

Minimizing fluoroscopic exposure in supraventricular tachycardia ablation

PhD thesis

by

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1. INTRODUCTION

Supraventricular tachycardias (SVT) are characterized by an elevated heart rate exceeding 100 beats per minute, originating from the tissue above the His bundle. This term encompasses various arrhythmias excluding ventricular tachycardias (VT) and atrial fibrillation (AF). The main forms of SVT include atrioventricular nodal re-entrant tachycardia (AVNRT), atrioventricular re-entrant tachycardia (AVRT), atrial flutter (AFL), and atrial tachycardia (AT). SVT affects approximately 2.25 individuals per 1000 people, with a notably higher prevalence among women and individuals over 65 years old. Symptoms often manifest rapidly and can include palpitations, dyspnoea, and, in severe cases, loss of consciousness. The Valsalva manoeuvre is commonly effective in terminating SVT episodes.

For symptomatic and recurrent SVT, catheter ablation is the preferred long-term treatment owing to its high success rate and minimal complications. This procedure generally leads to significant improvements in patients' quality of life. In cases of AVNRT, the slow-pathway ablation has a success rate of 97% with a very low risk of atrioventricular block. Catheter ablation is also recommended for recurrent AVRTs and pre-excited AF.

Atrial fibrillation, the most common sustained arrhythmia, significantly increases the risk of complications such as heart failure and stroke, particularly in individuals over 45. Diagnosis relies on electrocardiograms, and treatment involves rhythm and rate control strategies, with pulmonary vein isolation being the gold standard for symptomatic cases. The latest guidelines of European Society of Cardiology suggest options like pacemaker implantation and AV node ablation (AVNA) when drug therapy fails.

Catheter ablation procedures traditionally utilize fluoroscopy, which poses risks associated with ionizing radiation exposure. Interventional cardiologists often experience elevated radiation exposure in sensitive areas, such as the head and thyroid, increasing their cancer risk. According to the “as low as possible” (ALARA) principle, which aims to minimize ionizing radiation exposure to the lowest achievable level, several technical tools have been developed in electrophysiology (EP) as an alternative guidance to fluoroscopy, such as three-dimensional electroanatomical mapping systems (EAMSs) or intracardiac echocardiography (ICE). ICE and EAMSs facilitate real-time visualization of cardiac anatomy, including vessels, chambers, and catheter movement; thereby contributing to a reduction in fluoroscopy use during electrophysiological procedures. This multifaceted approach to managing SVT and AF,

alongside innovative imaging tools, underscores the evolving landscape of cardiac care that prioritizes patient safety and treatment efficacy.

2. AIMS

The main aims of our studies were the following:

1. to estimate the effect of ICE guidance on procedural outcomes in patient with permanent AF who underwent AVNA
2. to compare the feasibility, safety, and success rate of using solely ICE-guided, zero-fluoroscopy (ZF) ablation techniques to standard ablation technique for ablation of the cavotricuspidal isthmus (CTI) in patients diagnosed with typical AFI
3. to compare fluoroscopic guidance to zero/minimal fluoroscopy approaches for the treatment of SVT

3. BACKGROUND

3.1 Comparison of Conventionally Performed and Intracardiac Echocardiography Guided Catheter Ablation of Atrioventricular Node

AVNA combined with permanent pacemaker implantation is a recommended rate control strategy for patients with permanent AF when intensive pharmacological treatments fail to achieve the desired effect. Recent evidence suggests that “pace and ablate” approach is superior to pharmacological therapy in decreasing hospitalization rates and reducing mortality among patients for whom a rhythm control strategy proved ineffective. AVNA demonstrates a low complication rate and high acute- and long-term success rate: a prospective registry reported that only 3.5 % of patient undergoing AVNA experienced recurrence of AV conduction during the extended observational period.

