative effectiveness of SA and CA in this population. (Gerontol Pol 2024; 32; 217-227) doi: 10.53139/GP.20243224*

Keywords: *elderly, atrial fibrillation, surgical ablation, Cox-Maze IV, age, long-term outcomes*

Streszczenie

Wprowadzenie. *Ablacja chirurgiczna (surgical ablation, SA) jest obiecującą strategią kontroli rytmu serca w migotaniu przedsionków (atrial fibrillation, AF) u pacjentów w podeszłym wieku, grupy z rosnącą częstością występowania AF i specyficznymi wyzwaniami klinicznymi. SA umożliwia utrzymanie rytmu zatokowego w 58%-80% przypadków, szczególnie gdy towarzyszy dużym operacjom kardiochirurgicznym. Niemniej jednak wiąże się z ryzykiem proceduralnym i brakiem bezpośrednich porównań z ablacją cewnikową (catheter ablation, CA) w tej populacji.* **Cel.** *Ocena skuteczności i bezpieczeństwa SA w leczeniu AF u osób starszych, analiza długoterminowych wyników oraz wskazanie obszarów przyszłych badań, szczególnie w kontekście porównania z CA.* **Materiał i metody.** *Przeprowadzono niesystematyczny przegląd literatury z baz danych PubMed, Web of Science i Google Scholar, obejmujący publikacje z lat 2019–2024. Analizie poddano 25 badań dotyczących populacji w wieku ≥60 lat.* **Wyniki.** *SA wykazuje wysoką skuteczność w utrzymywaniu rytmu zatokowego i poprawie przeżycia u osób starszych, szczególnie w połączeniu z innymi procedurami kardiochirurgicznymi. Techniki małoinwazyjne zmniejszają ryzyko proceduralne przy zachowaniu skuteczności. Brak porównań między SA a CA pozostaje istotnym ograniczeniem w formułowaniu zaleceń postępowania z pacjentami starszymi chorującymi na AF.* **Wnioski.** *SA zapewnia istotne korzyści w leczeniu AF u pacjentów starszych, zwłaszcza w połączeniu z operacjami kardiochirurgicz-*

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nymi. Konieczne są dalsze randomizowane badania w celu optymalizacji strategii leczenia i porównania skuteczności SA i CA w tej grupie pacjentów. (Gerontol Pol 2024; 32; 217-227) doi: 10.53139/GP.20243224

Słowa kluczowe*: osoby starsze, migotanie przedsionków, ablacja chirurgiczna, Cox-Maze IV, wiek, długoterminowe wyniki*

Introduction

Atrial fibrillation (AF), the most common persistent cardiac arrhythmia, contributes significantly to morbidity, mortality, and healthcare costs. By 2050, the prevalence of AF in the United States is expected to rise from 2.3 million to 5.6 million cases, with elderly populations experiencing an eighteenfold higher incidence than younger age groups [1,2]. This trend, driven by global aging, increases the urgency of effective AF management for improved quality of life (QoL) and reduced mortality [3].

AF management emphasizes four key strategies: stroke prevention via anticoagulation, sinus rhythm control, ventricular rate control, and minimizing cardiovascular risk factors [4]. Rhythm control can be achieved through cardioversion, antiarrhythmic drugs (AADs), catheter ablation (CA), or surgical ablation (SA) [5]. However, invasive treatment for AF in elderly patients remains debated due to increased risks. Studies suggest CA in older adults yields similar recurrence risks to younger patients but with higher complication rates [6]. While comprehensive meta-analyses are lacking, reports indicate SA in elderly (≥75 years) patients may result in greater recurrence and short-term mortality compared to younger cohorts [7].

Further complicating management, there is no direct comparative data on SA versus CA for elderly populations, though the CASA-AF trial indicates both methods offer similar long-term outcomes [8]. Some studies suggest SA may have superior outcomes in certain cases, yet definitive conclusions remain elusive [9–11]. Given SA's potential to improve survival and QoL in elderly AF patients, its role warrants careful consideration [12].

SA's long-term efficacy makes it attractive for elderly patients, particularly when combined with procedures like coronary artery bypass grafting (CABG), left atrial appendage occlusion (LAAO), or valve surgery [13]. Advancements in minimally invasive techniques also aim to reduce procedural risks. This review evaluates the evidence on SA's efficacy, safety, and complications in elderly AF patients, emphasizing gaps in research that hinder optimal clinical decisions.

