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CATHETER ABLATION OF CARDIAC ARRHYTHMIAS DURING PREGNANCY: SAFETY, OUTCOMES, AND PHYSICAL ACTIVITY CONSIDERATIONS – A NARRATIVE REVIEW

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ABSTRACT

Background: Cardiac arrhythmias increasingly complicate pregnancy, affecting 68–166/100,000 pregnancy-related hospitalizations in the US, driven by advanced maternal age, congenital heart disease, and comorbidities. First-line pharmacotherapy carries risks including teratogenicity, hemodynamic disturbance, fetal growth restriction, and preterm delivery.

Aim: To assess the safety, indications, and outcomes of catheter ablation in pregnant women.

Material and Methods: PubMed and MEDLINE for catheter ablation, arrhythmia, zero fluoroscopy, antiarrhythmic drugs, physical activity in pregnancy, and cardiovascular regulation, supplemented by ESC 2025, HRS 2023, and EAPC/EHRA guidelines.

Results: Zero-fluoroscopy ablation with electroanatomical mapping is safe and effective for drug-refractory arrhythmias, hemodynamic instability, recurrent tachyarrhythmias, and arrhythmia-induced cardiomyopathy, best performed after the first trimester. Fetal adverse events were more frequent with fluoroscopy than zero-fluoroscopy (14.3% vs. 0.9%, $p=0.015$); procedural success exceeded 84%, with favorable neonatal outcomes.

Conclusions: In selected pregnant patients, zero-fluoroscopy ablation with Pregnancy Heart Team involvement is a safe alternative to chronic antiarrhythmic therapy and may allow faster return to physical activity, though unstudied in pregnancy. Randomized trials and standardized qualification protocols remain lacking.

KEYWORDS

Catheter Ablation, Pregnancy, Arrhythmia, Zero Fluoroscopy, Antiarrhythmic Drugs, Sports Cardiology

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1. Introduction

Cardiac arrhythmias are a significant clinical problem in pregnancy. In the United States they are diagnosed in 68–166 per 100,000 pregnancy-related hospitalizations. (Conti et al. 2024; Tamirisa et al. 2022) Over the last decades their frequency among pregnant patients has been rising. This trend is driven mainly by advancing maternal age, a growing proportion of women with congenital heart disease reaching reproductive age, and an increasing burden of comorbidities. (Tamirisa et al. 2022; Roelas et al. 2025; Wheat and Davis 2024) Pregnancy brings a series of adaptive changes including physiological myocardial remodeling, alteration on hormonal levels, hemodynamics shift and autonomic nervous system alterations. These changes predispose to new-onset arrhythmias or to worsening of pre-existing ones. (Conti et al. 2024; Tamirisa et al. 2022; Roelas et al. 2025) The problem is interdisciplinary and often requires a Pregnancy Heart Team approach. (Joglar et al. 2023; De Backer et al. 2025) Pharmacotherapy is usually first line treatment, but its side effects raise considerable concern. Usage of antiarrhythmic drugs in pregnant women may lead to maternal and fetal complications related to cardiovascular system, endocrine system, may affect fetal development and cause premature birth. (Conti et al. 2024; Tamirisa et al. 2022; Mariani et al. 2024) Catheter ablation is an alternative to pharmacological treatment, but it also raises questions about procedural safety, usage of anesthetics during the procedure, optimal time to start procedure and fetal impact. (Joglar et al. 2023; De Backer et al. 2025) This review was aimed at assessing the safety, indications, and outcomes of catheter ablation in pregnant women.

2. Material and Methods

PubMed and MEDLINE database were searched with the keywords: catheter ablation AND pregnancy, arrhythmia AND pregnancy, zero fluoroscopy AND pregnancy, antiarrhythmic drugs AND pregnancy, physical activity AND pregnancy, and cardiovascular regulation.

Papers published between 2015 and 2025 were included. The current ESC 2025 and HRS 2023 guidelines, together with the EAPC/EHRA position statement on physical activity and sport in patients with arrhythmias, were additionally incorporated.

3. Pathophysiology of Arrhythmias in Pregnancy

The primary arrhythmogenic mechanism in pregnancy is the increase in circulating blood volume. Plasma volume expands by 10–15% in early pregnancy and rises progressively to 40–50% above pre-pregnancy values by 30–34 weeks of gestation. Estrogen and progesterone additionally activate the renin-angiotensin-aldosterone system (RAAS), which leads to renal sodium and water retention. The increased circulating volume raises preload and stretches the atrial and ventricular walls, which activates stretch-sensitive ion channels and is therefore arrhythmogenic. (Conti et al. 2024; Tamirisa et al. 2022; Tsikouras et al. 2025)

Cardiac output increases by 30–50% over pre-pregnancy values and in multiple pregnancies the rise may reach 60–70%. (Conti et al. 2024) This is due to increased preload, reduced afterload from lower peripheral vascular resistance, and a higher heart rate. (Conti et al. 2024; Tamirisa et al. 2022; Roelas et al. 2025) The fall in vascular resistance is mediated by greater endothelial nitric oxide (NO) production under the influence of estrogen and relaxin and by the low-resistance placental circulation. (Conti et al. 2024; Tamirisa et al. 2022; Roelas et al. 2025; Bai et al. 2020; Leo et al. 2017)

Balance between the sympathetic and parasympathetic nervous systems shifts. Sympathetic activation increases, while resting vagal tone decreases. (Conti et al. 2024; Tamirisa et al. 2022; Roelas et al. 2025; Joglar et al. 2023) This is a compensatory response to the reduced vascular resistance and the direct cause of physiological pregnancy-related tachycardia. Heart rate rises by 10–30 beats per minute as early as the first trimester. It reaches a maximum at 34 weeks, with a median of 91 beats per minute (3rd–97th percentile range: 68–115 beats per minute). (Conti et al. 2024)

Pregnancy induces transient remodeling of heart muscle. The left atrial diameter increases by 0.4–0.5 cm, left ventricular muscle mass increases by 5–10%, minor pericardial effusions may appear, and the electrical axis shifts leftward by 15–20 degrees. The main pathophysiological mechanisms that promote arrhythmogenesis in pregnancy are summarized in Table 1. (Conti et al. 2024)

Table 1. Pathophysiological mechanisms promoting arrhythmogenesis during pregnancy.

