Original Article

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Interventional Electrophysiology in Children: A Single-Center Experience

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Abstract

Objective: Ablation techniques of cardiac arrhythmia in children have significantly progressed in the past decade; however, the number of pediatric ablations is still significantly lower than that in adults. Accordingly, there is less information regarding the success rate and complications in this age group.

Methods: All pediatric ablations conducted between March 2005 and February 2011 at Rajaie Heart Center were studied. Abolishing the arrhythmia source by the end of procedure was considered as success. Recurrences before hospital discharge and those thereafter were named early recurrence and late recurrence, respectively.

Findings: A total of 125 catheter ablations were performed for 112 patients. Of them 118 (94.4%) procedures were successful. The success rate was significantly higher in the patients with atrioventricular nodal reentry tachycardia (AVNRT). Of 105 patients who continued follow-up program, 7 (6.7%) cases experienced recurrence; the recurrence rate was inversely dependent on the patients' body size (*P*-value <0.05). There was no mortality. Five cases were complicated during or early after the procedure, all the complications were cured completely.

Conclusion: Therapeutic electrophysiology in children is an effective and relatively low-risk method. The recurrence and complication rates are similar to those reported in adults. Considering our results and the previous reports, pediatric patients with serious arrhythmia should not be deprived from ablation and should not be exposed to long-term toxic drugs.

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Introduction

Diagnosis and management of cardiac arrhythmias in children is challenging. The source of knowledge for pediatric arrhythmias is the data from the adult population; however, the causes of arrhythmias are considerably different in these two age groups. Arrhythmias are mostly related to ischemic heart diseases in adults, while they are mainly associated with developmental alterations in the conductive system in children[1,2]. Antiarrhythmic drugs were the only treatment for many years. Propranolol was the most commonly used drug. For arrhythmia refractory to beta-

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blockers class Ic and class III drugs were used widely. After approval of radiofrequency ablation, considerable group of children with arrhythmia underwent this modality of treatment. Catheter ablation was introduced for adult patients in 1981[3] and has been applied in children since 1989[4]. Catheter ablation in selective pediatric cases, especially those with supra-ventricular tachycardia, has enjoyed a considerable improvement over the last decade[4] and the results have been promising[5]; nonetheless, many questions regarding the safety and efficacy are still to be answered[6]. We performed this retrospective study to show the types of arrhythmias ablated and achieved success.

Subjects and Methods

This retrospective, descriptive study was conducted at Shaheed Rajaie Cardiovascular Research Center, the largest Iranian pediatric cardiology center affiliated to Tehran University of Medical Sciences. The medical records of all patients less than 18 years of age having undergone the ablation procedure between 2005 and 2011 were reviewed.

Case selection for ablation was according to the ACC/AHA Guidelines[7], and all ablation cases were categorized in Class I and Class IIa indication. The success and complication rates were compared with respect to the patients' demographic characteristics and the type of arrhythmia.

The procedure: All the patients were sedated with intravenous Midazolam (1mg/kg) 30 minutes before the procedure, and intravenous Propofole was continuously administrated during the procedure, as required. Endotracheal intubation was done only in one patient. Three to five venous lines were obtained for positioning the catheters in the high right atrium (HRA), right ventricle (RV), His bundle, coronary sinus (CS), and ablation catheters. The conventional endocardial mapping technique with multi-polar electrode catheters was employed for detecting the ablation sources. The ablation procedures were terminated when the arrhythmia source was completely abolished or if it could not be eliminated during a judicious period (at the discretion of the electro-physiologist).

Tools and apparatus: Five French delivery sheaths were used for patients less than 15 kg of body weight and 6 French delivery sheaths for larger patients. Additionally, 7 French sheaths were utilized only for the ablation catheters in cases weighing more than 15 kg. The catheters used were manufactured by Medtronic (USA), and St. Jude (USA) companies. The electrophysiology study (EPS) apparatuses were Bard Lab System Pro, versions 5 and 8 (USA) and Cardiotek EP Tracer 38 (Italy). The ablation machines were Atakr II by Medtronic Co (USA). and Irvine IBI-1500 T II by St. Jude Co (USA).

Follow-up: All the patients were monitored for 24 hours after the procedure. Out-of-bed ambulation was recommended 6 hours after the procedure except in the complicated cases. The uncomplicated cases were discharged from the hospital 48 hours after the procedure. Oral ASA (5mg/kg) was prescribed for 1 month after the ablations. Outpatient visits were done 1, 3, and 6 months after the procedures and then yearly.