Aim

The aim of this study was to evaluate the efficacy and safety of surgical ablation for atrial fibrillation in elderly patients, to assess its impact on long-term outcomes, and to identify factors influencing procedural success and complications in this population.

Material and Methods

A non-systematic literature review was conducted using databases like PubMed, Web of Science, and Google Scholar. Searches focused on terms like "atrial fibrillation," "surgical ablation," "elderly,", "clinical trial", and "meta-analysis" to ensure the inclusion of recent studies (2019-2024) on SA's feasibility, effectiveness, and safety in AF patients. We prioritized studies with elderly populations (≥60 years) based on mean or median age criteria, selecting 25 studies for detailed analysis (table I).

Results and discussion

Twenty-five studies met inclusion criteria: 19 two--arm studies [7,14–31], three three-arm studies [32–34], and three single-arm studies [13,35,36]. Four studies exclusively examined elderly populations (≥60 years) [15,20,24,32]. Three studies reported that at least 50% of participants were elderly, based on interquartile range (IQR) values [16,26,27]. In 10 studies, standard deviation (SD) values indicated that at least 68% of the study populations were elderly [14,17–19,22,23,29,31,33,35]. Three studies explicitly reported the proportion of elderly individuals: ≥65 years (95.68%) [25], >60 years (77.92%) [30], and ≥60 years (84.9%) [31]. Our analysis confirmed the lack of studies directly comparing the outcomes of SA versus CA in elderly patients. This gap underscores the need for research focused on the elderly population, particularly in comparing these two ablation techniques in terms of efficacy and safety.

Table I. The summary of studies included in the literature review. All studies were published between 2019 and 2024

Tabela I. Podsumowanie badań uwzględnionych w przeglądzie literatury. Wszystkie badania zostały opublikowane w latach 2019–2024

Ref.	Age group	Condition/ patient group	Procedure	Results and major findings
Vroomen et al.	On-pump: Mean age of 71.1 years (64-79, SD); Off-pump: Mean age of 69.2 years (61-77, SD)	AF + CABG	SA + off-pump CABG vs SA + on-pump CABG	-Overall rate of in-hospital major cardiac and cerebrovascular events and incidence of pacemaker implantation was no different between both groups -The rate of sinus rhythm at 1 year was similar between both groups (61% on-pump, 65% off-pump)
Uzzaman et al.	>70 years	AF and ≥2 other cardiac procedures non-AF related	Cox-maze IV surgical procedure vs non-surgical AF treatment	-Cox-maze IV is highly effective with 80% success at 5 years follow-up -Cox-maze IV is not associated with additional perioperative risk -Cox-maze IV is associated with an increased percentage of patients remaining in NYHA 1 status on long-term follow-up
Mehaffey et al.	≥65 years	AF + CABG or valve repair/replacement	LAAO alone vs surgical ablation + LAAO vs no AF treatment	-SA + LAAO is associated with significantly reduced 3-year mortality compared to other groups -SA + LAAO significantly reduces the 3-year composite mortality or stroke compared to LAAO alone
Treffalls et al.	Median age of 71 years (66-76, IQR)	AF and concomitant CABG	SA (open approach; not specified) + CABG vs no SA + CABG	-No difference in in-hospital mortality in both groups -Both groups had similar short-term readmission rates; ablated patients had significantly higher rates of mortality during readmission -Readmission up to 1 year was similar between both groups
Kowalewski et al.	Mean age of 66 years (60-71, SD)	AF and conventional sternotomy heart surgery	SA vs no SA	-Concomitant major cardiac surgery and SA are associated with improved long-term survival regardless of the baseline surgical risk of older patient
van der Heijden et al.	Mean age of 69 years (61-77, SD)	AF and concomitant left anterior descending artery grafting	Left-sided thoracoscopic radiofrequency ablation + off-pump minimally invasive direct coronary artery bypass	-After 12 months sinus rhythm was maintained in 81% of patients; 38% of them were AADs-free at 12 months -The left atrial ejection fraction increased significantly from 26 to 38% postoperatively
Sasaki et al.	Maze procedure: Mean age of 73 years (64-82, SD); PVI procedure: Mean age of 71 years (63-79, SD)	Concomitant AVR and AF	Maze procedure vs PVI vs no SA	-SA during AVR is not associated with an increased risk of postoperative complications -Both SA techniques maintained sinus rhythm within 24 months, regardless of the use of class I or III antiarrhythmic drugs
Gerdisch et al.	Paroxysmal AF: 68.1 (10.2, SD) Peristent AF: 68.3 (± 8.9, SD) Longstanding persistent AF: 80.1 (± 8.8, SD)	AF and concomitant cardiac surgery	Cox-Maze IV and concomitant cardiac surgery in patients with paroxysmal vs persistent vs longstanding persistent AF	-30-day mortality was 3.3% (8 patients) -AF freedom was 88.3% at 1 year and 84.7% at 3 year follow-up -AF freedom was the highest in the case of preoperative paroxysmal AF -At 3-year follow-up, 84% of patients were ACDs-free and 74% were AADs-free

