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SPOTLIGHT

Irrigated contact force sensing catheter for redo ablation of slow–fast atrioventricular nodal reentrant tachycardia in pediatric and adolescent patients: A case series

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Slow pathway modification for atrioventricular nodal reentrant tachycardia (AVNRT) ablation is usually performed in children using cryoenergy or radiofrequency with a 4-mm nonirrigated ablation catheter in a temperature-controlled mode. Conventional catheters may be ineffective to obtain complete arrhythmia elimination in certain cases. The use of irrigated contact force sensing (ICFS) catheters has been increasing over time for radiofrequency catheter ablation (RFCA) of several arrhythmic substrates in both adults and children.[1–4] However, concerns about safety have limited their use for slow pathway modification in pediatric patients, mainly related to the risk of iatrogenic atrioventricular (AV) block.

Herein, we report five consecutive pediatric patients (aged 13–17 years) with slow–fast AVNRT who underwent redo ablation using an ICFS catheter at our Electrophysiology (EP) Laboratory between January 2019 and January 2023.

Clinical and procedural data are summarized in Table 1. All patients had one previous ablation procedure with conventional 4-mm nonirrigated ablation catheter and documented recurrences on ECG or implantable loop recorder[5] or persistent AVNRT inducibility.

EP study was performed using a near-zero fluoroscopy approach guided by Carto 3 mapping system (Biosense Webster) with ICFS ablation catheter (SmartTouch ThermoCool 3.5 mm, Biosense Webster) and one or two diagnostic catheters. Slow–fast AVNRT was induced using conventional pacing maneuvers (tachycardia cycle length 308 ± 40 ms). RF was released during sinus rhythm at the site of a clear slow pathway potential when CF value was between 3 and 20 g, setting power between 20 and 35 W. Temperature ranged between 37 and 45°C with low irrigation flow rate. If a stable slow junctional rhythm was observed during the first 10 s, the lesion was considered to be effective, and RF was applied until a total time of 60 s (Figures 1 and 2). After a few seconds of waiting time, RF lesion was consolidated with further 30–60 s of energy at the same point to reduce the risk of recurrences. If a rapid irritative junctional rhythm occurred, RF was immediately stopped, and the slow pathway was remapped. RFCA was considered successful when AVNRT was no longer inducible despite isoproterenol challenge. Otherwise, the slow pathway was remapped, and further RF shots were applied.

AH and HV intervals and AV Wenckebach point were measured before and after ablation and resulted to be unchanged. Mean distance between slow pathway ablation site in the right atrium and His bundle location was 20.4 ± 7 mm. Mean number of RF pulses required to obtain effective slow pathway modification was 2.8 ± 1.3, with low RF time (156 ± 88 s) and low CF average (7.8 ± 3.2 g). Mean procedure time was 87 ± 19 minutes with minimal fluoroscopy exposure (22 ± 18 s).

Primary endpoint for successful AVNRT ablation is elimination of AVNRT inducibility after ablation-induced junctional rhythm. Residual slow pathway conduction is not considered a marker of recurrence. We obtained elimination of both AH jump and AVNRT inducibility in all patients. Outcome was good in all cases since no complications and no recurrences were observed during follow-up (21.6 ± 17.6 months).

Nonirrigated catheters are conventionally used for AVNRT ablation in a temperature-controlled mode since deep lesions are not usually required for successful slow pathway modulation. However, nonirrigated catheters cannot be able to create adequate lesions for effective slow pathway modification in certain cases, causing persistent tachycardia inducibility or recurrences[2] despite induction of

TABLE 1 Clinical and procedural data from the study cohort.

	#1	#2	#3	#4	#5
Sex	M	F	F	M	F
Age (years)	17	14	13	16	16
Weight (Kg)	69	49	50	55	59
Height (cm)	180	162	151	162	158
AH (ms)	100	72	80	85	88
HV (ms)	44	46	48	44	40
AV WP (ms)	490	360	330	380	440
TCL (ms)	270	260	320	350	340
SP-HBE distance (mm)	30	16	15	15	26
Effective RF pulses	5	2	3	2	2
Effective RF time (s)	300	90	180	90	120
Power (W) (mean)	35	20	25	28	27
CF average (g)	5	13	8	5	8
Impedance Drop (Ω) (mean)	8	12	6	9	10
X-ray time (s)	30	51	6	12	13
Procedure time (min)	120	80	90	70	75

Abbreviations: AV WP, atrioventricular Wenckebach point; CF, contact force; RF, radiofrequency; SP-HBE, slow pathway-His bundle electrogram; TCL, tachycardia cycle length.

slow junctional rhythm during ablation, as we noted reviewing previous RFCA procedures in our cohort. Therefore, a higher number of RF pulses close to the compact AV node may be necessary to try to eliminate AVNRT, increasing the risk of AV block, or complex left-sided ablation procedures.