3.2. Fluoroless catheter ablation for typical atrial flutter using solely intracardiac echocardiography guidance

Catheter ablation is considered the first-line therapy for recurrent, symptomatic CTI-dependent AFL. This technique achieves a bidirectional conduction block across the CTI, demonstrating high success rates in both short- and long-term follow-ups, with a low incidence of complications. Although catheter ablation of the CTI has a high success rate, it can pose significant challenges in certain cases, primarily due to anatomical variations. Clinical evidence suggests that ICE-guided CTI ablation significantly shortens procedure and fluoroscopy times, leading to reduced radiation exposure compared to fluoroscopy-only approaches. However, no current data substantiate the feasibility of performing ICE-guided, zero-fluoroscopy CTI ablation in the absence of EAMS.

3.3. Zero and Minimal Fluoroscopic Approaches During Ablation of Supraventricular Tachycardias

Catheter ablation has become the standard therapeutic approach for paroxysmal SVT due to its high efficacy and low complication rates. The development and widespread adoption of three-dimensional EAMSs over the past decade have revolutionized EP procedures. EAMSs significantly reduce radiation exposure and fluoroscopy duration, making zero- or minimal-fluoroscopy (Z/MF) approaches a viable and effective alternative. A 2016 meta-analysis comprising 10 studies with 2,261 patients demonstrated reduced fluoroscopic exposure and shorter ablation times with Z/MF techniques for arrhythmia treatment, while maintaining comparable procedure durations and success rates to traditional fluoroscopy-guided methods. Following this meta-analysis, further important studies—including prospective, randomized, and multicenter trials—have been published by comparing these two different strategies.

4. METHODS

4.1 Comparison of Conventionally Performed and Intracardiac Echocardiography Guided Catheter Ablation of Atrioventricular Node

In this retrospective, single-center trial, we analyzed a cohort of 62 patients who underwent AVNA for permanent AF with an uncontrolled ventricular rate despite maximal dose

pharmacological treatment at our university hospital between January 2015 and January 2024. The patients were categorized into two distinct groups based on the utilization of ICE during the procedure, specifically the ICE group and the Standard group, for subsequent comparative analysis. Patients referred for a repeat (redo) procedure were excluded from the study, as were cases involving crossovers where ICE was not initially utilized at onset of the procedure but was introduced later in the process due to the unsuccessful achievement of the procedural endpoint. The procedural endpoint was defined as complete AV block after a 20-minute waiting period from the last ablation. Long-term success was defined as persistent complete AV block 30 days after the procedure. Major complications were identified as pericardial tamponade/effusion or vascular complications necessitating intervention or extended hospitalization, such as major hematomas, pseudoaneurysms and arteriovenous fistulas. The procedure duration, quantified in minutes, spanned from the initial femoral vein puncture to the removal of the last catheter.

4.2. Fluoroless catheter ablation for typical atrial flutter using solely intracardiac echocardiography guidance

In our prospective, observational single-center study, we enrolled a total of 80 consecutive patients with ECG recordings suggesting ongoing or recent CTI-dependent AFL, based on ECG criteria as adopted by Granada et al. The first 40 patients underwent standard ICE-guided CTI ablation according to our institutional protocol (Standard ICE group), while the other 40 patients underwent ZF CTI ablation, using only ICE and intracardiac ECGs for catheter navigation (Zero ICE group).

4.3. Zero and Minimal Fluoroscopic Approaches During Ablation of Supraventricular Tachycardias

Electronic databases [PubMed, Excerpta Medica Database (EMBASE), Cochrane Central Register of Controlled Trials (CENTRAL)] were searched for relevant articles between January of 2000 and July of 2021. The search string was “zero-fluoroscopy or near-zero fluoroscopy or fluoroless or non-fluoroscopic” and “electrophysiology or electrophysiological” and “catheter ablation” and “or supraventricular or supraventricular tachycardia or paroxysmal supraventricular tachycardia”. We extended the search with the reference list of the relevant

