



Catheter Treatment of Tachyarrhythmias in Children under 5 years old Using Thermal Mapping and Discrete Applications

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Abstract. Radiofrequency catheter ablation (RCA) for the treatment of tachyarrhythmias in children under the age 5 years is not used as often as in patients of other age groups. The RCA procedure has great advantages over chronic antiarrhythmic therapy, but its use in young children is limited due to specific complications. The objective is to analyse our own experience in catheter treatment for tachyarrhythmias in children under the age of 5 years using the method of thermal mapping and discrete applications. **Material and methods.** The article presents the results of 68 RCA in 56 consecutive patients under the age of 5 years old, who underwent surgical interventions from 2007 to 2017. Ablations of accessory pathways were more frequent among the procedures. There were 12 (17.9%) reoperations. The immediate efficacy of RFA was 88.0%, after reoperations – 96.0%. 5 (7.3%) complications were reported, of which 2 (2.9%) were significant. There was no mortality. RCA was carried out by one or two 6F (with a body weight of up to 15 kg) or 7F non-irrigated catheters with a 4-mm distal pole. The parameters of applications did not exceed 53 °C, 35 W, 40 s. After 2011, the applications were applied discretely at (45 °C → 48 °C → 50 °C → 53 °C) and after thermal mapping. **Results and discussion.** After the introduction of clear indications to RCA in young children in 2011, despite an annual increase in the number of children with tachyarrhythmia treated in our clinic, the percentage of ablation performed at early age decreased.

Since 2012, ablations were performed in older children with a greater body weight. At the same time, despite the greater number of RCA in children younger than 5 years old during this period, there were no complications, and the success of procedures increased from 85% to 91%.

We associate the growth of RCA direct success with the fact that we were able to avoid urgent procedures and procedures in decompensated patients.

A new treatment protocol and less aggressive, well-defined indications for RCA in children under the age 5 years have allowed us to reduce the number of ablation at earlier age when the probability of complications is greatest.

The 'gentle' RCA method allows us to make sure that the application in the selected place was safe, and in case of adverse effects – to immediately stop it without irreversible consequences. The advantages of this technique are confirmed by the absence of complications associated with RCA after the new method implementation.

Since 2012 we have had a higher percentage of reoperations (up to 18%), but all of them were performed at older age. We consider this to be justified in the absence of complications and high efficacy of RCA.

Keywords: *tachyarrhythmias, children, catheter ablation.*

In the last decade, the use of RCA has significantly improved the results of treatment for tachyarrhythmias in children. The RCA procedure has great advantages over chronic antiarrhythmic therapy, but its use is limited in young children due to specific complications [1]. Only eight out of 100,000 young children undergo catheter ablation, and out of 1,000 of all RCAs, only one procedure is performed in children under 5 years of age [2].

Since January 1, 1991, information on RCA procedures performed in patients under the age of 21 has been accumulated in the Unified Multicenter Paediatric RCA Registry of the US-based Society of Paediatric Electrophysiologists [3]. The analysis of information from the Registry in 2002 showed that complications occur more frequently in children weighing less than 15 kg. However, over time, the overall incidence of major complications decreased from 4.2% to 3%, and increased from 6% to 9% in children under 5 years. The most common serious complications associated with RCA reported in the above-mentioned Registry include complete AV blockade, blood clots, and perforation of the heart wall [4].

There is still no generally accepted indication for RCA in children. However, most authors emphasize that there should be very serious reasons for RCAs for children under 5 years of age and/or weighing less than 15 kg [5-7]. It is in this age group that there are significant technical difficulties in conducting RCA, with the greatest number of its complications reported [8]. In addition, the relatively positive prognosis for most tachyarrhythmias in this group is an important factor leading to the limited use of RCA in children in the first years of life [9].

Given the available information, professionals experienced in RCA in young children largely determine the indications for these procedures, based on their own experience and, above all, the risk of complications, which is most dependent on the age and weight of the child.

The objective of the study is to analyse our own experience in catheter treatment for tachyarrhythmias in children under the age of 5 years using the method of thermal mapping and discrete applications.

Materials and methods of the study

The study group included 56 children from 1 month to 5 years old, who underwent 68 RCA of tachyarrhythmias at the State Institution Scientific and Practical Medical Centre for Paediatric Cardiology and Cardiac Surgery, MoH of Ukraine, from January 2007 to December 2017. The mean age at the time of intervention was 2.9 ± 1.7 years (from 1 month to 5 years 9 months), the average body weight was 17.3 ± 11.4 kg (from 2.8 kg to 29 kg). The observation period ranged from 4 months to 10 years.