ICFS catheters may be an option in these cases. These catheters are capable to delivery greater power since they are not limited by temperature and impedance rise at the catheter-tissue interface, obtaining larger and deeper lesions in power-controlled mode, as opposed to non-irrigated ablation catheters, which are constrained by the temperature increase for effective lesions creation.[2–4] It has been advocated to use the lowest programmable irrigation flow rate to reap the benefits of irrigated catheters for AVNRT ablation, such as deliver higher power and create more durable and effective lesions on the slow pathway, without extending the lesion size excessively, minimizing the risks of damage on the AV node.[2] Nowadays, irrigated catheters also incorporate CFS technology. The real-time monitoring of the catheter-endocardial contact can be useful to obtain even more effective lesions, providing an earlier discontinuation of ineffective RF applications in case of inadequate CF, consequently reducing the total number of RF pulses and total RF time.[1–4] At the same time, CF monitoring allows to avoid dangerous high CF values and high impedance drop, reducing the risk of perforation and vascular injury on coronary arteries that are located in the posteroseptal region, such as the AV nodal artery.[1]

The primary safety concern for the spread of ICFS catheters for AVNRT ablation is the greater risk of AV block than adult

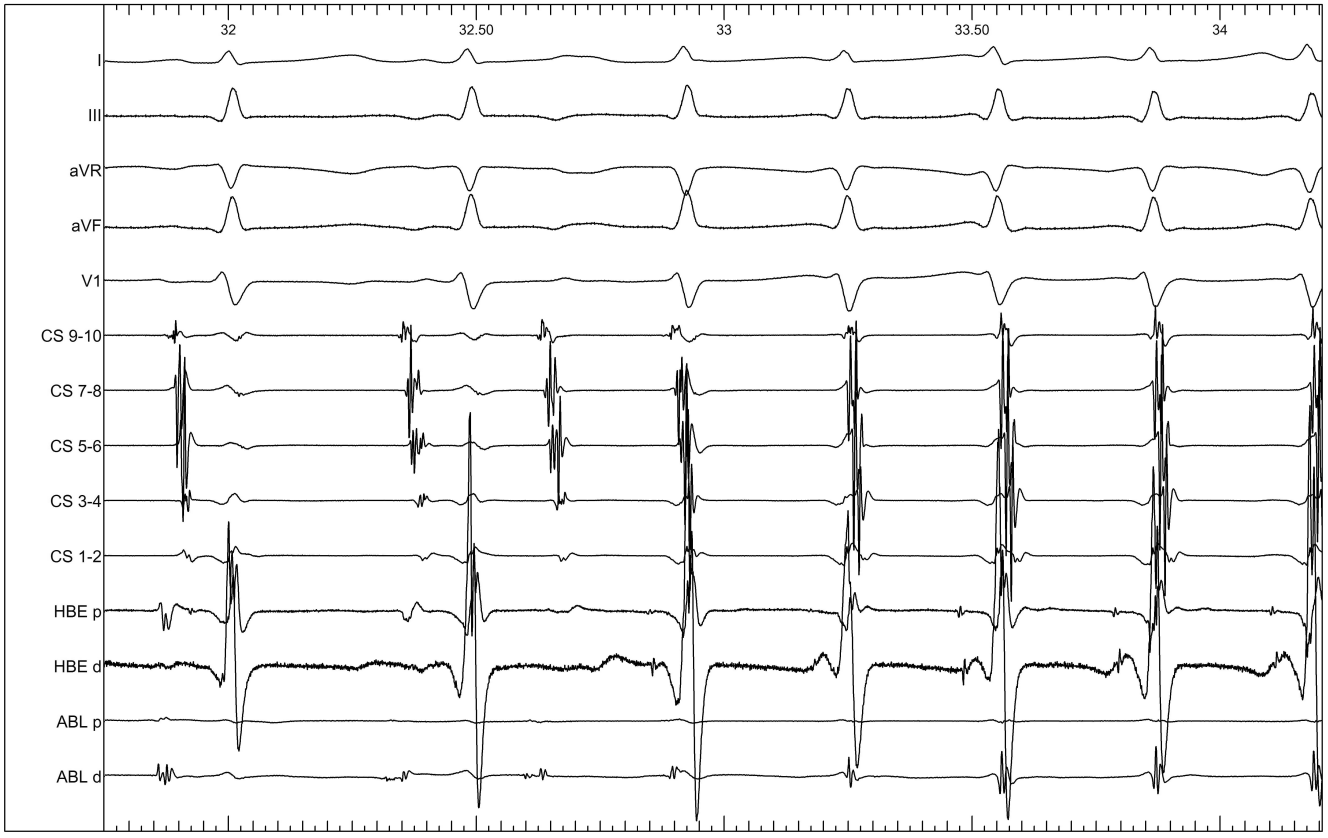

FIGURE 1 Slow–fast atrioventricular nodal reentrant tachycardia.

