

# Radiofrequency ablation without the use of fluoroscopy – in what kind of patients is it feasible?

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## Abstract

**Introduction:** The aim of the study was to describe the experience in performing ablation without fluoroscopy.

**Material and methods:** From 575 ablation procedures with CARTO performed in the period 2003–2008, 108 (42 M; age 40 ±16 years) were done without fluoroscopy. One patient had ablation using the Localisa system. There was one man with thrombocytopenia and two pregnant women.

**Results:** Right ventricular (RV) outflow tract arrhythmias and other RV arrhythmias were noted in 38 patients (35%) and 17 patients (15%), respectively. There were 5 (4.6%) left ventricular (LV) outflow tract arrhythmias and 19 (17.5%) other LV tachycardias; right accessory pathways in 17 patients (20%), in the middle cardiac vein in 1, Mahaim fibres in 1, and 3 cases of permanent junctional reciprocating tachycardias. One patient with CRT had AV node ablation (Localisa). In 3 patients there were also other arrhythmias treated: slow AV nodal pathway, typical flutter isthmus and right atrial tachycardia. In 2004, 1/96 CARTO procedures was done without fluoroscopy, in 2006 2/97, in 2007 19 (2 in LV) of 93, in 2008 87 (22 in LV) of 204. The percentage of ablations without fluoroscopy in every hundred CARTO procedures was: 1%, 1%, 8%, 23%, 46%, 28% (mean 18%). There were no procedure-related complications.

**Conclusions:** It is feasible to perform ablations within both right and left sides of the heart without fluoroscopy. The number and type of non-fluoroscopic procedures depends on the operator's experience. Pregnant patients, with malignant history or with hematologic diseases should be ablated without fluoroscopy in centres that specialise in these kinds of procedures.

**Key words:** radiofrequency ablation, pregnancy, electroanatomical system, no fluoroscopy.

## Introduction

Contemporary, cardiac electrophysiology has gained an influential position as a treatment method of patients with different arrhythmias. In the past, radiofrequency (RF) ablation was applied exclusively to atrioventricular nodal re-entrant tachycardias, atrioventricular tachycardias using accessory pathways and typical atrial flutter. Over the last two decades the scope of arrhythmias treated by RF ablation has expanded impressively. Owing to technological advances in recent years, we may use many types of flexible ablation catheters which allow us not only to reach places that previously remained inaccessible but also to make use of new, different sources of energy such as cryo, laser, ultrasound, and microwave. New mapping

and navigation systems have also appeared. They facilitate the procedure due to three-dimensional imaging and make it safer as they reduce the fluoroscopy. The above-mentioned achievements of catheter technology allowed enlargement of the population of people that may be ablated. However, some complex cases require more than one procedure, which in turn may cause excessive exposure to radiation and related side-effects.

As diagnostic imaging is commonly used, more and more patients are subject to X-ray based examinations. This leads to an increase in individual exposure and radiation-related risks of a fatal malignancy. Predisposition to late malignancies as a sequel to radiation exposure is therefore a source of concern. Taking into account the above, one should aim at decreasing radiation to an absolute minimum or eliminating it completely in order to avoid further complications.

The purpose of this study was to describe our experience in performing ablation without fluoroscopy, usually using the CARTO (Biosense Webster, Johnson & Johnson) system.

## Material and methods

We analysed retrospectively, with CARTO, 575 ablation procedures that were performed in our centre between 2003 and 2008. One hundred and eight patients (42 men and 64 women; mean age  $40 \pm 16$  years) were ablated without fluoroscopy. In the analysed group there was one man with thrombocytopenia and two pregnant women. In the first 30 procedures, in the beginning, we used a very short-lasting X-ray pulse ( $0.008 \pm 0.02$  min) in order to assess the position of RefPath. Next 78 procedures were performed without such an assessment. One patient with CRT had AV nodal ablation using the Localisa system (Medtronic). An ablation catheter (NaviStar 4 mm, Johnson & Johnson) was inserted using a femoral vein approach and, when

left ventricle or mitral annulus mapping was necessary, an aorta approach was used. Patients with long RP tachycardias and pregnant women had reference and ablation catheters placed through the right internal jugular vein. A coronary sinus (CS) reference catheter required the guidance of transthoracic echocardiography (TTE). A proper QRS complex or CS atrial activity (in atrial arrhythmias) was usually set as a reference. Ablation with the Localisa system was performed using a Marinr 4-mm tip catheter (Medtronic).