Ref.	Age group	Condition/ patient group	Procedure	Results and major findings
Pyo et al.	Ablated group: mean age of 70.6 years (± 7.8, SD); Non-ablated group: mean age of 72.7 years (± 7.7, SD);	AF and concomitant left-sided valve replacement with bioprostheses	SA (Cox-Maze III) + prior valve bioprosthesis replacement vs no SA + prior valve bioprosthesis replacement	-The ablation group had a lower risk of perioperative mortality and overall mortality -Ablated patients had a greater risk of permanent pacemaker implantation -There was no significant difference in the risk of overall stroke between both groups
Patrick et al.	SAVR-SA group: mean age of 75.7 (± 6.3, SD); TAVR: mean age of 83.6 (± 6.8, SD)	AF and surgical or transcatheter aortic valve replacement	SA (open technique, not specified) + SAVR vs TAVR	-SAVR+SA was associated with significantly lower all-cause mortality compared to TAVR -The incidence of pacemaker implantation was significantly lower in SAVR-SA compared to TAVR (in the early postoperative period) -SAVR-SA was associated with significantly lower readmission due to heart failure (at 5 years)
MacGregor et al.	≥75 years (elderly) & <75 years	AF	Cox-Maze IV in <75 years vs in ≥75 years	-The elderly are associated with an increased rate of overall major postoperative complications and 30-day mortality -AF recurrence occurs within 5 years in 33% of the elderly group and only 20% of the <75 group
Petersen et al.	Mean age of 68.4 years (± 9.07, SD)	AF	SA (complete left atrial ablation, isolated PVI, biatrial ablation)	-30-day and 1 year-survival after SA is 97.7% and 95.8%, respectively -Concomitant CABG in elderly, double valve surgery, preoperative persistent AF, significantly increase AF recurrence risk within 12 months
Malaisrie et al.	≥65 years	AF and concomitant CABG	SA + CABG vs CABG alone	-The risk of mortality and stroke/systemic embolization is significantly lower in ablated patients who survived for more than 2 years compared to non-ablated patients
Hald et al.	Mean age of 68.3 years in the biatrial group (± 9.2, SD); The mean age of 70.0 years in the PVI group (± 8.1, SD)	AF and concomitant cardiac surgery	Biatrial ablation vs PVI	-Biatrial ablation in persistent AF is associated with a significantly higher proportion of AF-free patients compared to PVI -<65 years is a predictor of postoperative freedom from AF in biatrial ablation -Biatrial ablation is associated with an increased risk of permanent pacemaker implantation compared to PVI
Churyla et al.	Mean age of 71.5 years (± 8.9, SD)	AF and concomitant AVR	SA (open approach, not specified) + AVR vs AVR alone	-Concomitant SA during AVR surgery is associated with similar postoperative stroke risk and 30-day mortality compared to non-ablated group -SA is associated with a higher rate of postoperative pacemaker implantation
Mehaffey et al.	Mean age of 68 years (61-74, SD)	AF and concomitant mitral valve surgery (MVS)	SA (various techniques) + MVS vs MVS alone	-Concomitant SA and MVS are not associated with increased morbidity, permanent pacemaker implantation, or operative mortality -Concomitant SA and MVS are less frequently performed in the case of older patients
Lin et al.	≥70 years	AF and concomitant valve replacement	SA (Cox-Maze IV) + valve replacement vs valve replacement alone	-SA during valve replacement surgery is not associated with increased mortality or major postoperative morbidity in the elderly -Patients after the combined procedure had a better overall survival; cumulative incidence of cardiovascular death during follow-up among ablated patients was significantly lower -Freedom from AF 5 years post-surgery was 58.0% in the ablated group compared to 3% among the non-ablated group