Physiological Change	Primary Mechanism	Arrhythmogenic Consequence	Ref.
Increased blood volume (↑ plasma volume 40–50%)	↑ Preload → atrial wall stretching → activation of stretch-sensitive ion channels → membrane depolarization, shortened refractoriness, slowed conduction	Predisposition to reentrant arrhythmias (AVNRT, AFL, AF); facilitation of reentrant pathway lengthening	(Conti et al. 2024; Tamirisa et al. 2022; Joglar et al. 2023)
Increased cardiac output (↑ 30–50%; up to 60–70% in multiple pregnancy)	↑ Preload + ↓ afterload + ↑ HR → ventricular dilation → myocardial structural remodeling	Progressive LV/RV chamber enlargement; risk of AiCM with sustained tachyarrhythmia	(Conti et al. 2024; Tamirisa et al. 2022)
Decreased systemic vascular resistance	Estrogen-induced NO production; relaxin-mediated vasodilation; low-resistance uteroplacental circuit	Compensatory sympathetic activation → ↑ resting HR; predisposition to triggered automaticity	(Conti et al. 2024; Tamirisa et al. 2022; Roelas et al. 2025; Bai et al. 2020; Leo et al. 2017)

Physiological Change	Primary Mechanism	Arrhythmogenic Consequence	Ref.
Autonomic imbalance (↑ sympathetic / ↓ parasympathetic tone)	↑ Plasma catecholamines; ↑ adrenergic receptor density and sensitivity in myocardium; shift from vagal to sympathetic milieu	Abnormal automaticity; triggered activity; increased risk of new-onset arrhythmia or worsening of pre-existing arrhythmic substrate	(Conti et al. 2024; Tamirisa et al. 2022; Roelas et al. 2025; Joglar et al. 2023)
Hormonal changes (↑ estrogen, progesterone, relaxin, cortisol)	Estrogen and progesterone increase number and responsiveness of adrenergic receptors; cortisol potentiates sympathoadrenal activity	Enhanced arrhythmogenic potential; proarrhythmic effects on cardiac repolarization	(Conti et al. 2024; Tamirisa et al. 2022; Roelas et al. 2025; Bai et al. 2020; Leo et al. 2017)
Structural cardiac remodeling	LA diameter ↑ 0.4–0.5 cm; LV mass ↑ 5–10%; minor pericardial effusion; ECG axis shift leftward 15–20°	Altered conduction pathways; increased substrate for supraventricular arrhythmias	(Conti et al. 2024)
Postpartum period	Rapid reversal of hemodynamic adaptations; fluid redistribution; hormonal withdrawal	Highest arrhythmogenic risk period — new-onset arrhythmias or recurrence of previously controlled arrhythmias	(Conti et al. 2024; Tamirisa et al. 2022)

Abbreviations: AF — atrial fibrillation; AFL — atrial flutter; AiCM — arrhythmia-induced cardiomyopathy; AVNRT — atrioventricular nodal reentrant tachycardia; ECG — electrocardiogram; HR — heart rate; LV — left ventricle; NO — nitric oxide; RAAS — renin-angiotensin-aldosterone system; RV — right ventricle. Based on: Conti et al. (2024); Tamirisa et al. (2022); Roelas et al. (2025); Joglar et al. (2023); Bai et al. (2020); Leo et al. (2017).

4. Antiarrhythmic Pharmacotherapy in Pregnancy

In pregnancy, a large increase in plasma volume raises the glomerular filtration rate and speeds up the elimination of renally excreted substances. Increased hepatic blood flow accelerates the metabolism of drugs with a high hepatic extraction ratio (ER), such as propranolol and verapamil. Higher progesterone levels slow small intestinal motility, which may reduce the absorption of some drugs. In addition, pregnancy-induced activation of the CYP3A4 and CYP2D6 enzymes may lower the plasma concentration of active substances such as metoprolol, compared with non-pregnant women. Regular monitoring of AAD plasma concentrations throughout pregnancy is recommended. (Mariani et al. 2024; Joglar et al. 2023) Some drugs are also excreted into breast milk during lactation. A relative infant dose (RID) below 5–10% is considered a safe level of infant exposure. (De Backer et al. 2025)

In hemodynamically stable, non-recurrent supraventricular arrhythmias, vagal maneuvers are an effective first-line approach. These include the Valsalva maneuver, carotid sinus massage, and cold water facial immersion. (Conti et al. 2024; Roelas et al. 2025; Wróblewski et al. 2024)

In the Vaughan-Williams classification, antiarrhythmic drugs are divided into four classes by their primary mechanism of action. The safety profiles of the commonly used AADs in pregnancy are summarized in Table 2.

Class I, sodium channel blockers, divided into three subclasses.

Class IA agents (quinidine, procainamide) serve as second-line therapy in hemodynamically stable ventricular arrhythmias; quinidine is also used to prevent arrhythmic events in Brugada syndrome. Quinidine carries a risk of QT prolongation and torsade de pointes. Procainamide is associated with preterm labor and drug-induced lupus and requires periodic plasma concentration monitoring. (Tamirisa et al. 2022; Mariani et al. 2024) Class IB agents (lidocaine, mexiletine) are used in ventricular tachycardias. Lidocaine requires plasma concentration monitoring, and mexiletine has been linked with lower Apgar scores and isolated cases of fetal resorption. (Tamirisa et al. 2022; Mariani et al. 2024) Class IC agents (flecainide, propafenone) slow

conduction most strongly without affecting action potential duration. Flecainide is used in both maternal and fetal arrhythmias. Caution is warranted in patients with structural heart disease because of the risk of proarrhythmic events. Class IA, IB and flecainide cross the placenta. (Tamirisa et al. 2022; Mariani et al. 2024)

Class II, beta-blockers.

