RESEARCH PAPER

Arrhythmia in Children and Adolescents and Outcome of Radiofrequency Ablation for Tachyarrhythmias - A Single Center Experience Over 16 Years

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Correspondence to: Dr Debabrata Bera, Holy Family Hospital, Hill Road, Bandra(West), Mumbai 400050,India. debabratabera81@gmail.com Submitted: October 14, 2019; Initial review: November 20, 2019; Accepted: April 9, 2020. **Objectives**: Radiofrequency (RF) ablation for tachycardia in children poses challenges in view of slender veins and delicate cardiac structures in close proximity. **Methods**: We reviewed hospital records for patients below 18 years,who underwent RF ablation from August, 2001 to February, 2017 at a single hospital. **Results**: Among 214 patients (134 males, age12.5 (4.6) years), there were 221 tachycardia substrates: accessory pathways in 85 patients (39%), AV nodal re-entrant tachycardia in 79 patients (36%), ventricular tachycardia in 28 patients (13%) and atrial tachycardia in 21 patients (9.6%).The overall success rate of RF ablation was 95% (204/214). Success rate in those younger than 6 years was similar to those in older age groups.There were no major complication. **Conclusion**: RF ablation below 18 years of age has a high success rates and low complications.

Keywords: Catheter ablation, Management, Outcome, Supraventricular tachycardia.

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atheter ablation in children using radiofrequency (RF) energy has been in vogue since 1989 [1]. Radiofrequency ablation ensures a permanent cure of arrhythmias and hence, is the preferred treatment in the vast majority. Previous registries have demonstrated that RF ablation can safely and effectively be performed in children [2,3]. However, patients weighing less than 15 kg have been identified as being at greater risk for complications [2,3]. Though medical therapy is an alternative option, it has its own limitations [5]. The experience from India on RF ablation is also limited [4], due to a lack of widespread availability, lack of expertise, and fear of complications in children, though rare [6].

We have been using conventional RF ablation techniques in the pediatric age group since the last two decades. We conducted a retrospective study of patients aged up to 18 years and analyzed them for the tachycardia substrates, success and complications.

METHODS

The patients were categorized into three groups according to age: Groups A (younger than six year), B (aged 6-12 years) and C (older than 12 years). General anesthesia was required for the procedure for majority of children in Groups A and B; midazolam, propofol,

fentanyl and sevoflurane were the drugs used. For Group C, local anesthesia and sedation were used.

All anti-arrhythmic drugs were suspended for a duration of at least four half-lives before the procedure. For AVNRT (Atrioventricular nodal re-entrant tachycardia) and right-sided accessory pathways (APs), three venous punctures were sufficient – for coronary sinus (CS), His bundle and a roving catheter. For left sided APs, two femoral venous accesses and one femoral arterial route were employed. The sheaths used ranged from 4F to 7F caliber. Unfractionated heparin was used for all cases (50 units/kg for venous route and 100 units/kg for arterial route).

When the arrhythmia was not induced at baseline, intravenous isoprenaline was administered ($1-2 \mu g/min$). Atropine (according to bodyweight) was used when isoprenaline failed. Fluoroscopy time and procedure time were noted. The RF energy output, length of application and temperature were individually titrated. After ablation, 30-45 minute waiting period was kept along with isoprenaline and atropine for re-induction.

Acute success of RF ablation was defined as failure to induce causal arrhythmia after application of adequate number of RF energies. Failure was defined when tachycardia remained inducible at the end of the procedure.

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There were two subsets, *viz.* unable to ablate the tachycardia source/circuit, or unable to deliver RF energy due to apprehension of complication or due to mechanical stunning of the pathway. Relapses/recurrence was defined as recurrence of same clinical arrhythmia after acute success of RF ablation.

Follow-up was done by reviewing the patients' medical records, outpatient visits and telephonic conversation. Follow-up period varied from 2-16 years.

Statistical analyses: The SPSS software was used for database organization and statistical calculations. The discrete variables were compared using Chi-square test, considering P value below 0.05 as significant.

RESULTS

A total of 2980 cases underwent the procedure during study period -229 (8%) were performed in patients aged younger than 18 years [mean (SD) age, 12.5 (4.6) year]. In 11 patients the data was incomplete; and another 4 patients did not have inducible tachycardia.Finally, data of 214 children (62% males) undergoing RF ablation were analyzed for this study.