Ref.	Age group	Condition/ patient group	Procedure	Results and major findings
Rankin et al.	≥65 years (95.68% of 626 patients in the ablated cohort)	AF and concomitant CABG	SA (not specified) + CABG vs No SA + CABG	-SA is less frequently performed during CABG surgery in older patients (≥75 years) -Ablated patients had a higher risk of readmission for cardiac arrhythmias after 2 years from the procedure, however, these patients had significantly decreased late mortality risk (29% lower)
Van Hoof et al.	Mean age of 68.9 years (± 9.4, SD)	AF and concomitant cardiac surgery	SA + paroxysmal AF vs SA + non-paroxysmal ablation; SA + mitral surgery vs SA + non-mitral surgery; Full Cox-Maze IV vs Box lesion set vs PVI	-Reoperation for bleeding (1.35%) and acute conduction block was more frequently performed in non-paroxysmal AF, patients undergoing mitral intervention, and Cox-Maze IV lesion set -The total pacemaker implantation rate was higher in non-paroxysmal AF, patients undergoing mitral surgery or Cox-Maze IV ablation -Freedom from AF at 24 months (without AAD) was 44.4%
Kowalewski et al.	Median age of 68.6 (63.2-73.6, IQR); >70 years (181; 41.9%); 50-70 years (246, 56.9%)	AF and concomitant CABG	SA (not specified) + CABG vs no SA + CABG	-Ablated patients had significantly better late survival (25% improvement) -The greatest survival benefit was observed in the group with concomitant SA, CABG, and mitral valve surgery
Suwalski et al.	Median age of 62 (61-72, IQR); >70 years (114; 32.95%); 50-70 years (227, 65.61%)	AF and concomitant CABG	SA (not specified) + CABG vs no SA + CABG	-Relative risk of the 30-day mortality and multiorgan failure were significantly decreased in the CABG + SA group -During the study period, CABG + SA was associated with significant survival benefits compared to CABG alone -CABG + SA had especially pronounced benefits in lower-risk older patients (>70 years undergoing elective procedure)
Ad et al.	Median age of 64 years (57-70, IQR)	AF	Stand-alone SA off-pump (beating heart) vs on pump	-The on-pump group had a greater prevalence of pneumonia, ventilation >24 hours, acute renal failure, and blood transfusion but no difference in perioperative stroke and 30-day mortality compared to off-pump patients
Raissouni et al.	Mean age of 71.1 years (± 9.2, SD)	AF and concomitant cardiac surgery	Cardiac surgery + epicardial ablation vs cardiac surgery + surgical endocardial ablation	-At 12 months 60% of ablated patients were free from AF -Freedom from AF at 12 months in the epicardial vs endocardial group was 64 vs 57% (no statistical difference between both techniques)
Elbadawi et al.	>60 years (77.92% of 23974 patients in the ablated cohort)	Concomitant AF + vulvar heart surgery or CABG	SA (not specified) + cardiac surgery vs no SA + cardiac surgery	-The SA group had significantly lower in-hospital mortality, lower rate of in-hospital cardiovascular accidents, and shorter hospital stays compared to the non-ablated group
Iribarne et al.	≥60 years (84.9% of 634 patients in ablated cohort); Mean age of 69.8 (± 9.1, SD)	Concomitant AF + cardiac surgery	SA (intracardiac, epicardial) + cardiac surgery vs no SA + cardiac surgery	-Intraoperatively, SA was not associated with increased frequency of bleeding, stroke, AKI, mediastinitis or sternal dehiscence, or pneumonia -Long-term survival was 39% superior for ablated patients compared to the non-ablated group

Effectiveness and safety profile of surgical ablation

SA is an effective intervention for achieving long-term freedom from AF in elderly patients, particularly when performed concomitantly with other cardiac procedures. Below is a detailed breakdown of our findings.