Beta-blockers are the drugs of choice in arrhythmias driven by sympathetic hyperactivity. Among them the selective beta-1 blockers metoprolol and bisoprolol are preferred. Compared with non-selective beta-blockers they show lower rates of intrauterine growth restriction (IUGR) and weaker effects on uterine contractility and peripheral vasodilation. (Welzel et al. 2021) Caution is needed in patients with pre-excitation or Wolff-Parkinson-White syndrome, because the arrhythmia may convert to pre-excited atrial fibrillation. Adverse effects include neonatal bradycardia and hypoglycemia. Propranolol carries a modest risk of IUGR. Atenolol is the only beta-blocker in FDA category D. A 2024 meta-analysis confirmed that it raises the risk of small-for-gestational-age (SGA) neonates significantly more than labetalol, propranolol, bisoprolol, and metoprolol, so it should be avoided in pregnancy. (Tamirisa et al. 2022; Mariani et al. 2024; Bratton et al. 2024)

Class III, potassium channel blockers (amiodarone, dronedarone, sotalol).

Amiodarone crosses the placenta and may cause fetal hypothyroidism with congenital goiter, growth restriction, prematurity and neurodevelopmental abnormalities, so its use should be limited to life-threatening cases refractory to other drugs. (Tamirisa et al. 2022; Mariani et al. 2024) Dronedarone is absolutely contraindicated in pregnancy because of the risk of vascular, limb, and cleft palate defects. (Tamirisa et al. 2022; Mariani et al. 2024) Sotalol causes fetal bradycardia and hypoglycemia. Both sotalol and amiodarone may prolong the QT interval and trigger torsade de pointes, a life-threatening ventricular tachycardia. Risk of serious maternal arrhythmias and the possibly stronger effect on the immature fetal heart lead to mandatory ECG monitoring when these drugs are started or their dose is changed. (Conti et al. 2024; Tamirisa et al. 2022; Mariani et al. 2024)

Class IV, the calcium channel blockers (verapamil, diltiazem).

Class IV is associated with more frequent preterm delivery and lower neonatal birth weight (23.8% vs. 6.5% in the placebo group). Verapamil may cause neonatal bradycardia and hypotension. Diltiazem has shown embryotoxic effects in animal studies and should be used with caution. (Tamirisa et al. 2022; Mariani et al. 2024)

Agents that are not included in classification (adenosine, digoxin).

Adenosine, because of its very short half-life (10–30 seconds), is the safe drug of choice for terminating hemodynamically stable paroxysmal supraventricular arrhythmias once vagal maneuvers have failed. Rare adverse effects include transient dyspnea, flushing, or chest discomfort. (Conti et al. 2024; Mariani et al. 2024) Digoxin remains debated. Circulating digoxin-like immunoreactive substances in plasma may falsify its concentration measurements, so signs of toxicity must be assessed clinically in parallel. (Mariani et al. 2024)

Refractory atrial fibrillation is especially difficult to manage pharmacologically in pregnancy (see Section 5.1.1).

Table 2. Safety profiles of antiarrhythmic drugs (AADs) in pregnancy — Vaughan-Williams classification.

VW Class	Drug	FDA Cat.	Placental Transfer	Main Fetal / Neonatal Risks	Fetal Arrhythmia Use	Ref.
–	Adenosine	C	Unknown	Transient dyspnea, flushing; no significant fetal adverse effects at standard doses	No	(Conti et al. 2024; Mariani et al. 2024)
IB	Lidocaine	B	Yes	Requires plasma monitoring; no effect on fetal HR or uteroplacental circulation at therapeutic doses	No	(Tamirisa et al. 2022; Mariani et al. 2024)
–	Digoxin	C	Yes	Measurement may be falsified by digoxin-like immunoreactive substances; requires clinical monitoring	Yes	(Mariani et al. 2024)
II	Metoprolol / Bisoprolol	C	Yes	Neonatal bradycardia, hypoglycemia; preferred beta-1-selective agents in pregnancy	No	(Tamirisa et al. 2022; Mariani et al. 2024; Welzel et al. 2021)
II	Propranolol	C	Yes	Neonatal bradycardia, hypoglycemia; modest risk of IUGR	No	(Tamirisa et al. 2022; Mariani et al. 2024)
II	Atenolol	D	Yes	Significantly increased SGA risk vs. other beta-blockers — AVOID in pregnancy	No	(Tamirisa et al. 2022; Mariani et al. 2024; Bratton et al. 2024)
IA	Procainamide	C	Yes	Risk of preterm labor, drug-induced lupus; requires periodic plasma monitoring	No	(Tamirisa et al. 2022; Mariani et al. 2024)
IA	Quinidine	C	Yes	QT prolongation, risk of torsade de pointes	No	(Tamirisa et al. 2022; Mariani et al. 2024)
IB	Mexiletine	C	Yes	Lower Apgar scores, fetal resorption (rare); requires plasma monitoring	No	(Tamirisa et al. 2022; Mariani et al. 2024)
IC	Flecainide	C	Yes	Caution with structural heart disease (proarrhythmia risk); used in fetal arrhythmias	Yes	(Tamirisa et al. 2022; Mariani et al. 2024)
IC	Propafenone	C	Yes	Limited safety data; avoid in structural heart disease	No	(Tamirisa et al. 2022; Mariani et al. 2024)
III	Sotalol	B	Yes	Fetal bradycardia, hypoglycemia; QT prolongation and torsade de pointes risk — ECG monitoring required	Yes	(Tamirisa et al. 2022; Mariani et al. 2024)