studies. Duplicates and review publications were excluded. We performed the analyses according to the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) guidelines. In this meta-analysis, we included studies that accomplished the following criteria: (1) patients who underwent EP study and/or catheter ablation for paroxysmal SVT, AVNRT, AVRT, AT, or CTI-dependent AFl; (2) patients having at least one Z/MF-only and one conventional fluoroscopy-only arm; (3) randomized or non-randomized prospective studies and retrospective studies enrolling consecutive patients; and (4) studies written in English. The primary outcome of the study was the acute success rate. Secondary outcomes included procedural parameters: “skin-to skin procedure time”(minutes); “ablation time”, that is the sum of ablation time during the entire procedure (seconds); “application number”, which means the sum of the RF delivery; and “total fluoroscopy time” (minutes), “fluoroscopy dose” (mGy), and “fluoroscopy exposure” [dose area product (DAP), cGy/cm²]. Complications and long-term success rate were also analysed.

5. RESULTS

5.1 Comparison of Conventionally Performed and Intracardiac Echocardiography Guided Catheter Ablation of Atrioventricular Node

A total of 62 participants were recruited for the study. Among them, twenty-eight patients underwent ICE-guided AVNA, while 34 cases exclusively utilized fluoroscopy. The baseline demographic characteristics, such as sex distribution (male: 64% vs. 59%, $p=0.66$) and age (72.3 ± 9 vs. 68.3 ± 8.8 years, $p=0.08$), indicated no substantial differences between the two groups. ICE guidance was linked to a shorter procedure duration (40 [34; 55] min vs. 60 [45;110], $p=0.02$) and reduced fluoroscopy time (0.30 [0.06; 0.85] min vs. 7.95 [3.23; 6.59] min, $p<0.01$). Likewise, the time from the first to the last ablation was decreased (4 [2; 16.3] min vs. 26.5 [2.3; 72.5] min, $p=0.02$), and although the total ablation time (199 [91; 436] sec vs. 294 [110; 659] sec, $p=0.22$), and total ablation energy (8272 [4004; 14651] J vs. 6065 [2708; 16406] J, $p=0.28$) were reduced in the ICE group. The acute success rate was comparable between the groups (ICE: 100% vs. Standard: 94%, $p=0.49$), with one case of recurrent AVN conduction reported in each group ($p=0.94$). One complication occurred in the ICE group during the study period, which was a major hematoma associated with the femoral puncture site requiring vascular surgery ($p=0.94$). Results are summarized in Table 1.

	ICE group (n=28)	Standard group (n=34)	p
Procedure time (min)	40 [34; 55]	60 [45;110]	0.02
Fluoroscopy time (min)	0.30 [0.06; 0.85]	7.95 [3.23; 6.59]	<0.01
Total ablation time (min)	199 [91; 436]	294 [110; 659]	0.22
From first to the last ablation time (min)	4 [2; 16.3]	26.5 [2.3; 72.5]	0.02
Total ablation energy (J)	8272 [4004; 14651]	6065 [2708; 16406]	0.28
Acute success (%)	100	94	0.49
Complication (n)	1	0	0.94
Recurrence (%)	0	0	0.90

Table 1.: Summary of outcomes. Abbreviation: ICE: intracardiac echocardiography.