Overall success rate and procedure – specific effectiveness

SA demonstrates substantial effectiveness in restoring and maintaining sinus rhythm, with success rates achieving up to 80% over long follow-up periods. These high success rates are especially pronounced in studies involving complex lesion sets, such as the Cox-Maze IV procedure. For instance, in a cohort of patients over 70 years of age undergoing high-risk cardiac surgery combined with the Cox-Maze IV procedure, the AF freedom rate was 80% at five years [15]. Lin et al. found that elderly patients undergoing valve replacement with SA had a 58% AF-free rate at five years, compared to 3% without SA [24]. Gerdisch et al. reported an 88.3% AF--free rate at one year for patients undergoing Cox-Maze IV combined with cardiac surgery, with variable outcomes based on AF type [34].

SA's efficacy may vary by technique. MacGregor et al. noted that Cox-Maze IV in elderly patients (≥75 years) had lower AF freedom, higher complication rates and 30-day mortality compared to younger patients [7]. Petersen et al. corroborated that age did not significantly impact one-year AF freedom but noted that SA was less effective in elderly patients undergoing concomitant CABG surgery [13].

Although Cox-Maze IV is effective, its use in elderly patients is limited due to prolonged surgery and atrial access needs, leading to a shift toward less invasive techniques. Sasaki et al. reported similar sinus rhythm maintenance between paroxysmal and nonparoxysmal AF groups in elderly patients undergoing aortic valve replacement (AVR) with maze or PVI techniques [33]. Van Hoof et al. found that AF freedom declined over time (61.3% at 3 months and 44.4% at 24 months), with Cox--Maze IV and PVI showing higher long-term effectiveness than the Box lesion. However, Cox-Maze IV was associated with increased pacemaker implantation rates [36]. Hald et al. observed that biatrial ablation yielded higher AF freedom in persistent AF cases but also increased pacemaker implantation compared to unilateral and less extensive approaches like PVI [21].

Minimally invasive techniques, such as thoracoscopic epicardial ablation, have recently shown potential for reducing perioperative risks while maintaining efficacy. Van der Heijden et al. reported 81% sinus rhythm maintenance at 12 months following left-sided thoracoscopic ablation during off-pump CABG, along with improved left atrial ejection fraction [35]. Raissouni et al. found no difference in 12-month AF freedom rates between the Cox-Maze IV and Box lesion groups in a cohort averaging 71.1 years old [29].

SA is an effective approach for long-term sinus rhythm control in elderly patients, achieving success rates of 58-80%, particularly with comprehensive lesion sets like Cox-Maze IV. While SA has risks, such as increased pacemaker needs, minimally invasive techniques offer safer alternatives with comparable efficacy. Further trials are needed to assess the long-term effectiveness of these less invasive approaches. Overall, SA is valuable for rhythm control in elderly patients, with careful selection and tailored approaches to optimizing outcomes.

Long-term efficacy in high-risk groups

The long-term efficacy of SA is evident, particularly when combined with major cardiac procedures like CABG or valve surgery. Kowalewski et al. found that SA with conventional sternotomy in AF patients reduced long-term mortality by 16% regardless of the patient's baseline surgical risk [17]. In a cohort with a mean age of 69.8, SA improved five-year survival by 45% for CABG, 58% for valve surgery, and 32% for combined procedures [31]. Treffals et al. reported no increase in one-year readmission risk with combined SA and CABG [16]. Petersen et al. showed a 95.8% one-year survival rate and AF freedom of 62-72% in elderly patients undergoing SA, though CABG combined with double valve surgery had higher AF recurrence within a year [13]. Rankin et al. noted a reduced late mortality risk (29%) with SA and concomittant CABG, despite increased arrhythmia-related readmissions after two years [25].

Kowalewski et al. and Suwalski et al. provided further evidence for SA's benefits in elderly patients. Kowalewski et al. in a cohort with a median age of 68.6 years found improved long-term survival with SA in patients undergoing CABG and mitral valve surgery, while Suwalski et al. reported a 33% survival increase with combined SA and CABG, particularly in lower-risk patients over 70 years old undergoing elective procedures with 3-vessel disease and good ventricular function [26,27]. Malaisrie et al. observed a survival advantage with SA during CABG after two years, along with reduced stroke risk [20]. Mehaffey et al. recently showed that adding LAAO to SA in elderly (≥65 years) CABG or valve surgery patients significantly reduced 3-year mortality and

stroke risk, supporting LAAO as a key component in comprehensive AF management during major cardiac surgeries [32].