VW Class	Drug	FDA Cat.	Placental Transfer	Main Fetal / Neonatal Risks	Fetal Arrhythmia Use	Ref.
III	Amiodarone	D	Yes	Fetal hypothyroidism, growth restriction, prematurity — restrict to life-threatening, last-resort use only	No	(Tamirisa et al. 2022; Mariani et al. 2024)
III	Dronedarone	X	Unknown	ABSOLUTELY CONTRAINDICATED — vascular, limb abnormalities and cleft palate	No	(Tamirisa et al. 2022; Mariani et al. 2024)
IV	Verapamil	C	Yes	Neonatal bradycardia, hypotension; cardiovascular collapse risk if EF unknown/reduced (Wang et al. 2020)	No	(Tamirisa et al. 2022; Mariani et al. 2024; Wang et al. 2020)
IV	Diltiazem	C	No	Embryotoxic in animal studies; increased preterm delivery and reduced birth weight	No	(Tamirisa et al. 2022; Mariani et al. 2024)

Abbreviations: AAD — antiarrhythmic drug; EF — ejection fraction; FDA — Food and Drug Administration; HR — heart rate; IUGR — intrauterine growth restriction; SGA — small for gestational age; VW — Vaughan-Williams. FDA categories: B — no fetal risk in animal studies; C — adverse effects in animal studies, limited human data; D — evidence of human fetal risk; X — contraindicated. Based on: Mariani et al. (2024); Joglar et al. (2023); Pan et al. (2024); Bratton et al. (2024); Welzel et al. (2021); Wang et al. (2020).

5. Catheter Ablation in Pregnancy

5.1 Indications

Catheter ablation is not first-line therapy for arrhythmias in pregnant patients. The 2025 ESC Guidelines recommend considering it preferably after the first trimester, in symptomatic, recurrent arrhythmias refractory to pharmacological treatment. The list includes ventricular tachycardia (VT), atrioventricular nodal reentrant tachycardia (AVNRT), atrioventricular reentrant tachycardia (AVRT), focal atrial tachycardia (FAT), cavotricuspid isthmus-dependent atrial flutter, and selected benign forms of right-sided VT (Class IIb, Level C). The same guidelines add that catheter ablation has no role in treating atrial fibrillation during pregnancy. (De Backer et al. 2025)

The main concern with catheter ablation in pregnancy is fetal exposure to ionizing radiation. The 2023 HRS Expert Consensus Statement notes, however, that the estimated radiation dose during ablation is unlikely to exceed the 50 mGy threshold, above which fetal developmental abnormalities have been described. (Conti et al. 2024; Tamirisa et al. 2022; Joglar et al. 2023) Modern techniques such as zero-fluoroscopy and electroanatomical mapping (EAM) can remove ionizing radiation exposure for both mother and fetus altogether (Class IIa, Level C according to ESC 2025). (You et al. 2023; Mladoniczky et al. 2023; Klebukowska et al. 2024; De Backer et al. 2025; Albertini and Spears 2023) HRS 2023 confirms the efficacy and safety of catheter ablation performed this way, but adds that every case should be supervised by a multidisciplinary cardio-obstetric team. (Joglar et al. 2023; Albertini and Spears 2023)

Table 3 gives an overview of the indications for catheter ablation during pregnancy together with the matching guideline recommendations.

Table 3. Indications for catheter ablation during pregnancy according to ESC 2025 and HRS 2023 guidelines.

Indication	Description	Guideline	Class / Level	Ref.
Drug-refractory arrhythmia	Persistence of a symptomatically significant, poorly tolerated arrhythmia despite appropriate AAD therapy. Includes AVNRT, AVRT, FAT, cavotricuspid isthmus-dependent AFL, and selected benign right-sided VT. Preferred after the first trimester.	ESC 2025 / HRS 2023	IIb / C	(Joglar et al. 2023; De Backer et al. 2025)
Hemodynamic instability	Arrhythmia causing syncope, heart failure, cardiogenic shock, or placental hypoperfusion with fetal hypoxia. Ablation should not be deferred regardless of gestational age in life-threatening situations.	ESC 2025 / HRS 2023	IIa / C	(Conti et al. 2024; Tamirisa et al. 2022; Joglar et al. 2023; De Backer et al. 2025)
Arrhythmia-induced cardiomyopathy (AiCM)	LV systolic dysfunction secondary to sustained tachyarrhythmia; reversible upon arrhythmia elimination. PVC burden >10% on 24-h Holter is clinical threshold. Aggressive treatment with beta-blockers and/or catheter ablation recommended.	HRS 2023	IIa / C	(Joglar et al. 2023; Varrenti et al. 2025; Shoureshi et al. 2024)
Ventricular tachycardia (VT)	Drug-refractory, recurrent, sustained, or poorly tolerated VT. Emergency ablation may be necessary when life-threatening. Zero-fluoroscopy technique in experienced center.	ESC 2025	IIb / C	(De Backer et al. 2025; Liu et al. 2025; Li et al. 2024)
AF coexisting with WPW syndrome	Pre-excited AF in WPW — the only scenario where AF in pregnancy may be an indication for ablation. Target of ablation is the accessory pathway, not the pulmonary veins.	ESC 2025	IIa / C	(Yuan 2022; De Backer et al. 2025)

Abbreviations: AAD — antiarrhythmic drug; AF — atrial fibrillation; AFL — atrial flutter; AiCM — arrhythmia-induced cardiomyopathy; AVNRT — atrioventricular nodal reentrant tachycardia; AVRT — atrioventricular reentrant tachycardia; FAT — focal atrial tachycardia; LV — left ventricular; PVC — premature ventricular contraction; VT — ventricular tachycardia; WPW — Wolff-Parkinson-White syndrome. Based on: De Backer et al. (2025); Joglar et al. (2023); Varrenti et al. (2025); Shoureshi et al. (2024); Liu et al. (2025); Li et al. (2024).