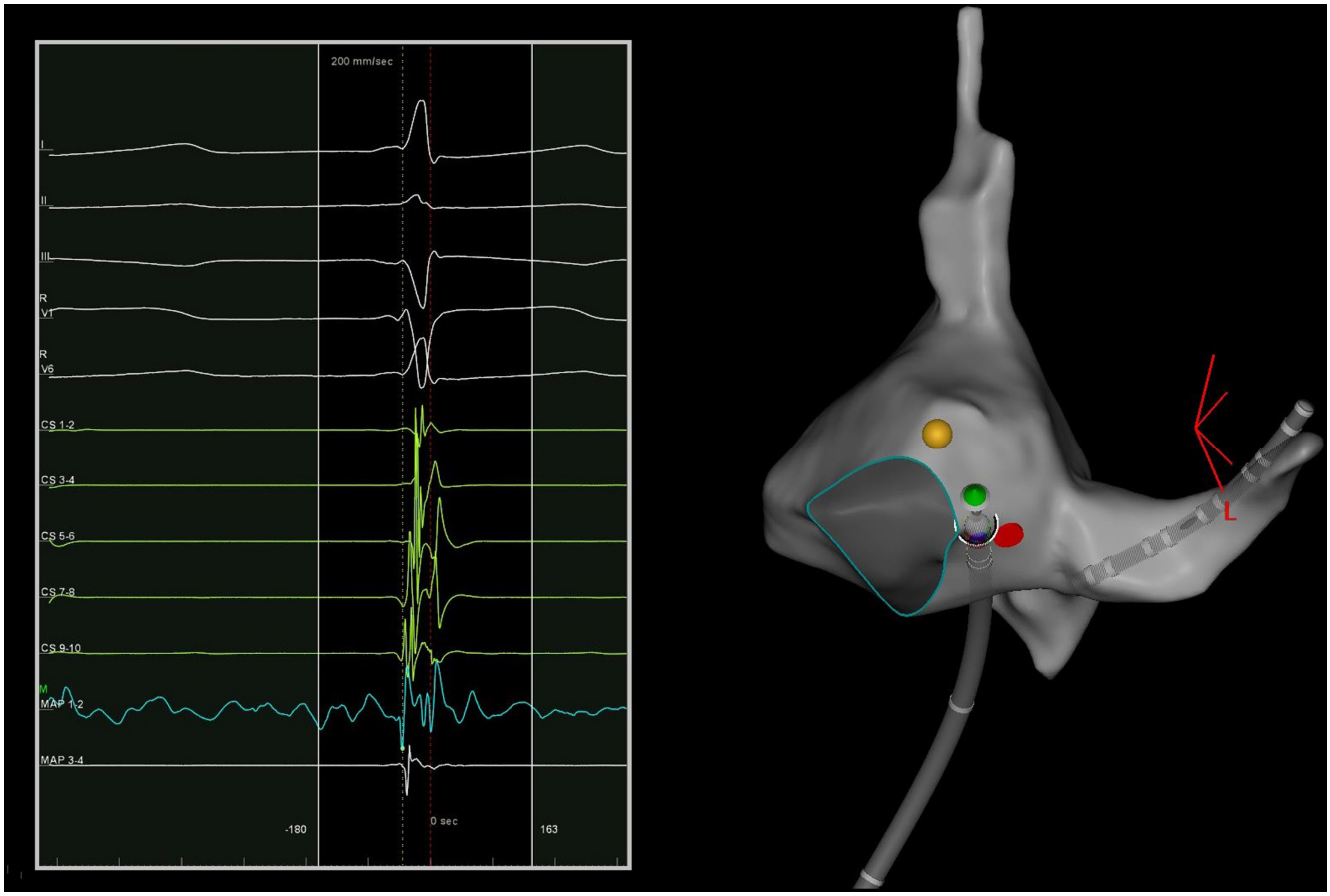

FIGURE 2 3D reconstruction of the right atrium and Koch's triangle. Irrigated contact force sensing ablation catheter was used for careful mapping of the Koch's triangle, identifying the compact AV node and the His bundle electrogram (yellow dot), the slow pathway location and the coronary sinus ostium. Slow pathway was effectively ablated with two radiofrequency applications (red dots) associated with slow irritative junctional rhythm.

population. We observed no cases of iatrogenic AV block nor coronary injury in our study cohort, maintaining low CF values with low irrigation flow rate and precisely targeting the slow pathway by electroanatomic mapping. Some limitations have to be considered. Most of our patients were adolescents with body size similar to adults. Furthermore, slow and fast pathways were at adequate distance in the Koch's triangle (>10 mm). This evidence suggests that irrigated ablation may be restricted to a selected population of older children or adolescents that could benefit most from this approach (AVNRT recurrences or persistent AVNRT inducibility after nonirrigated ablation) with no increased risks. ICFS catheter is not suitable for younger children with very small body size and short distance between slow and fast pathways. To date, cryoablation or nonirrigated RF ablation still represent the safest approach for these patients.

Despite these considerations, our case series provide new insight for a possible further utility of these catheters in the pediatric population. Our preliminary experience suggests that ICFS catheters may be considered in pediatric and adolescent patients to obtain a more extensive slow pathway modulation for redo ablation, avoiding dangerous RF applications close to the compact AV node or complex left-sided procedures.

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CONFLICT OF INTEREST STATEMENT

All authors report no financial relationships that could be construed as a conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

PATIENT CONSENT STATEMENT

This case series complied with the Declaration of Helsinki and its later amendments. Informed consent was obtained from patient's parents/legal guardians.

CLINICAL TRIAL REGISTRATION

Not applicable.

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