Studies on valve surgeries further support SA's efficacy. Sasaki et al. found that SA with AVR did not increase major cardiac or cerebrovascular events over two years [33]. Patrick et al. reported lower all-cause mortality and reduced AF-related rehospitalization rate at five years for combined SA and surgical AVR (SAVR) compared to transcatheter AVR (TAVR) alone, with no significant difference in stroke ratess [19]. Pyo et al. observed decreased long-term mortality and less severe tricuspid regurgitation with SA and left-sided valve replacement, with stroke risks similar between groups [18]. Lin et al. showed improved overall survival with combined SA and valve replacement in elderly patients, with five- and ten-year survival rates of 82% vs 68% and 58% vs 15%, along with lower rates of cardiovascular death and stroke during follow-up [24].

In conclusion, SA offers significant long-term benefits for elderly patients, especially when combined with major cardiac procedures like CABG or valve surgeries. It improves survival rates and reduces long-term mortality, particularly in carefully selected older patients with preserved cardiac function undergoing elective surgeries. These findings highlight SA's role as a key intervention for improving outcomes in elderly AF patients.

Perioperative mortality and complication rates

While SA demonstrates significant effectiveness in managing AF in elderly patients, it is not without risks, particularly given the higher susceptibility of this population to complications. In this section we will discuss the safety data, emphasizing perioperative risks, common complications, and overall safety comparisons.

Petersen et al. reported an 8.5% incidence of postoperative pacemaker implantation and a 2.3% 30-day mortality rate following SA [13]. In-hospital mortality for SA during major cardiac surgeries is 1.7%, with complications like bleeding-related reoperation and acute conduction block occurring at 1.4% and 2.3%, respectively. These risks are higher in patients with non-paroxysmal AF undergoing mitral valve surgery or full Cox-Maze IV lesion sets [36].

Elbadawi et al. found that adding SA to major cardiac surgeries reduced in-hospital mortality and rates of cerebrovascular events, cardiogenic shock, and prolonged ventilation but increased incidences of heart block, sinus node dysfunction, and pacemaker implantation compared to non-ablated patients [30]. Iribarne et al. reported no increase in perioperative risks (e.g., reoperation, stroke, or kidney injury) or in-hospital mortality with SA during cardiac surgery among older patients [31]. Uzzaman et al. found no significant differences in stroke rates or 30-day mortality in patients over 70 undergoing major cardiac surgery with or without Cox-Maze IV ablation. ICU stay duration and overall hospital stay were also similar between ablated and non-ablated groups [15].

SA during concomitant CABG does not increase in-hospital mortality and both 30- and 90-day readmission rates in older patients compared to CABG alone [16]. Suwalski et al. reported lower 30-day mortality and multiorgan failure risk but longer ICU stays with SA during concomittant CABG [27]. Prolonged CPB time and factors like heart failure, hypertension, age ≥75, and high CHA2DS2-VASc scores were linked to increased operative mortality risk during combined SA and CABG [20].

In valve replacement surgeries, studies show favorable safety profiles with SA. Lin et al. found no increase in mortality or major complications in patients over 70 with added SA, despite longer CPB times [24]. Sasaki et al. found that adding SA during AVR for both paroxysmal and non-paroxysmal AF did not increase postoperative complications such as myocardial infarction, stroke, thrombotic events, pacemaker implantation, or 30-day mortality compared to the non-ablated group [33]. Churyla et al. reported that SA with AVR significantly prolonged perfusion and cross-clamp times and increased pacemaker implantation rates and heart failure-related readmissions within 30 days, though postoperative stroke and 30-day mortality rates were unaffected [22]. Pyo et al. showed that SA with valve bioprosthesis replacement did not raise rates of early adverse outcomes, including 30-day mortality, stroke, or pneumonia. However, it was linked to a higher rate of early pacemaker implantation and reduced need for newly initiated dialysis [18]. Patrick et al. found that combining SA with SAVR significantly lowered early permanent pacemaker implantation rates compared to TAVR without ablation [19]. Concomitant SA is also safe during mitral valve surgery (MVS), with longer CPB times but reduced blood transfusions. There was no difference in major morbidity, operative mortality, or new pacemaker implantation between SA with MVS and MVS alone [23].