5.1.1 Drug-refractory arrhythmias

The primary indication for catheter ablation in pregnancy is an arrhythmia refractory to pharmacotherapy. This is defined as a symptomatically significant, poorly tolerated arrhythmia that persists despite appropriately selected antiarrhythmic drugs. (Joglar et al. 2023; De Backer et al. 2025) AVNRT is the most common arrhythmia in pregnancy. Wang et al. suggest referring patients with AVNRT to a center with a Pregnancy Heart Team and zero-fluoroscopy capability when arrhythmia is refractory to pharmacotherapy and a heart rate reaches ≥ 170 beats per minute during episodes. (Wang 2023)

In the review by Yuan et al., which covered 128 patients, the main indication for ablation was refractoriness to pharmacotherapy (80.8% of cases). The most frequent arrhythmias were AVNRT (24.8%), AT (16.3%), and WPW syndrome (5.4%); AF and VT each accounted for 2.3%. Part of the AF cases were in fact AF coexisting with WPW syndrome, where the target was the accessory pathway. This is consistent with the current 2025 ESC Guidelines, under which isolated AF is not an indication for ablation during pregnancy. (Yuan 2022; De Backer et al. 2025)

Even when ablation is not indicated, controlling AF pharmacologically during pregnancy can be a serious challenge. Refractory AF is the most difficult scenario. In the report by Abu Za'nounh et al., a 35-year-old pregnant patient (G4P1) presented at 19 weeks of gestation. She had undergone postpartum pulmonary vein isolation after her third pregnancy but developed recurrent AF during her fourth. The arrhythmia did not respond to metoprolol, flecainide, digoxin, or verapamil, and raising the beta-blocker dose caused syncope. She was eventually maintained until term on metoprolol with low-dose flecainide and delivered a healthy infant at 40 weeks. (Abu Za'nounh et al. 2026)

5.1.2 Hemodynamic instability

Hemodynamic instability from an arrhythmia threatens both mother and fetus. In the mother it may cause syncope, heart failure, cardiogenic shock, thromboembolic complications, and stroke. Any hemodynamic deterioration (whether from the arrhythmia itself or from side effects of antiarrhythmic drugs such as hypotension) can lead to placental hypoperfusion and fetal hypoxia. This requires urgent intervention. (Conti et al. 2024; Tamirisa et al. 2022; Mariani et al. 2024; Yuan 2022)

5.1.3 Arrhythmia-induced cardiomyopathy

A separate group of indications is patients with arrhythmia-induced cardiomyopathy (AiCM). AiCM is a left ventricular systolic dysfunction caused by sustained tachyarrhythmias and reversible once the arrhythmia is stopped. Left ventricular function deteriorates progressively as the tachycardia dilates the ventricle. The course may be asymptomatic, but without treatment it leads to maternal cardiomyopathy. (Yuan 2022) The clinical threshold for AiCM risk is a premature ventricular contraction burden above 10% of all beats on 24-hour Holter monitoring. (Varrenti et al. 2025) These changes are reversible at first, after successful treatment of the arrhythmia. Recurrent tachyarrhythmia, however, may cause permanent ultrastructural myocardial damage, and reports of sudden death in patients with a normalized ejection fraction cast doubt on the idea that AiCM is fully reversible. (Shoureshi et al. 2024) The 2023 HRS Guidelines recommend aggressive treatment of AiCM with beta-blockers and/or catheter ablation. (Joglar et al. 2023) In AiCM the arrhythmia has to be eliminated early and reliably, and pharmacotherapy cannot guarantee that. This makes catheter ablation the method of choice in this group, as it helps avoid permanent left ventricular dysfunction in the mother and the fetal complications that follow. (Joglar et al. 2023; Varrenti et al. 2025; Shoureshi et al. 2024) AiCM should not be confused with peripartum cardiomyopathy (PPCM), an idiopathic systolic dysfunction of the left ventricle with a hormonal-vascular etiopathogenesis, in which the arrhythmia is a consequence, not a cause, of damage to the heart muscle. (Zielonka et al. 2023)

In the systematic review by Wang et al. suspected AiCM was found in as many as 67% of pregnant patients with AT, and the left ventricular ejection fraction improved in 15 of 15 patients with post-treatment follow-up. The authors also warn against verapamil in patients with an unknown or reduced ejection fraction, since two cases of cardiovascular collapse after its use have been described in this group. (Wang et al. 2020)

5.1.4 Ventricular tachycardia

Pharmacotherapy-refractory ventricular tachycardia (VT) is a particularly difficult indication and forces urgent decisions. Liu et al. described a successful emergency zero-fluoroscopy ablation in a patient at 32 weeks of gestation. She had idiopathic VT arising from the posterior fascicle of the left ventricle after myocarditis, unresponsive to adenosine and to drugs. The procedure was done as an emergency with a multidisciplinary team and restored sinus rhythm, with no fetal complications. The patient delivered a healthy infant two months later. (Liu et al. 2025) Li et al. reported a comparable outcome at the ACC 2024 Congress. A 24-year-old patient at 29 weeks of gestation, with VT from the left ventricular outflow tract refractory to lidocaine, sotalol, and metoprolol, underwent successful zero-fluoroscopy ablation through retrograde aortic access and delivered a healthy infant at 36 weeks. (Li et al. 2024)