The procedure without fluoroscopy requires that catheters be smoothly and gently inserted in the right or left atrium of the heart. After that the mapping catheter is visualised by the CARTO system in two perpendicular planes. Guided by the CARTO image and potentials, one can acquire points within the right atrium starting from the superior vena cava (SVC). As a first step, we try to delineate the crucial points in the area of interest (e.g. tricuspid valve, pulmonary trunk cusps, SVC and IVC, CS and His potential in right-sided arrhythmias). Having obtained these points, the procedure continues as in an ordinary CARTO procedure.

All patients were informed about potential risks and provided written consent before undergoing an ablation procedure. All procedures without fluoroscopy were performed by the same experienced operator.

## Results

The majority of 108 procedures without fluoroscopy concerned the right ventricle (RV). Right ventricular outflow tract tachycardias (RVOT VT) and right ventricular tachycardias (RV VT) accounted for 35% and 15%, respectively. There were 4.6% left ventricular outflow tract tachycardias (LVOT VT) and 17.5% left ventricular tachycardias (LV VT). Right accessory pathways were present in 19 patients (20%) including 1 case of Mahaim fibre and 3 cases of permanent junctional reciprocating tachycardias (PJRT). All procedures are presented in detail in Tables I and II.

The percentage of ablations without fluoroscopy in every hundred CARTO procedures was as follows: 1%, 1%, 8%, 23%, 46%, 28%. The decrease in the last year stems from a significant increase in permanent atrial fibrillation ablation with the CARTO system. Procedures without fluoroscopy accounted for 18% of all CARTO procedures. The above-mentioned data are presented in Table III.

A comparison of the quantity of all procedures without radiation with X-ray-free procedures from the last year is shown in Figure 1.

## Discussion

Potential risks for patients and operators exposed to ionising radiation are well known [1]. Keep-

Table I. Ablation procedures without fluoroscopy

Variable	Arrhythmia	Number (%)
Arrhythmia from RV	RVOT VT	38 (35%)
	RV VT	17 (15%)
Arrhythmia from LV	LVOT VT	5 (4.6%)
	LV VT	19 (17.5%)
WPW syndrome	Right-sided ACP	17 (20%)
	ACP in middle cardiac vein	1
	PJRT	3 (2.7%)
	Mahaim fibre	1 (0.9%)
Other arrhythmias	AVNRT	1 (0.9%)
	AVN ablation	1 (0.9%)
	Atrial tachycardia from RA	1 (0.9%)

**Table II.** Number and percentage of CARTO procedures without fluoroscopy per year

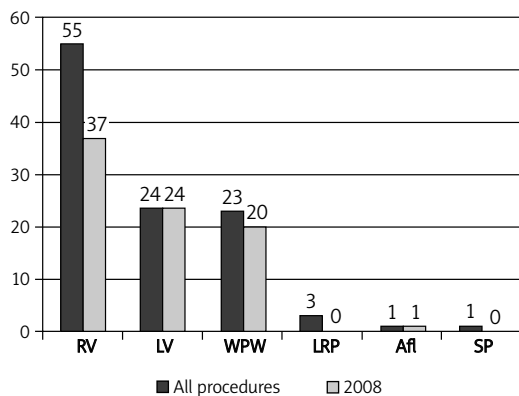
Year	No. (%) of all procedures without X-ray	No. (%) of procedures within LV without X-ray	No. of all CARTO procedures
2003	0	0	2
2004	1 (1)	0	96
2005	0	0	83
2006	2 (2)	0	97
2007	19 (20)	2 (2)	93
2008	84 (41)	22 (10)	204

ing that in mind during ablations, one endeavours to maximally reduce the use of X-ray. In conventional mapping (exclusively fluoroscopy), the amount of radiation during the procedure depends on the operator’s experience [2, 3]. The introduction of new navigation and electroanatomical systems made it possible to reduce fluoroscopy almost in all kinds of arrhythmias [4–18]. Radiation reductions for staff may be achieved through remote magnetic catheter navigation (RMCN) [19]. However, the restricted availability of RMCN significantly limits its widespread use. There are some data published on CARTO- or EnSite NavX-guided ablations, performed completely without X-ray usage [20–24]. Most of them describe right-sided accessory pathway ablations. Some cases of left-sided pathways have also been reported but the groups of patients are not large [23]. So far, procedures that completely avoid fluoroscopy within the left atrium and left ventricle have been extremely rare in the literature. In our study, we analysed a substantial group of patients ( $n = 108$ ) with different types of arrhythmias, arising from both right and left chambers of the human heart. Most of our patients had premature ventricular contractions from the right ventricle; next were the patients with right-sided accessory pathways and premature ventricular contractions from the left ventricle. Both the quantity of CARTO ablations and the level of complexity of arrhythmias ablated (left-sided ones) increased each year. The number