5.2. Fluorless catheter ablation for typical atrial flutter using solely intracardiac echocardiography guidance

In this study, 80 patients were included, with 40 assigned to the Standard ICE group and 40 to the Zero ICE group. The baseline characteristics, including gender distribution (male: 70.0% vs. 67.5%, $p=0.81$) and age (49.6 ± 14.9 vs. 53.0 ± 13.4 years, $p=0.15$), revealed no significant differences between the two groups. Typical AFL was ongoing in 57.5% of cases in the Standard ICE group and 52.5% in the Zero ICE group. Data analysis showed no significant difference in procedure time (55.5 [46.5; 66.8] min vs. 51.5 [44.0; 65.5], $p=0.50$) and puncture to first ablation time (18 [13.5; 23] min vs. 19 [15; 23.5] min, $p=0.50$) between the two groups. Additionally, the time from the first to the last ablation (16 [10; 31] min vs. 12 [5; 25.5] min, $p=0.16$) and the time from puncture to the last ablation (35 [27; 50] min vs. 32 [24; 46.5] min, $p=0.51$) also demonstrated similar findings. All 80 cases successfully reached the procedural endpoint, resulting in a 100% acute success rate. In the Zero ICE group, 39 out of 40 patients (97.5%) underwent fluoroscopy-free ablation, resulting in significantly less fluoroscopy time (57 [36.3; 90] sec vs. 0 [0; 0] sec, $p<0.001$). The duration in the Standard ICE group was 29 to 184 seconds, while in the Zero ICE group, it ranged from 0 to 78 seconds. The radiation dose was also significantly lower (3.17 [2.27; 5.63] mGy vs. 0 [0; 0] mGy, $p<0.001$) compared to

the Standard ICE group. Throughout the study no complications were observed. Result are summarized in Table 2.

	Standard ICE group (n=40)	Zero ICE group (n=40)	p
Total procedure time (min)	55.5 (46.5; 66.8)	51.5 (44.0; 65.5)	0.50
From puncture to first ablation (min)	18 (13.5; 23)	19 (15; 23.5)	0.50
Total ablation time (sec)	597 (447; 908)	430 (260; 750)	0.02
Total ablation energy (Ws)	22458 (14836; 31116)	17043 (10533; 29302)	0.10
From first to last ablation time (min)	16 (10; 31)	12 (5; 25.5)	0.16
From puncture to last ablation time (min)	35 (27; 50)	32 (24; 46.5)	0.51
Total fluoroscopic time (sec)	57 (36.3; 90) range: 29-184	0 (0; 0) range: 0-78	<0.001
Total fluoroscopy dose (mGy)	3.17 (2.27; 5.63)	0 (0; 0)	<0.001
First line block (%)	55.0	55.0	1.0
Acute reconnection (%)	25.3	35.0	0.31
Acut success (%)	100	100	1.0
Complication (%)	0	0	NA

Table 2.: Summary of outcomes of secondary endpoints. Abbreviations: ICE: intracardiac echocardiography; NA: not available.

5.3. Zero and Minimal Fluoroscopic Approaches During Ablation of Supraventricular Tachycardias

A total of 24 studies involving 9,074 patients were assessed. Among these studies, three were randomized controlled trials, while the remainder were observational studies. The EnSite NavX system was utilized in 18 studies, the EnSite Precision System in 3, the EnSite Velocity System in 3, the CARTO System in 8, the Rhythmia System in 1, and the MediGuide System in 1 study.

The mean follow-up period varied from 42 to 1,584 days. No significant differences were observed between Z/MF and conventional ablation procedures in terms of acute success rate (97.4 vs. 97.55%; RR: 1.00, 95% CI: 0.99–1.01, $p = 0.97$; Figure 1.) or long-term success rate (97.02 vs. 96.17%; RR: 1.01, 95% CI: 1.00–1.03, $p = 0.13$; Figure 2.). The overall complication rate was 1.59% across the study population, with no significant differences between the groups (RR: 0.68, 95% CI: 0.45–1.05, $p = 0.08$; Figure 3.).