5.2 Procedural Timing

Both the 2023 HRS and the 2025 ESC guidelines recommend performing catheter ablation after the first trimester. This is justified by the risk from ionizing radiation and the risk of general anesthesia during the ongoing organogenesis in the first trimester. The radiation problem can be removed by using zero-fluoroscopy techniques and electroanatomical cardiac mapping. The anesthesia risk during this period, on the other hand, remains a separate reason for caution. (Mariani et al. 2024; Joglar et al. 2023; De Backer et al. 2025)

In the review by Yuan et al., all fetal adverse events fell in the second trimester, and none in the first or third. On this basis the authors suggested that the third trimester may be the optimal timing. (Yuan 2022) Both guidelines recommend that in a life-threatening maternal arrhythmia ablation should not be delayed because of gestational age. (Joglar et al. 2023; De Backer et al. 2025)

Antiarrhythmic drugs should be avoided where possible, above all in the first trimester, because the risk of adverse effects during organogenesis is higher. (Mariani et al. 2024; Yuan 2022)

5.3 Procedural Techniques

In pregnancy, catheter ablation is performed under conscious sedation, with maintained verbal contact and under local anesthesia. Where possible, antiarrhythmic drugs (AADs) should be stopped at least two weeks before the planned procedure. The preferred vascular access is the right femoral vein, and the right internal jugular vein is the alternative. Electroanatomical cardiac mapping is done with the CARTO EAM or NavX-EnSite EAM systems, which let the procedure run with the zero-fluoroscopy technique. A standard electrophysiological study (EPS) uses a decapolar coronary sinus catheter, a quadripolar right ventricular catheter, and a His bundle catheter. In selected cases the arrhythmia is induced with an intravenous infusion of isoproterenol, a beta-adrenergic receptor agonist, and rapid pacing is kept to a minimum to protect fetal well-being. Periprocedural anticoagulation is given as a bolus of 5,000 units of unfractionated heparin. When a transseptal puncture is needed because of a left-sided accessory pathway, it is carried out under intracardiac echocardiography (ICE) guidance, still without fluoroscopy. (Yuan 2022; Mladoniczky et al. 2023)

ICE also allows intraprocedural monitoring of fetal cardiac activity, as Vipparthy et al. showed in the first documented case of zero-fluoroscopy PVI in a pregnant patient. (Vipparthy et al. 2023)

The procedure differs from standard ablation in non-pregnant patients in several respects. In pregnancy the patient lies with left lateral uterine displacement rather than supine, so that the enlarged uterus does not compress the aorta and vena cava. Intraprocedural fetal monitoring with cardiotocography (CTG) is obligatory. Radiation-free EAM systems must replace the standard C-arm fluoroscopy. (Yuan 2022; Mladoniczky et al. 2023; Rodkiewicz et al. 2022)

The zero-fluoroscopy technique allows safe ablation even in anatomically difficult locations. Li et al. described a successful ablation of ventricular tachycardia arising from the left coronary cusp (LCC) in a 25-year-old patient at 12 weeks of gestation, performed with the NavX system. The LCC is a demanding site, because the left main coronary artery lies in close proximity and procedural risk is therefore higher. (Li et al. 2023)

5.4 Pregnancy Heart Team

The decision to perform catheter ablation in pregnancy requires a Pregnancy Heart Team (a cardio-obstetric team) with a clearly defined composition and division of duties. The obstetrician-gynecologist provides overall care. The maternal-fetal medicine specialist leads fetal care, a role taken over by the neonatologist after delivery. The cardiologist and electrophysiologist handle both pharmacological and interventional management of arrhythmia and decide together on eligibility for ablation. The anesthesiologist is responsible for vascular cannulation, safe administration of procedural drugs, and supervision of conscious sedation, all of which limit fetal risk. The 2023 HRS Expert Consensus Statement emphasizes that shared decision-making should cover the maternal and fetal risks and benefits of both drugs and interventional procedures, and the risk of withholding treatment. When ablation is planned, the team should additionally prepare for urgent delivery in high-risk cases. The 2025 ESC Guidelines add that not every hospital has to set up a dedicated Pregnancy Heart Team, but every center should arrange the interdisciplinary cooperation needed for comprehensive care of pregnant patients with arrhythmias. (Joglar et al. 2023; Yuan 2022; De Backer et al. 2025; Albertini and Spears 2023)

Table 4 sets out the composition and roles of the Pregnancy Heart Team in the context of catheter ablation in detail.

Table 4. Composition and responsibilities of the Pregnancy Heart Team in the management of arrhythmias requiring catheter ablation.

Team Member	Primary Responsibilities	Role in Catheter Ablation Context	Ref.
Obstetrician-gynecologist	Overall maternal care throughout pregnancy, labor, delivery, and postpartum period; coordination of referrals and emergency management	Primary provider of obstetric care; coordinates emergency cesarean delivery if required during ablation procedure	(Joglar et al. 2023; Yuan 2022; De Backer et al. 2025)
Maternal-fetal medicine specialist (MFM)	Specialized fetal surveillance; high-risk pregnancy management; assessment of fetal well-being before, during, and after invasive procedures	Leads fetal care during antepartum period; indispensable in high-risk procedures; role assumed postpartum by neonatologist	(Joglar et al. 2023; Yuan 2022; De Backer et al. 2025)
Cardiologist / Electrophysiologist	Arrhythmia diagnosis and management; pharmacotherapy optimization; decision-making regarding ablation eligibility; performance of catheter ablation	Central clinical decision-maker for arrhythmia treatment; performs zero-fluoroscopy ablation; responsible for EAM-guided mapping	(Joglar et al. 2023; Yuan 2022; De Backer et al. 2025; Albertini and Spears 2023)
Anesthesiologist	Vascular access (internal jugular vein cannulation); conscious sedation management; hemodynamic monitoring; drug safety during procedure	Ensures safe periprocedural sedation; minimizes fetal risk from pharmacological agents; prepares for emergency delivery if needed	(Joglar et al. 2023; Yuan 2022)
Neonatologist	Preparation for potential preterm delivery; neonatal resuscitation readiness; management of drug-related neonatal adverse effects	Present or on-call during high-risk procedures; assumes fetal care role after delivery	(Joglar et al. 2023; Yuan 2022)
Pediatric electrophysiologist (if fetal arrhythmia present)	Diagnosis and management of fetal arrhythmias; guidance on transplacental pharmacotherapy for fetal indications	Involved when maternal AAD therapy is administered for fetal arrhythmia (e.g., fetal SVT, fetal AF)	(Joglar et al. 2023)
Genetic counselor (if indicated)	Assessment of inherited arrhythmia syndromes (LQTS, Brugada, CPVT, HCM); family risk counseling; reproductive planning	Involved in pre-conception counseling and when inherited arrhythmic substrate is identified	(Joglar et al. 2023; De Backer et al. 2025)