Data collection and analysis: All the demographic data, ablation indications, surface ECG characteristics, ablation results, and complications were recorded on data sheets. The data analysis was performed with SPSS 15 for Windows (SPSS Inc., Chicago, Illinois) by an epidemiologist. The continuous variables were expressed as mean±SD, and the categorical (nominal) variables were compared using the McNemar, Pearson Chi-square, and Fisher Exact tests.

Findings

Between March 2005 and February 2011, 125 catheter ablations were performed for 112 patients (57.6% male). The patients' weight,

Table 1: Characteristics of selected patients for ablation

Parameter	Mean (Standard Deviation)	Range
Age (yr)	12.20 (3.68)	3-18
Weight (kg)	48.88 (18.51)	14-108
Height (cm)	152.65 (20.54)	100-185
BMI (kg/cm²)	20.14 (4.29)	13.47-35.80

SD: Standard Deviation; BMI: Body Mass Inde

height, and body mass index (BMI) are summarized in Table 1. In total, 118 (94.4%) ablations were successful. The success rate was significantly higher in the patients with atrioventricular nodal reentry tachycardia (AVNRT) and lower in those with ectopic atrial tachycardia (*P*-value 0.005). The success rate was not dependent on the patients' sex, age, and body size (*P*-values more than 0.5).

The mean follow-up duration was 10.65±3.53 months in this study. Twenty cases did not continue the programmed follow-up for more than 3 months post procedure, and some were followed up in other centers and they were, consequently, lost to follow-up. A total of 105 patients were followed up, amongst whom there were 7 (6.7%) cases of recurrence; the recurrence rate was inversely dependent on the patients' body size (*P*-value <0.05).

There was no mortality. Five cases were complicated during or early after the procedure, with all the complications occurring in patients with left lateral accessory pathways. The most severe complication was severe femoral vascular injury in a 6-year-old-boy, in whom surgical vascular revision was done. The other complications included significant pericardial effusion because of septostomy wire entrance into the pericardial sac in 1 case, transient myocardial ischemia in 1 case, and minor vascular injuries in the others.

Most of the ablations, i.e. 83 (66.4%) cases, were conducted for accessory pathway elimination. Of them, 42 cases had pre-excitation on the surface ECG and the others had concealed accessory pathways. Atrioventricular reentrant tachycardia (AVRT) in all cases was orthodromic. Accessory pathway locations, mode of ablation, and relative success rates are summarized in Table 2. There were 5 complications for the AVRT ablations; in one case the ablation was not done because the trans-septal puncture had become complicated.

Twenty-five (20.3%) cases underwent slow pathway ablation for the elimination of AVNRT, and the arrhythmia circuit in all the cases was slow-fast (typical AVNRT). All of these procedures were performed using RF energy and all were successful without any complications.

In 6 cases, the source of arrhythmia was atrial ectopic focus. RF energy was utilized for all these cases. In 4 cases, the arrhythmia focus was eliminated, but the ablation was unsuccessful in the remaining 2 cases. No complication was reported.

Eleven ablations with RF energy were done to abolish the sources of premature ventricular complex (PVC) and ventricular tachycardia (VT).

Table 2: Ablation results according to accessory pathway locations

Accessory pathway location	Number of cases	Radiofrequency (RF) energy	Cryo energy	Successful	Unsuccessful
Right anteroseptal	7	6*	3*	6	1 (RF)
Right posteroseptal	16	15	1	15	1 (RF)
Right free walls	11	9	2	11	0
Left posteroseptal	8	8	0	8	0
Left free walls	38	37	1	36	RF and cryo (both)
Mahaim fiber	3	2	0	3**	0
Total	83	77	7	79 (95.2%)	4 (4.8%)

*In 2 cases, both RF and cryo energies were used; RF usage was because of the failure of the cryo energy.
**One Mahaim fiber was traumatically ablated and did not return at one year's follow-up.

Ten ablations were successful, and no complication was reported for this group.

Only 1 case of atrial flutter was ablated: It was a case of typical isthmus-dependent counter-clockwise circuit. The cavo-tricuspid isthmus was ablated successfully with RF energy without complications.

