Radiofrequency Ablation of Childhood Arrhythmia. Observational Registry in 125 Children

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Abstract

Background: **Radiofrequency ablation (RFA) in children is an increasingly common practice.**

Objective: **To evaluate, in our institution, the results of RFA in children younger than 15 years.**

Methods: **A total of 125 children submitted to RFA between May 1991 and May 2010 were analyzed.**

Results: **Sixty-seven (53.6%) children were males, aged between 44 days and 15 years (mean 8.6 ± 3.3 years) with median weight of 31 kg. Heart disease was present in 21 (16.8%) patients. The RFA of accessory pathways (AP) was the most common procedure (62 children - 49.6%). The RFA of nodal reentrant tachycardia (NRT) was the second most common arrhythmia in 27 (21.6%), followed by atrial tachycardia (AT) in 16 (12.8%) and ventricular tachycardias (VT) in 8 (6.4%) children. The success criteria were achieved in 86.9%, 96.1%, 80% and 62.5% of patients undergoing RFA of AP, NRT, AT and VT, respectively. Transient AVB occurred during RFA in 4 (3.2%) and LBBB in 7 (5.6%) children. Twenty-five children underwent a new RFA due to initial failure or recurrence. During the mean follow up of 5.5 ± 3.4 years, 107 (88.4%) remained without recurrence. There was no statistical difference regarding the results and the age at which the patient underwent the procedure. No child had persistent AVB or required a permanent pacemaker.**

Conclusion: **Catheter ablation is a safe and effective alternative therapy in children with recurrent tachycardias refractory to medical treatment. (Arq Bras Cardiol 2012;98(6):514-518)**

Keywords: **Arrhythmias; cardiac; catheter ablation; child.**

Introduction

Percutaneous radio frequency ablation (RFA) was first used in adult patients with paroxysmal supraventricular tachycardia in 1987 and has become an alternative to medical treatment for a variety of arrhythmias in the pediatric population since the first report in 1989[1-3]. With technological advances in the power applied in RFA and the development of small-diameter deflectable catheters, RFA is now used as the non-pharmacological treatment of choice of tachycardias in the pediatric population.

However, the use of RFA in children under five years of age and/or weighing less than 15 kg is still controversial[4]. There are many variables that increase the complexity and risk of the procedure in this age group, such as vascular access limitations, small heart, possible anatomical variations due to the presence of congenital heart disease, lesion expansion and potential effects of exposure to radiation on developing cells[5-10].

Although the drug therapy of cardiac arrhythmias in this age group is possible, the recurrence is high and the side effects are not negligible. Therefore, the objective of this study was to analyze the results of RFA in the pediatric population at our institution.

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Methods

We analyzed the clinical characteristics (Table 1) of 125 children aged < 15 years who underwent RFA at Instituto do Coração da Faculdade de Medicina da Universidade de São Paulo (InCor FMUSP) from May 1991 to May 2010.

Throughout this period, the children with tachycardia have been, initially and routinely evaluated by physicians from the team of cardio-pediatrics of our institution, who carry out the first therapeutic measures to reverse the crisis, decide which drugs to use to prevent recurrences and carry out the clinical follow-up.

Patients are referred to be evaluated by the arrhythmia group for possible ablation in the following cases: 1) Newborns and infants refractory to antiarrhythmic drugs including amiodarone, and with unfavorable clinical course, 2) Children aged under five years and/or who weigh < 15 kg, with unacceptable side effects to medical treatment or refractory to antiarrhythmic drugs, 3) Children older than five years or who weigh > 15 kg, as an alternative to medical treatment and/or when the only effective medication is amiodarone (to avoid its chronic use).

The electrophysiological study (EPS) was always performed with the patient under general anesthesia with sevoflurane and propofol, and after discontinuation of antiarrhythmic drugs for five of their half-lives. We used one or two multipolar electrode catheters introduced through right and/or left

Table 1 - **Clinical characteristics of the studied population**

Characteristics of the patients	Total	0 to 4 years n = 18	5 to 9 years n = 63	10 to 15 years n = 44	p
Male sex	67 (53.6%)	10 (55.6%)	34 (54.0)	23 (52.3%)	0.96
Age	8.5 ± 3.3	3.0 ± 1.9	7.7 ± 1.5	11.9 ± 1.5	<0.0001
Weight, median (Q1; Q2)	31.0 (22.5; 42.3)	16.9 (9.3; 18.6)	27 (23.1; 35)	46 (38.5; 52)	<0.0001
Congenital cardiopathy	21 (16.8%)	3 (16.7%)	13 (20.6%)	5 (11.4%)	0.43
Surgical correction of congenital cardiopathy	15 (76.1%)	2 (66.7%)	9 (69.2%)	4 (80%)	0.71

femoral venipuncture or jugular venous access; and an ablation catheter, inserted through the right or left femoral artery or vein, according to the arrhythmia diagnosis. An electrophysiological study was performed before the ablation, with the aim of reproducing the clinical arrhythmia. If the latter was not induced, a new stimulation was performed after intravenous infusion of isoproterenol.