Abbreviations: AAD — antiarrhythmic drug; AF — atrial fibrillation; CPVT — catecholaminergic polymorphic ventricular tachycardia; EAM — electroanatomical mapping; HCM — hypertrophic cardiomyopathy; LQTS — long QT syndrome; MFM — maternal-fetal medicine; SVT — supraventricular tachycardia. Based on: Joglar et al. (2023); Yuan SM (2022); De Backer et al. (2025); Albertini & Spears (2023).

5.5 Outcomes in Mother and Neonate Following Catheter Ablation During Pregnancy

In the case series by Mladoniczky et al., which comprised 13 pregnant patients treated with zero-fluoroscopy ablation, no procedural complications were recorded. The procedural success rate was 84.6% (11/13 procedures). In 11 of the 13 patients (84.6%) no antiarrhythmic drug therapy was needed during long-term follow-up, and all patients stayed free of arrhythmia for the whole observation period (30.0 ± 25.0 months). The procedures were performed at a mean gestational age of 24 weeks (range: 20–27 weeks). In one patient with AiCM and a baseline left ventricular ejection fraction (LVEF) of 35%, the ejection fraction rose to 50% within a few days of a successful ablation of VT from the right ventricular outflow tract. (Mladoniczky et al. 2023)

Obstetrics and neonatal outcomes were favorable. Deliveries took place at a mean gestational age of 38 weeks (range: 36–39 weeks). Thirteen healthy neonates were born; 4 (30.8%) were delivered vaginally and 9 (69.2%) by cesarean section, most of the latter for fetal indications. Mean birth weight was $2,989 \pm 834$ g, within the normal range. Apgar scores were normal in every case, with a median of 9.0 (IQR 9.0–10.0) at 1 minute and 10.0 (IQR 9.3–10.0) at 5 minutes of life. (Mladoniczky et al. 2023)

In the review by Yuan et al., which covered 128 pregnant patients, procedural complications occurred in 2 (1.6%) cases: iliofemoral thrombosis in one, and severe hypoxemia with tachypnea and hypotension in the other. Pregnancy-related complications were recorded in 3 (2.4%) patients, namely placental abruption, pre-eclampsia with placental separation, and spontaneous abortion. There was no maternal mortality. Fetal adverse events occurred in 3.1% of cases, and their rate was significantly higher in the fluoroscopy group than in the zero-fluoroscopy group (14.3% vs. 0.9%, $p = 0.015$). The left ventricular ejection fraction rose significantly after the procedure compared with pre-procedural values ($30.7 \pm 10.3\%$ vs. $46.3 \pm 13.4\%$, $p = 0.013$). (Yuan 2022)

You et al. compared 16 ablations with complete elimination of fluoroscopy against 24 with minimal fluoroscopy in pregnant patients with SVT. The two techniques were comparable in efficacy and safety. Neither group had periprocedural complications, and obstetric outcomes, including the delivery of healthy neonates, were favorable in both. The zero-fluoroscopy technique has comparable efficacy and removes the theoretical risk of ionizing radiation, which makes it the preferred method in pregnant patients. (You et al. 2023)

The emergency zero-fluoroscopy ablation reported by Liu et al. (Section 5.1.4) restored sinus rhythm immediately, and the patient delivered a healthy infant with no arrhythmia recurrence. (Liu et al. 2025)

These data match outcomes in large cohorts of non-pregnant patients. In the retrospective single-center analysis by David et al., which included 605 consecutive SVT ablations, the acute procedural success rate exceeded 98% in both the zero-fluoroscopy and the fluoroscopy groups. Procedural complications (0.66%) occurred only in the fluoroscopy group, and none were recorded in the zero-fluoroscopy group in this cohort. Complications with the zero-fluoroscopy technique are still possible, however, and have been reported. Troisi et al., for instance, described cardiac tamponade and femoral vein thrombosis in a 34-year-old pregnant patient with recurrent AT from the right atrial appendage. The patient had previously undergone three catheter ablation procedures (1999, 2008, 2014) for right atrial tachycardia. (David et al. 2025; Troisi et al. 2024)

5.6 Physical Activity and Return to Exercise After Catheter Ablation

Successful catheter ablation does not only remove the arrhythmia itself. It can also change how much physical activity can be safely recommended to the mother for the rest of the pregnancy. The 2025 ESC Guidelines recommend at least 150 minutes of moderate-intensity aerobic activity per week for pregnant women with cardiovascular disease, with the exercise prescription individualized according to ventricular function, pulmonary artery pressure, aortic dimensions, presence of arrhythmias, and oxygen saturation or lung function. (De Backer et al. 2025)

Outside pregnancy, the EAPC/EHRA position statement on supraventricular arrhythmias states that patients who are asymptomatic and free of inducible arrhythmia after a successful ablation can return to full competitive sport, and that low-to moderate-intensity leisure activity can usually be resumed about a week after an uncomplicated procedure. (Heidbuchel et al. 2021) These recommendations were written for the general athletic population, not specifically for pregnant patients. Still, they point in the same direction as the data reviewed here: unlike chronic antiarrhythmic therapy, ablation opens up the possibility of a faster return to physical activity once the mother has recovered from the procedure and from delivery. This question has not been studied directly in pregnant patients and would be a reasonable target for future research.