These 214 patients had a total of 211 arrhythmia substrates. The commonest tachycardias found were APs in 85 (39 %) and AVNRT in 79 (36 %) patients. The most common arrhythmia with APs was orthodromic atrio ventricular re-entrant tachycardia (AVRT) followed by antidromic tachycardia (ADT) and pre-excited atrial fibrillation. Ventricular tachycardia was found in 28 patients (13 %), and atrial tachycardia (AT) in 21 patients (9.6%). Three patients had automatic junctional tachycardia and one patient had atrial flutter (previous surgery for atrial septal defect). Four patients had multiple tachycardia mechanisms and three patients had multiple APs.

We categorized them age-wise into three subgroups (*Table I*). In younger children, AP was the most common mechanism, but above 12 years, AVNRT emerged as the most common tachycardia mechanism. Fascicular VT

PROFILE OF PEDIATRIC TACHYARRHYTHMIA

Table I Tachycardia Substrates in Children Undergoing Radiofrequency Ablation $(N=211)^*$

	<i>≤6y</i>	7-12 y	13-18 y
	(n=33)	(n=53)	(n=135)
Males	18	32	84
LVEF, % [#]	70(9)	67 (9)	65 (10)
Upfront ablation			
Parental preference	1	5	22
Tachycardiomyopathy	1	1	2
AVNRT	8	22	49
ManifestAP(WPW)	14	15	31
Concealed AP	2	11	16
Atrial tachycardia	5	5	11
Fascicular VT	1	0	17
Outflow VT	3	0	7
Miscellaneous	0	0	4

*211 substrates in 214 children; [#]mean (SD); LVEF: Left ventricular ejection fraction; AVNRT: Atrioventricular nodal reentrant tachycardia; WPW: Wolff-Parkinson-White syndrome, AP: Accessory pathway; VT: Ventricular tachycardia.

was by far commoner in Group C. Among the 85 patients with APs, we detected 89 APs; of them there were nine right free wall Mahaim-like (atrio-fascicular) APs with antidromic tachycardia. Other than these, only two other patients had antidromic tachycardia, one of whom also had associated orthodromic AVRT. The left lateral location was the commonest (31/89, 35%). Left sided APs were more common in concealed APs (18/29, 62%) than in WPW group (13/60, 21%, P<0.001).

The overall immediate success rate (*Table II*) was 95% (204/214). For AVNRT, 98.7% (78/79) were ablated by slow pathway modification. Among the APs, immediate success rate was 96.4% (82/85); failure was most commonly seen in Ebstein anomaly and with Mahaim-like pathways (*WebTable I*). The success rates in the three groups were similar. There were no major or minor

	Total	Success	Fluoroscopy time (min)*	Mean procedure time (min)	No. of RF lesions*	Maximum temperature (°C)
AVNRT	79	78	10.9 (5.9)	78	4.7 (2.5)	60
Accessory pathway (AVRT)	85	82	14.6 (7.1)	90	5.1 (3.3)	55-60
Atrial tachycardia	21	19	19.3 (10.2)	117	4.3 (2.0)	50-60
Outflow tract VT	10	10	17.5 (13.3)	103	5.9 (3.1)	60
Fascicular VT	18	15	21.1 (11.1)	130	6.5 (2.5)	50-60
Miscellaneous	4	3	15 (7.2)	90	3.5 (2.2)	60

Table II Success Rate of Radiofrequency Ablation in Children With Tachyarrhythmia

*Values are expressed as mean (SD); AVNRT: Atrioventricular nodal re-entrant tachycardia; VT: Ventricular tachycardia.

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WHAT THIS STUDY ADDS?

Ablation in children using conventional radiofreauency energy was safe and effective, with similar success
rate among those younger or older than six years.

complication. The recurrence rate was 2.9 % (6/205); 2 had AVNRT, 3 had APs and 1 had AT.

We sub-categorized those who had prolonged procedures, arbitrarily defined more than two hours. There were seven such patients; three had atrial tachycardia, three had APs and one had VT. Five of them required left sided ablation; all these procedures were finally successful.