Macgregor et al. found that patients aged ≥75 undergoing SA (Cox-Maze IV) had longer CPB times, hospital stays, and AF at discharge than those under 75. Elderly patients also had higher rates of major complications, including pneumonia, pacemaker implantation, and 30-day mortality compared to younger patients [7].

Off-pump techniques like beating-heart ablation have been explored to improve safety. Surprisingly, these

techniques provide similar early and mid-term effects compared to a more invasive and extensive approach requiring CPB support. Vroomen et al. showed that off-pump SA during CABG is comparable to on-pump SA in maintaining 1-year sinus rhythm, with similar rates of pacemaker implantation and fewer postoperative class III AADs needed in the off-pump group [14]. Ad et al. reported that off-pump SA using a minimally invasive epicardial approach reduced perioperative pneumonia, renal failure, and blood transfusions compared to the on-pump group, with no significant differences in stroke, pacemaker implantation, or 30-day mortality between the techniques [28]. Iribarne et al. also found no difference in in-hospital mortality between less invasive epicardial and more invasive intracardial ablation approaches [31].

In summary, SA is generally safe for elderly patients during major cardiac surgeries, with perioperative risks similar to those in younger populations. While SA may increase complications like pacemaker implantation, it does not raise in-hospital mortality rates. Minimally invasive and off-pump techniques show potential to reduce complications and improve recovery. Careful patient selection and perioperative management are essential for optimizing outcomes in elderly patients.

Current standards and future perspectives

Current AF guidelines recommend surgical ablation for patients with paroxysmal/persistent AF undergoing left atrial open surgery, regardless of prior AAD failure, and for those with AAD intolerance undergoing closed surgery. Guidelines recommend Cox-Maze IV and, at minimum, PVI with left atrial posterior wall isolation [37].

The CASA-AF trial shows that SA and CA are equally effective for long-term arrhythmia control, with similar impacts on health-related QoL [8]. However, SA has higher costs and upfront complication risks than CA [38,39] Consequently, CA is often preferred for invasive AF treatment [37]. There are no age-specific CA guidelines; experts advise similar ablation indications for patients over 75 as for younger ones, considering comorbidities and preferences [37]. Current guidelines also lack specific recommendations on the feasibility, efficacy, and safety of SA in elderly AF patients [37].

The preferred ablation strategy (surgical vs. catheter) for elderly patients remains unclear due to a lack of clinical trials comparing perioperative safety and long-term outcomes in a homogenous elderly population (>60 years). Such studies are needed to guide clinicians in selecting the most effective ablation methods to improve management and survival for elderly AF patients. We await trials focused on evaluating the safety and efficacy of both techniques in this specific patient group.

Limitations

Our analysis has several limitations that should be acknowledged. First, as a non-systematic review, it may be biased in study selection and comprehensiveness. Most included studies were retrospective, relying on registries and databases, which could affect data accuracy. Only four studies focused on a homogenous elderly population (≥60 years), and age estimation often depended on mean or median values, limiting precision. Consequently, in seven studies, although the mean or median age was at least 60 years, it was impossible to determine the precise proportion of elderly participants. Additionally, despite an extensive literature search, we found no study directly comparing surgical and catheter ablation in elderly patients, reducing the clinical applicability of our findings. Nonetheless, this review highlights the need for future research to address these gaps and improve AF management in elderly patients, emphasizing the limited knowledge on surgical ablation's role in this specific population.

Conclusions

Our review confirms that SA is effective for long-term sinus rhythm in elderly AF patients, with success rates of 58% to 80%. When combined with other surgeries like CABG or valve replacement, SA improves long-term survival and reduces AF recurrence. However, risks such as pacemaker implantation and perioperative complications require careful patient selection. Minimally invasive techniques may reduce these risks, enhancing safety for older patients. A critical gap remains in the lack of comparative studies between SA and CA in elderly populations, and current guidelines lack age-specific recommendations. Most existing studies are retrospective and lack homogenous elderly cohorts, limiting generalizability. In summary, while SA shows promise for rhythm control and survival in elderly AF patients, there is an urgent need for clinical trials to optimize its role in this population.

Conflict of interest
None

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