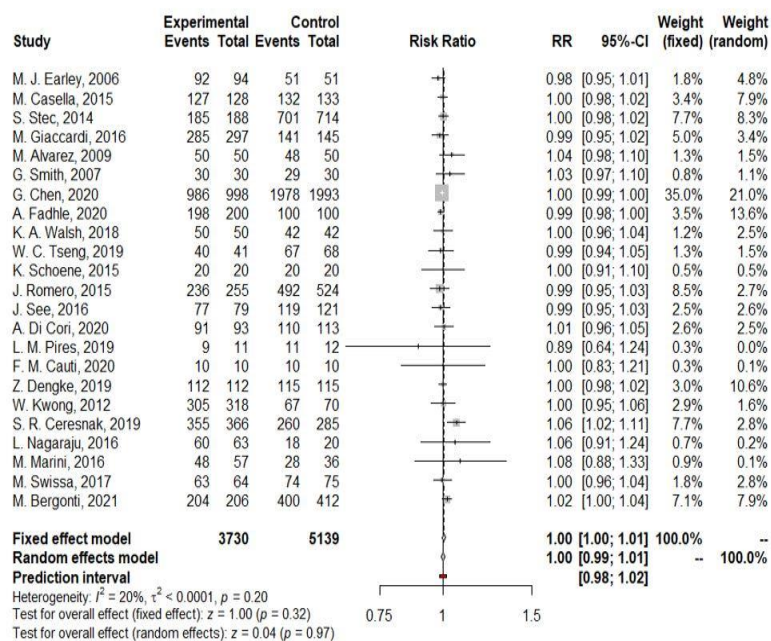


Figure 1.: Forest plot of acute success rate.

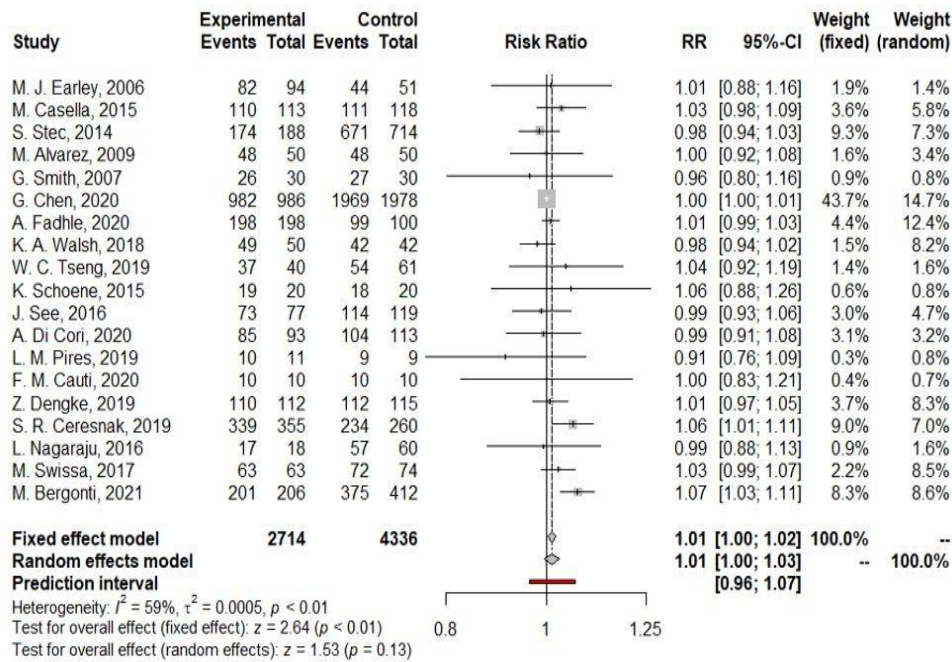


Figure 2.: Forest plot of acute success rate.