The ablation was performed only after the clinical arrhythmia induction. Catheter size varied from 5 to 7 French and catheter position was guided by fluoroscopy. After establishing the ideal site for ablation, radiofrequency energy was delivered through the ablation catheter. For patients with target located on the left, the transeptal approach was used in the absence of patent foramen ovale. RF was applied at a maximum power of 30 W with a controlled temperature of 55 °C, the borderline temperature used in children weighing < 15 kg. For those weighing > 15 kg, the maximum temperature was 60 °C, with a power of 50 W. The ultimate goal was not to reinduce the clinical arrhythmia. In cases of nodal reentrant tachycardia, the slow pathway modification was accepted, defined as persistence of conduction, but without tachycardia induction even after intravenous isoproterenol infusion.

At the end of the procedure, in the absence of complications, the patient was kept at the original hospital bed or referred to the pediatric intensive care unit for clinical observation. The withdrawal of anti-arrhythmic drugs after ablation is usually recommended and aspirin, given orally, 5 mg/kg/day for 30 days is maintained in those undergoing ablation of the left cardiac chambers. The first clinical evaluation is scheduled within 30 days after the procedure; the follow-up is carried out every 3-4 months in the first year and every 6-12 months thereafter. The echocardiogram, ECG and 24-h Holter are indicated according to the patient's clinical characteristics and the arrhythmia. The follow-up is carried out by cardiopediatric team.

Statistical Analysis

The Shapiro-Wilk test was used to determine whether the variable had a normal distribution. Continuous variables with normal distribution were described as mean ± standard deviation. Those without normal distribution were described as median and 25 and 75 interquartile ranges. Fisher's t test (variables with normal distribution) and Wilcoxon test (variables without normal distribution) were used to compare the association between occurrence of complications and the variables of different groups.

Results

Clinical characteristics of patients are shown in Table 1. Sixty-seven (53.6%) patients were males, aged 40 days to 15 years, with a mean of 8.6 ± 3.4 years, of which 83.2% had no structural heart disease. The sample was divided into three groups according to age: group 1 ranging from 0 to 4 years; group 2 from 5 to 9 years and group 3 from 10 to 15 years. Group 1 consisted of 18 patients (14.4%), of which 8 were females, group 2 had 63 patients, (50.4%), with 29 females and group 3 had 44 patients (35.2%), of which 21 were females.

In group 1 (15 patients), nine (60%) had anomalous pathways (AP) with three left, two right, three septal and one parahisian. One patient had nodal reentrant tachycardia (NRT) and five patients had right atrial tachycardia (AT). In group 2 (63 patients), 30 (47.6%) had AP, with 23 left, two right, three septal and two parahisian. Fifteen (23.8%) patients had NRT and seven (11.2%) had AT, four to the right and three to the left. In group 3 (48 children), 23 (52.3%) had AP, with nine left, six right, six septal and two parahisian. Eleven (25%) patients had NRT and four (9%) had AT, three right and one left (Table 2).

Ablation of ventricular arrhythmia was performed in two patients aged between 0 and 4 years (11.1%) and five aged between 5 and 9 years (8.2%). The EPS without ablation was carried out in 12 patients, one (5.6%) patient between 0 and 4, six between 5 and 9 (8.2%) and five (11.4%) between 10 and 15 years. Eight patients underwent only the EPS due to absence of induction of clinical arrhythmia, and four for risk stratification after syncope or CRA (Table 2).

The median weight of the study population was 31 kg (interquartile range 22.5 and 42.3), and seven patients (5.8%) weighed < 15 kg.

Of the 21 patients with congenital heart disease (Table 3), six (28.6%) were submitted to EPS (due to absence of induction of clinical arrhythmia) and 15 (71.4%) to RFA, of which six (28.6%) with ablation of the accessory pathway, five (23.8%) of AT, two (9.5%) of ventricular arrhythmias and two (9.5%) of NRT.

The success rate was lower compared to those without congenital heart disease, being 42.9% after the first ablation (RR: 4.87; p <0.0001) and 75% after new interventions (RR: 2.55; p = 0.05). Five patients (28.6%) underwent a second intervention.

Table 2 - Diagnosis of arrhythmias according to age range

Type of arrhythmia	Total	0 to 4 years n = 18	5 to 9 years n = 63	10 to 15 years n = 44
Accessory pathways	62 (49.6%)	9 (50%)	30 (47.6%)	23 (52.3%)
Right	10			
Left	35			
Septal	12			
Parahisian	5			
Nodal reentry tachycardia	27 (21.6%)	1 (5.6%)	15 (23.8%)	11 (25%)
Atrial tachycardia	16 (12.8%)	5 (27.8%)	7 (11.1%)	4 (9.1%)
Ventricular arrhythmias	8 (6.4%)	2 (11.1%)	5 (8.2%)	1 (2.3%)
Diagnostic EPS	12 (9.6%)	1 (5.6%)	6 (9.5%)	5 (11.4%)

EPS – Electrophysiological study.