Discussion

This study describes the demographic and electrophysiological patterns of arrhythmia as well as the results of catheter ablation therapy in children and young adults. Chiming in with some previous studies[6,8,9], we encountered a different pattern of arrhythmia in children by comparison with that in adults; be that as it may, there was no age difference in terms of arrhythmia type in our study population.

Our findings support the previous studies which showed that AVRT is the most common arrhythmia requiring catheter ablation in children[8,9]. In our study, AVRT was more common in the males (63.9%, ARI=2.1), whereas AVNRT was more frequent in the females (60%, ARI=2).

In our study population, the most common location of accessory pathways was the left lateral region of the mitral ring. We found no accessory pathway in the left anterior and left anteroseptal areas.

Tannel et al reported a 90% RFA success rate in pediatric arrhythmias and 96% in patients with accessory pathways[1]. Van Hare et al reported an overall success rate of 95.7% for supraventricular tachycardia due to accessory pathways or AVNRT[10]. Other investigators have reported success rates of 91.5 to 94.1% for pediatric arrhythmia ablations[8,11-13]. Our success rate for accessory pathway ablation was 94.7%, which is close to figures reported by internationally-renowned centers. It is deserving of note that we used less cryo energy than did other investigators[14-17]. The success rate of cryo-ablation in our patients was less than that of RF ablation; however, our relatively small sample size precludes a meaningful conclusion.

For the ablation of atrial ectopic focuses, our success rate was not on a par with those reported by the recent report. We succeeded in ablating 4 of the 6 atrial tachycardias, while Lee et al reported an 82% success rate for atrial ectopic focuses[18]; this difference may be in consequence of our less experience, inappropriate case selection, or small sample size.

For AVNRT, our success rate was 100%. This rate gains further significance when juxtaposed with the slightly less successful rates in the existing literature[16,18,19]. The difference may be explained by the fact that we employed RF energy for all AVNRT cases.

Our success rate for VT was 90.9%, which is close to the figures reported by Fauchier et al and Schneider et al[20,21]. In the adult population, the reported success rate of ablation is about 87.5% with AVRT and 99.5% with AVNRT ablation[22]. Similar to the other available reports, we found no difference in the success rates between children and adults for these arrhythmias [22,23].

The recurrence rate for all types of RF ablations has been reported at 7% to 8% [11,23]. Brugada et al showed no difference in the effectiveness, recurrence, and complications of RF ablations in children by comparison with adults [24]. In our study, the recurrence rate was 6.7%, and the mean age in the recurrence cases was significantly lower than that of the no-recurrence case (*P*-value = 0.002).

Complications occurred in 4.2 % of our study population. Complication rates of between 1.2% and 8.7% have been reported elsewhere[1,10,11,18]. In other reports, death, cerebrovascular accident, cardiac perforation, ventricular dysfunction, complete heart block, second-degree AV block, new arrhythmia, coronary artery injury, and femoral artery thrombosis requiring balloon re-canalization constituted the major compli-cations[1,23,24]. Blaufox et al reported a relationship between the complication rate and RF energy dose indexed for body size[25]. We found no such relationship, and nor did we find any significant age dependency for the complications. Our complication rate was not higher than those

reported in adult populations[26-28]. There was no mortality in our cases.

Before ablation approval for pediatric arrhythmia the main stay for treatment was drug therapy. One of the most potent drugs used for this purpose was Amiodarone. Vignati et al followed 27 children on Amiodarone for their supraventricular or ventricular tachyarrhythmias. In mean follow-up of 13 months they found thyroid side effect in one, corneal deposits in one, atrio-ventricular block in 4, and photosensitivity in 22% of cases[29]. Coumel et al reported 3 thyroid side effects in 135 cases treated with Amiodarone in mean follow-up of 4 months[30] and Ward et al reported 44% side effects including 15 important side effects in their follow-up of 75 patients with supraventricular or ventricular tachyarrhythmias[31].

Our results indicated less complication and side effects of ablation in comparison with oral Amiodarone.

First and foremost amongst the limitations of the present study is its insufficient sample size in the different arrhythmia subgroups. Another drawback of note is the unequal and, in some cases, inadequate follow-up duration. Moreover, that our study has a retrospective design might produce a few missing data.

Conclusion

The efficacy and safety of ablation in properly selected pediatric patients are not lower than those in adult patients. In light of the results of the present study and those in the literature, pediatric patients with serious arrhythmias should not be deprived from ablation and should not be exposed to long-term toxic drugs.

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Conflict of Interest: None

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