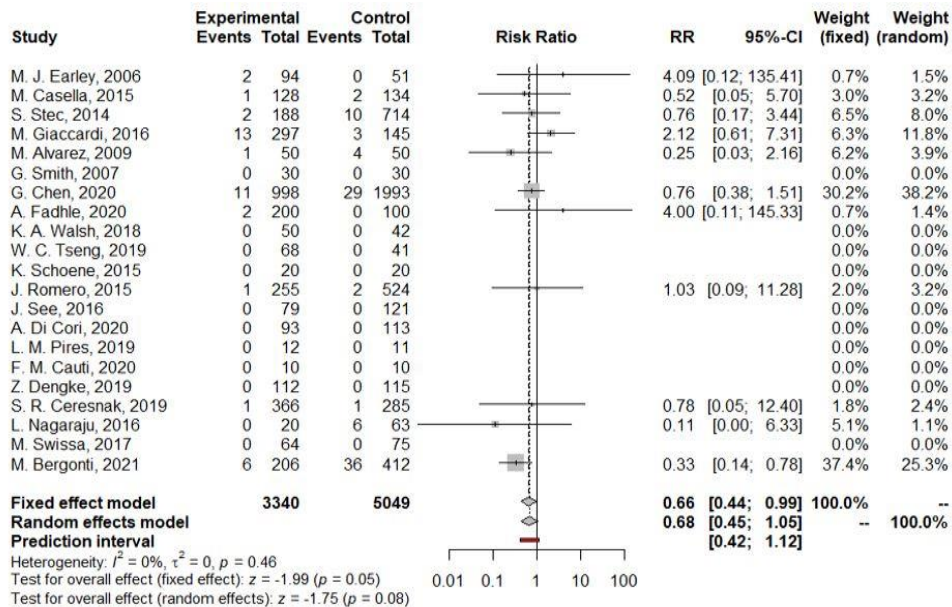


Figure 3.: Forest plot of complications.

Compared to the conventional method, the Z/MF approach demonstrated a significant reduction in fluoroscopic time [MD: -1.58 min (95% CI, -2.21 to -0.96 min; $p < 0.01$)], fluoroscopy dose [MD: -10.95 mGy (95% CI: -18.43 to -3.46 mGy)], and radiation exposure [DAP; MD: -52.39 cGy/cm² (95% CI: -65.38 to -39.40 cGy/cm²)]. Additionally, the Z/MF method was associated with a shorter ablation time [MD: -25.23 s (95% CI: -42.04 to -8.43 s; $p < 0.01$)].

However, no significant differences were identified between the two groups in the number of ablation applications [MD: 0.13 (95% CI: -0.86 to 1.11; p=0.80)] or total procedure time [MD: 3.06 min (95% CI: -0.97 to 7.08 min; p=0.14)] (Table 3.).

Outcome	Number of studies	Number of patients	Mean difference (95% CI)	Test for overall effect	Heterogeneity
Ablation time (sec)	7	4750	-25.23 (-42.04; -8.43)	p<0.01	I ² =40%; p<0.12
Ablation application number (n)	8	4098	0.13 (-0.86; 1.11)	p=0.80	I ² =71%; p<0.01
Fluoroscopy time (min)	17	7326	-1.58 (-2.21; -0.96)	p<0.01	I ² =98%; p<0.01
Fluoroscopy dose (mGy)	5	1154	-10.95 (-18.43; -3.46)	p<0.01	I ² =97%; p<0.01
DAP (cGy/cm2)	5	1651	-52.39 (-65.38; -39.40)	p<0.01	I ² =100%; p=0
Procedure time (min)	15	7290	3.06 (-0.97; 7.08)	p=0.14	I ² =91%; p<0.01

Table 3.: Summary of outcomes of secondary endpoints. Abbreviation: CI: confidence interval; DAP: dose area product.

6. DISCUSSION

6.1 Comparison of Conventionally Performed and Intracardiac Echocardiography Guided Catheter Ablation of Atrioventricular Node

This retrospective single-center study demonstrated that use of ICE during AVNA significantly reduced fluoroscopy time, total procedure duration, and the first-to-last ablation time, without compromising acute- or long-term outcomes or increasing complication rates. Previously, a single-center study including 91 patients has shown that ICE-guidance in slow-pathway ablations for the treatment of AVNRT significantly reduced mapping and ablation time, radiation exposure as well as total RF time and the number of RF applications compared to the

fluoroscopy-only method. Our findings align with these results, demonstrating that ICE guidance can reduce fluoroscopy time, total procedural duration, and ablation intervals during AVNA.