Ablations of accessory pathways were more frequent among the procedures. There were 12 (17.9%) reoperations. The immediate efficacy of RCA was 88.0%, after reoperations – 96.0%. 5 (7.3%) complications were reported, of which 2 (2.9%) were significant. There was no mortality (table 1).

Table 1. Nosological distribution of RCAs and their complications

Procedure	Number	Reoperations	Complications	Mortality
RCA of the right accessory atrioventricular connection	33	5	2	-
RCA of the left accessory atrioventricular connection	16	3	1	-
RCA of atrial tachycardia	6	2	1	-
RCA of ventricular tachycardia	5	2	-	-
RCA of AV nodal re-entry tachycardia	8	-	1	-
Total	68 (100%)	12 (17.9%)	5 (7.3%)	-

Of the 5 (7.3%) complications, 3 (pericardial effusion, vascular access hematoma, and transient AV blockade) were treated conservatively, did not require rehabilitation, and did not reduce patients' quality of life. Two (2.9%) complications (iatrogenic persistent complete AV block and femoral pseudoaneurysm) required surgery.

Since 2011 clear indications for RCA in young children have been identified in our clinic for children of the first years of life: persistent tachyarrhythmia with reduced left ventricular ejection fraction (EF) and paroxysmal symptomatic tachyarrhythmia in case of their resistance at all stages of antiarrhythmic therapy according to the protocol. At the same time, a new 'gentle' RCA technique was introduced for patients of this age category using thermos-mapping and discrete applications.

General anaesthesia, preferably intravenous, was used to support RCA procedures. In all first-year children and patients with significantly decreased left ventricular EF (below 40%), RCA was performed under endotracheal anaesthesia

with artificial lung ventilation. Radiofrequency ablation was performed with one or two non-irrigated catheters with the distal pole of 4 mm and thickness of 6F (body weight up to 15 kg) or 7F. Application parameters were limited to 53 °C, 35 W, 40 s.

After 2011, all children had discrete applications at (45 °C → 48 °C → 50 °C → 53 °C) and after temperature mapping (thermo-mapping). At the same time in the area of interest, trial applications were used with a fixed temperature limitation to 45 °C, which allowed evaluating their efficacy and safety in the case of reversible possible undesirable changes.

Results and discussion

After the introduction of clear indications for RCA in young children in 2011, despite the annual increase in the number of children with tachyarrhythmia treated in our clinic, the percentage of early ablation performed decreased (Table 2).

Table 2. RCA results in children under 5 years

Results	2007-2011	2012-2017
RCA performed	27	41
RCA performed in children under 3 years of age	7 (25.9%)	8 (19.5%)
Number of complications	5	0
Immediate success	85%	91%
Number of reoperations	4 (14.8%)	8 (19.5%)
Average age at the time of primary RCA	2.1±2.7 y	3.2±1.4 y
Average weight at the time of primary RCA	12.3±9.4 kg	18.6±11.4 kg

When comparing the two groups of patients above 5 years – before and after the introduction of RCA indications and ‘gentle’ ablation technique – it can be noted that since 2012, the ablations were performed to older children with a larger body weight. However, despite the large number of RCAs performed in this period in children younger than 5 years, there were no complications, and the success of procedures increased from 85% to 91%.

The increase in the direct success rate of RCA to 91% (according to literature – 82-89%) is attributed to the fact that after the introduction of the treatment protocol that prevents the occurrence of tachycardia more effectively, we manage to avoid urgent procedures and procedures in decompensated patients.

We believe that the new treatment protocol and less aggressive, clearly defined indications for RCA in children under 5 years have allowed us to reduce the number of ablations performed at an earlier age when the likelihood of complications is greatest. This allowed us to obtain a small percentage of major complications of RCA in young children – 2.9% (according to the literature 7-11%).

In addition, RCA complications in young children are mainly related to the effect on the tissues of the heart and its surrounding RF energy structures with the aggressive parameters recommended in the literature for RCA. However, when used

with the recommended parameters, changes in the tissues are usually irreversible due to the protein coagulation process. Our proposed 'gentle' RCA method allows us to make sure that the application is applied in the chosen place and in case of negative impact – immediately stop it without irreversible consequences. The advantages of such a method are confirmed by the absence of complications with RCA after its implementation.

It can be noted that in the second group of patients, there is a higher percentage of reoperation, but all of them were postponed and performed at an older age. We consider this to be justified in the absence of complications and high efficacy of RCA after 96% surgery (according to the literature 92-95%).

Conclusions

1. The RCA procedure in young children is sufficiently effective and safe.
2. RCA in children under 5 years is indicated only with ineffective medical treatment, which allows delaying the intervention.
3. The 'gentle' RCA technique avoids complications in young children, but the efficacy is achieved by a large number of reoperations in older age.

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