Among patients undergoing the procedures, six had congenital heart disease (three had atrial septal defect, two had Ebstein's anomaly and one had ventricular septal defect). Four more patients had tachycardiomyopathy, among whom three had incessant AT.

DISCUSSION

We found AVRT to be the most common tachycardia below six years; above this age, AVNRT and AVRT were comparable. This is in contrast to older studies [6], which found that accessory pathway was the most prevalent finding between age range of 2-18 years, with AVRT in 65%, AVNRT in 30%, ventricular tachycardia in 4%, and atrial tachycardia in 0.7%.

Previous report shave demonstrated that RF ablation can safely and effectively be performed in pediatric patients [2-4,6]. After 1-16 year follow up, the overall success rate was also higher than older studies [1]. With the advent of cryoablation, studies revealed, AV block was less with cryoablation, though recurrence was significantly higher [7]. We have performed only conventional RF for all age groups as cryoablation was unavailable at our center. Van Hare, et al. [1] reported a success rate of 95.7% with RF ablation in AVRT and AVNRT in pediatric patients. Simao, et al. [8] reported slightly lower success rate of 91.7% in AVNRT and 83.5% for APs. Our study is in concordance with these previous results [2-6]. Our study revealed better immediate success rate of 95% and recur-rence rate of only 2.9%. After successful ablation we could withdraw anti-arrhythmic drugs and the majority remained asymptomatic without recurrence.

In our cohort, infants were few and hence we did not compare or analyze the results separately. A unique finding in our study was higher incidence of Mahaim (atriofascicular) pathways (9/89, 10%). Compared to reports of only 3% of accessory pathways [9]. Another unusual finding in our study was that idiopathic VT comprised a significant proportion (12.9% of all tachycardias), where we had a good success rate (25/28, 89%). A study [10] comparing RF ablation in neonates and children between 1 and 18 months of age, found that neonates had significantly higher structural heart disease and yet the success rate and complications were surprisingly similar in both subsets. The comparable success rates in our cohort could partially be due to the fact that ablations in smaller children are more likely to be attempted by more experienced pediatric electro-physiologists and experience has been shown to be an important factor in successful pediatric RF ablation procedures [11].

This was a hospital-based retrospective analysis and suffers from the risk of bias and lack of generalizability. Infants and very small children were avoided unless pressing indications, hence these were few subjects in that age range. We did not have cryoablation, hence comparison was not possible between RF and cryoablation.

We believe RF ablation can be considered for pediatric arrhythmias, especially when they are recurrent and in children above 5 years of age. Whether RF ablation can be a primary treatment modality for young children is still a debatable issue, this can perhaps be addressed by more data from other Indian centers.

Ethical clearance: Institutional ethical committee of Holy Family Hospital; ECR/196/INST/MH/2013/RR-16, dated September 14, 2019.

Contributors: DB: analysed data and drafted the manuscript; VV:collection of data, designing study; CR: manuscript scrutiny and helped in data analysis; RS: helped in writing the manuscript and develop images; NB: performed echocardiography for majority of the patients and helped in data analysis; YL: concept of the study, supervised cognitive and behavioral assessments, supervised manuscript preparation.

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Advertisement



Age, y	Diagnosis	Cause of failure
14	WPW/Left lateral AP	Broad pathway, Epicardial location*
13	Junctional tachycardia	Proximity to AV node [#]
10	AVNRT	Proximity to AV node [#]
04	AT (right atrial)	Remained inducible*
16	AT (right superior pulmonary vein)	Remained inducible*
14	Fascicular (upper septal) VT	Proximity to his bundle [#]
15	Fascicular (upper septal) VT	Proximity to his bundle [#]
14	Ebstein's anomaly	Broad AP, could not be ablated completely*
14	Mahaim atrio-fascicular accessory pathway	Stunned by catheter contact and then could not be mapped [#]

Web Table I Details of Children With Failed Ablations (N=10)

Cause of failure: *Unable to ablate the tachycardia source/circuit; [#]Unable to deliver RF energy due to apprehension of complication or due to mechanical stunning of the pathway; AVNRT: Atrioventricular nodal re-entrant tachycardia, AP: Accessory pathway, AT: Atrial tachycardia, WPW: Wolff-Parkinson-White syndrome, VT: Ventricular tachycardia.