6.2. Fluoroless catheter ablation for typical atrial flutter using solely intracardiac echocardiography guidance

Our single-center, prospective observational study demonstrates that ICE-guided, ZF CTI ablation is both feasible and safe, with no adverse impact on the procedural time, first-pass block achievement, or acute reconnection rates. The Zero ICE group demonstrated a shorter total ablation time compared to the fluoroscopy group. However, no significant difference was observed in total ablation energy, indicating that, on average, higher power (W) values were utilized for CTI ablation using the zero strategy. Notably, the ZF strategy failed in only one case during catheter placement, but no fluoroscopy was employed after the catheters were successfully positioned within the heart. To the best of our knowledge, there is currently no scientific evidence available that specifically focuses on ZF AFI ablation solely guided by ICE.

6.3. Zero and Minimal Fluoroscopic Approaches During Ablation of Supraventricular Tachycardias

Our meta-analysis, encompassing 24 studies and 9,074 patients undergoing EP intervention for paroxysmal SVT, demonstrates that Z/MF ablation can significantly reduce radiation exposure, fluoroscopy, and ablation time. Importantly, Z/MF ablation showed no impact on procedural duration, complication rates, acute or long-term success rates, or the number of ablation applications when compared to fluoroscopy-guided ablation.

7. NOVEL FINDINGS

Based on the results of the cited studies, our major novel findings can be summarized as follows:

- the use of ICE in AV node ablation significantly decreases fluoroscopy time, overall procedure time and the first-to-last ablation time, without compromising acute- and long-term outcomes, and complication rates.

- solely ICE guided, ZF CTI ablation is feasible and safe method without influencing the procedural time, first-pass block and acute reconnection rates compared to traditional, fluoroscopy and ICE guided CTI ablation.
- Our meta-analysis demonstrates that Z/MF ablation for paroxysmal SVT can significantly reduce radiation exposure, fluoroscopy, and ablation time. Compared to the fluoroscopy guided ablation, the use of the Z/MF method proved to have no impact on the procedure time, the risk of complications, the acute or long-term success rate, and the number of ablation applications.

8. PUBLICATION LIST

Topic-related scientific articles

Debreceeni D, Janosi K, Vamos M, Komocsi A, Simor T, Kupo P: Zero and Minimal Fluoroscopic Approaches During Ablation of Supraventricular Tachycardias: A Systematic Review and Meta-Analysis, **Frontiers in Cardiovascular Medicine** (2022); 856145 **IF= 3.6 Q1**

Dorottya Debreceeni, Kristof-Ferenc Janosi, Márton Turcsán, Daniel Toth, Botond Bocz, Tamas Simor, Peter Kupo: Feasibility and safety of cavotricuspid isthmus ablation using exclusive intracardiac echocardiography guidance: a proof-of-concept, observational trial. **Frontiers in Cardiovascular Medicine** (2023); 1244137 **IF=2.8 Q2**

Dorottya Debreceeni, Maja Mandel, Kristof-Ferenc Janosi, Botond Bocz, Dalma Torma, Tamas Simor, Peter Kupo: Comparison of Conventionally Performed and Intracardiac Echocardiography Guided Catheter Ablation of Atrioventricular Node—A Retrospective Single-Center Study. **Journal of Clinical Medicine** (2024); 13, 4565; **IF= 3.0 Q1**

IMPACT FACTOR: 9.4

Non-topic related scientific articles

P Kupó, R Pap, L Sággy, D Tényi, A Bálint, D Debreceeni, I Basu-Ray, A Komócsi: Ultrasound guidance for femoral venous access in electrophysiology procedures-systematic review and meta-analysis; **Journal of Interventional Cardiac Electrophysiology** (2019); 59:407-414 **IF=1.277 Q2**

Kupó Péter, Földi Eszter, Debreceeni Dorottya, Pál Endre, Faludi Réka, Tényi Dalma, Molnár Fanni, Lovadi Emese, Varga Dávid, Simor Tamás: Implantálható kardioverter-defibrillátor által sikeresen megszüntetett malignus kamrai ritmuszavar dystrophia myotonicában szenvedő betegben, **Orvosi Hetilap** (2021); 1856-1858 **IF=0.707 Q2**