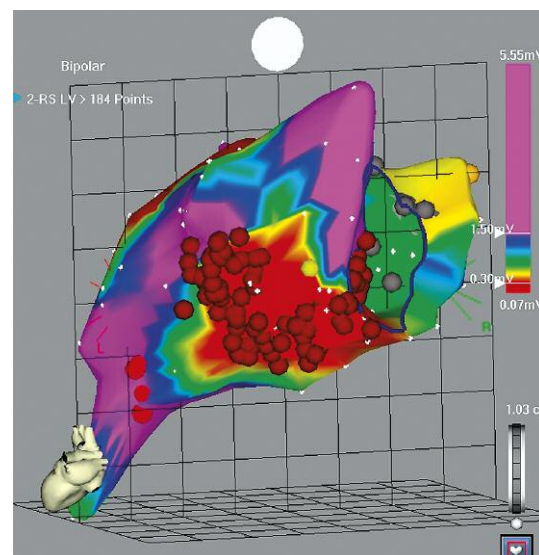
**Table III.** Number of ablations without fluoroscopy distributed among each one hundred CARTO procedures

No. of all CARTO procedures	Percentage of procedures without X-ray
1–100	1
101–200	1
201–300	8
301–400	23
401–500	46
501–575	28

of ablations without fluoroscopy within the right ventricle in 2008 accounted for 67% of all CARTO procedures performed at our department. The same growing trend was noted for procedures concerning Wolff-Parkinson-White (WPW) ablations (50% of CARTO cases) and left-sided arrhythmogenic foci (50% of CARTO cases). These data can be explained



**Figure 1.** Comparison of all procedures without X-ray with those performed exclusively in 2008



**Figure 2.** Potential CARTO map performed during non-fluoroscopic ablation of post-myocardial left ventricular VT in patient with anaemia because of myelodysplastic syndrome. Violet indicates healthy regions, red – low voltage regions. Brown points – places where RF application was done; red points – Purkinje potentials; blue circle – mitral annulus

by the operator's learning curve. All ablations from the left ventricle were performed using the aortic approach.

As far as we know, there are no reports on entirely non-fluoroscopic left atrial procedures. This may be attributed to the difficulty in performing transseptal puncture without X-ray. However, recently, Shepherd *et al.* described a puncture without radiation, performed by means of EnSite NavX [25]. Wide application of the above-mentioned technique, intracardiac echocardiography (ICE) or transoesophageal echocardiography (TEE), may make non-fluoroscopic procedures feasible and safe even within the left atrium.

The present study has some limitations. It was retrospective and non-randomized. However, it seems unethical to plan randomization concerning usage of radiation in RVOT VTs because one should endeavour to reduce or even completely eliminate fluoroscopy and in most cases it is possible. A prospective, randomized study regarding people suffering from WPW syndrome with right-sided accessory pathways is worth doing and we have already planned to begin work on it in the near future. The lack of randomization makes it difficult to assess the exact number of non-fluoroscopic procedures within patients taken to hospital for CARTO ablation. It is also hard to compare safety, success rate and time of procedures performed with and without radiation as patients who undergo ablations do not represent homogeneous groups. This limitation may also stem from the fact that these procedures illustrate various stages of the operator's learning curve. However, we did not observe any complications during and after the procedures without fluoroscopy.

Despite the above-mentioned limitations, our work clearly shows that non-fluoroscopic CARTO ablations of various arrhythmias are feasible.

In conclusion, it is feasible to perform CARTO ablations within both right and left sides of the heart without fluoroscopy. The number of non-fluoroscopic procedures depends on the operator's experience. Left-sided procedures are more challenging and demand more experience. Pregnant patients, with malignant history or with hematologic diseases should be ablated without fluoroscopy in centres that specialise in these kinds of procedures.

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