Table 3 - Diagnosis of congenital cardiopathy according to age range

Congenital cardiopathy	Total n = 21	0 to 4 years n = 3	5 to 9 years n = 13	10 to 15 years n = 5
Complex congenital cardiopathy	7	1	4	2
Ebstein anomaly	4	0	2	2
Tetralogy of Fallot	2	0	1	1
ASD	2	0	2	0
Patent ductus arteriosus	2	1	1	0
VSD	1	0	1	0
Aorta coarctation	1	0	1	0
Situs inversus totalis with subvalvular aortic stenosis	1	0	1	0
Corrected transposition with ASD	1	1	0	0

ASD - atrial septal defect; VSD - ventricular septal defect.

The mean follow up time was 5.4 ± 3.2 years. Success, defined as an interruption of the arrhythmia as well as absence of its reinduction, was obtained with the first ablation in 95 patients (78.5%) and after more than one intervention in 107 (88.4%) children. One hundred (80%) children were submitted to a single procedure, 22 (17.6%) to two procedures, two (1.6%) to three and one (0.8%) to four procedures. Among the 95 patients who achieved success at the initial ablation, 17 (17.9%) had recurrence of arrhythmia, of which 10 with an accessory pathway, four with NRT and three with AT. A new ablation was performed in 16 (94%), of which 14 were successfully treated (87.5%).

Complications

A total of 15 complications (12%) were observed in the children during these procedures. Twelve (9.5%) were related to the conduction system: 2:1 AV block during catheter handling in one child; transient CAVB induced by catheter handling in another child, and during RFA in 3 children (2.4%) Right bundle-branch block occurred in seven children (5.6%), six during catheter handling and one during RFA.

Ablation failure was observed in two patients and immediate success with recurrence in two others, who had atrioventricular or right bundle-branch block during the procedure. In the other 8 patients, ablation was successful and without recurrence at follow-up. We did not observe any permanent block, and no patient required a pacemaker at follow-up.

Other complications included: accident during transeptal puncture, which resulted in hemopericardium, resolved during the procedure by drainage through the subxiphoid puncture, without need for surgery, and skin burn caused by the RFA plate (Table 3).

There were no differences in weight among children who had complications (33.8 ± 14.8 kg without complications and 29.4 ± 16.6 kg with complications, p = 0.29), as well as the number of complications between the children who weighed more or less than 15 kg (p = 0.21).

Discussion

To the best of our knowledge, this is the largest series of cases of tachycardia ablation in children with long-term follow-up published in Brazil. Our data are consistent with other international series[1-4], confirming that RFA is an effective and safe alternative in the long term for the treatment of tachyarrhythmias with difficult clinical control in pediatric patients. The atrioventricular tachycardia involving accessory pathways of AV conduction is the most frequent indication for ablation in children, followed by nodal reentrant tachycardia and atrial tachycardia[11]. Ventricular tachycardia is rarely indicated due to its low prevalence in children[11].

The success rate described in the literature varies widely in the pediatric population (50-96%), when compared with rates between 82% and 99% in the adult population[12,13]. Success was observed in 79.2% in the first procedure, regardless of the tachycardia mechanism. The lowest success rate, when comparing the data of the adult population, was not due to vascular access problems and/or mapping, but the disappearance of accessory pathway or transient AV blocks caused by catheter handling, preventing the procedure completion.

In this study, we observed no difference in success rates between different age groups and weight (greater or less than 15 kg).

This finding is consistent with other publications, where low weight was not a determinant of failure[14]. Another finding, also according to the literature[4,12-14], was the lower success rate in the population with congenital heart disease, when compared to patients without structural heart disease, due to anatomical variations found in this population.

The conventional clinical recommendations to delay the indication of catheter ablation in younger children derive from experimental studies, which suggest further expansion of RF lesions in developing individuals, as well as from clinical studies that demonstrate increased fragility of the conduction system, more restricted vascular access and increased risk of coronary artery and valvular disease in children[15]. Another consideration that must be made is the greater risk of developing malignancies by exposure to fluoroscopy[6-8].

However, with a lower number of catheters used in the procedure, their cautious handling, shorter fluoroscopy exposure and use of non-fluoroscopic mapping, which have been recently used, the risk of complications can be reduced. Special attention should be given to the presence of accessory pathways near the atrioventricular conduction system, as they have a higher risk of CAVB. In such cases, literature has shown that cryoablation procedure has been considered[16].

Limitations

This is a retrospective study with a relatively small number of patients aged 0-5 years and weighing less than 15 kg, which does not allow a meaningful analysis of results in this age group. The data refer to results from a single institution, but it is a significant sample.

Conclusion

Given these observations, we conclude that catheter ablation is a safe and effective alternative therapy in children with recurrent tachycardias refractory to clinical treatment.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

This study is not associated with any post-graduation program.

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