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Janosi K, Debreceeni D, Simor T, Kupo P: AV-nodális reentry tachycardia, mint a pitvarfibrilláció potenciális triggere. **Cardiologia Hungarica** (2022); 254-256

Janosi K, Debreceeni D, Janosa B, Bocz B, Simor T, Kupo P: Visualizable vs. standard, non-visualizable steerable sheath for pulmonary vein isolation procedures: Randomized, single-centre trial. **Frontiers in Cardiovascular Medicine** (2022); 1033755 IF=3.6 Q1

Debreceeni D, Janosi K, Bocz B, Turcsan M, Lukacs R, Simor T, Bor A, Vamos M, Komocsi A, Kupo P: Zero fluoroscopy catheter ablation for atrial fibrillation: a systematic review and meta-analysis. **Frontiers in Cardiovascular Medicine** (2023); 856145 IF=2.8 Q2

Janosi K, Debreceeni D, Simor T, Kupo P: Diagnosztikus elektrofiziológiai vizsgálatok indikációi az ESC 2022. évi kamrai tachycardiák ellátására és a hirtelen szívhalál megelőzésére vonatkozó irányelvei alapján. **Cardiologia Hungarica** (2023); 212-217

Debreceeni D, Janosi K, Bocz B, Turcsan M, Simor T, Kupo P: Bal pitvari fülcsethrombus kimutatása intrakardiális echokardiográfiával. **Cardiologia Hungarica** (2023); 259-261

Bocz B, Debreceeni D, Janosi K, Turcsan M, Simor T, Kupo P: Electroanatomical Mapping System-Guided vs. Intracardiac Echocardiography-Guided Slow Pathway Ablation: A Randomized, Single-Center Trial. **Journal of Clinical Medicine** (2023); 5577 IF=3.0 Q1

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Janosi K, Debreceeni D, Bocz B, Torma D, Keseru M, Simor T, Kupo P: The Influence of Different Multipolar Catheter Types on Procedural Outcomes in Patients Undergoing Pulmonary Vein Isolation for Atrial Fibrillation. **Journal of Clinical Medicine** (2024); 13(4), 11029 IF=3.0 Q1

Topic-related Abstracts published in scientific journals

Debreceeni Dorottya, Jánosi Kristóf, Simor Tamás, Kupó Péter: Zero-fluorószkópiás stratégia összehasonlítása paroxysmalis supraventricularis tachycardiák katéterablációja során – metaanalízis. Aritmia és Pacemaker Kongresszus, Eger, 2021. 2021.09.23-25. **Cardiologia Hungarica** (2021); (Suppl C); B4

D Dorottya, K Janosi, G Vilmanyi, T Simor, P Kupo: Comparison of conventionally performed and electroanatomic mapping system guided catheter ablation for AV nodal reentrant tachycardia-prospective single-centre study. **Europace** (2021); 22 (Abstract supplement); 304
IF= 5.486 Q1

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D Debreceni, J Kristof-Ferenc, M Vamosi, A Komocsi, P Kupo: Zero-and minimal fluoroscopic approaches during ablation of supraventricular tachycardias: A sytematic review and meta-analysis. **Europace** (2022); 24 (Abstract supplement); 40672 **IF= 5.2 Q1**

Kupó Péter, János Kristóf-Ferenc, Bocz Botond, Turcsán Márton, Simor Tamás, Debreceni Dorottya: Röntgensugárzás-mentes cavotricuspidalis isthmus abláció elektroanatómiai térképezőrendszer nélkül: prospektív, egycentrumos vizsgálat. A Magyar Kardiológusok Társasága 2023. évi Tudományos Kongresszusa, Balatonfüred 2023.05.10-13. **Cardiologia Hungarica** (2023); (Suppl A); A364

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