6. Discussion

This narrative review indicates that zero-fluoroscopy catheter ablation is a safe and effective alternative to antiarrhythmic pharmacotherapy in selected arrhythmias during pregnancy. The analyzed studies show that, when an arrhythmia is refractory to drugs or poorly tolerated, ablation carries a more favorable fetal safety profile than prolonged antiarrhythmic therapy. (Mladoniczky et al. 2023)

Polypharmacy in pregnancy is one especially relevant problem. Pregnant patients with comorbidities such as arterial hypertension, gestational diabetes, cholestasis, or thyroid disorders often take several medications at once. Adding another antiarrhythmic agent to an already complex regimen raises the risk of drug interactions, fetal adverse effects, poorer compliance, and difficulty in attributing adverse events to a specific drug when several medications are used concurrently. Studies report that between 4.9% and 62.4% of pregnant women are prescribed two or more medications at the same time (wide range reflects the heterogeneity of polypharmacy definitions used across studies, as well as differences in data collection methods, populations studied, and whether over-the-counter medications were included). As a one-time intervention, catheter ablation eliminates the need for chronic pharmacotherapy and thus avoids adding to an already complex drug regimen. (Mariani et al. 2024; Subramanian et al. 2023; Anand et al. 2023)

The available data still shows clear limits of the current literature. Most of the evidence comes from case reports and small case series. Randomized clinical trials are lacking, since in this population they are both methodologically hard and ethically problematic. Yuan et al. directly point to this absence as the main obstacle to evidence-based clinical decisions. (Yuan 2022)

Current epidemiological data on trends in arrhythmia incidence during pregnancy are also limited, as the most recent figures reach only 2019. With the rising age of pregnant women, the heavier comorbidity burden, and the growing number of adults with congenital heart disease reaching reproductive age, the real scale of the problem may be much larger than the present data suggest. (Thakkar et al. 2022)

Another open question is the lack of a precise definition of ‘drug-refractory arrhythmia’ in pregnancy. The guidelines use the phrase arrhythmia ‘refractory to pharmacotherapy and poorly tolerated’, but they do not set the threshold at which a partial response to drugs justifies considering ablation. (Joglar et al. 2023; De Backer et al. 2025)

The case by Abu Za’nounh et al. is the first reported AF refractory to both pharmacotherapy and a prior ablation in a pregnant patient. It shows that the limits of the indications for ablation in pregnancy are still undefined, and that treatment decisions need an individualized approach that goes beyond the current guidelines. (Abu Za’nounh et al. 2026)

The case by Troisi et al. shows how complex ablation in pregnancy can be. A 34-year-old patient had recurrent AT from the right atrial appendage. Procedural complications appeared, namely cardiac tamponade and femoral vein thrombosis, yet sound interdisciplinary management still secured a good outcome for both mother and fetus. The case underlines how much depends on an experienced center able to provide comprehensive cardio-obstetric care. (Troisi et al. 2024)

How much physical activity is reasonable for a woman once her arrhythmia has been treated during pregnancy is so far barely addressed in the literature. The recommendations discussed in Section 5.6, including the EAPC/EHRA position statement on return to sport after ablation, were developed for the general athletic population rather than for pregnant patients recovering from the procedure and preparing for delivery. Whether they can be applied directly to this group is unclear and has not, to our knowledge, been studied.

Despite these limits, the overall body of data justifies considering the use of zero-fluoroscopy catheter ablation as a safe option in carefully selected pregnant patients with arrhythmia, performed in experienced centers with Pregnancy Heart Team involvement. Future work should build multicenter registries and develop standardized qualification protocols for the procedure in this population. (Joglar et al. 2023; Yuan 2022; Mladoniczky et al. 2023; De Backer et al. 2025)

7. Conclusions

Cardiac arrhythmias in pregnant patients are a problem of rising prevalence, and they call for an interdisciplinary approach within a Pregnancy Heart Team. Under the current guidelines antiarrhythmic pharmacotherapy is the first or second line of treatment after vagal maneuvers. It carries documented adverse effects for both mother and fetus, and against the background of widespread polypharmacy in pregnancy it adds further risks of drug interactions and reduced compliance. (Mariani et al. 2024; Joglar et al. 2023; Subramanian et al. 2023; Anand et al. 2023)

The indications for catheter ablation in pregnancy are arrhythmias refractory to pharmacotherapy, hemodynamic instability, recurrent tachyarrhythmias, and arrhythmia-induced cardiomyopathy (AiCM). The method of choice is the zero-fluoroscopy technique with electroanatomical cardiac mapping, performed after the first trimester in experienced centers. Fetal adverse events were reported only in the conventional fluoroscopy group, not in the zero-fluoroscopy group. AiCM is reversible once the arrhythmia is treated successfully, whether by drugs or by ablation. (Yuan 2022; You et al. 2023; Mladoniczky et al. 2023; De Backer et al. 2025)

In selected arrhythmias during pregnancy, catheter ablation may be a safer option than chronic antiarrhythmic pharmacotherapy. Randomized clinical trials in this population are still lacking, however, as are standardized procedural qualification protocols and clear guidance on physical activity after the procedure. This is an important limitation of the current evidence and a clear direction for future research. (Joglar et al. 2023; Yuan 2022; Mladoniczky et al. 2023; De Backer et al. 2025)

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