Cardiol Young 2001; 11: 182–187
© Greenwich Medical Media Ltd.
ISSN 1047-9511

Original Article

Abbreviated combined anatomical/electrophysiological approach for catheter ablation of atrioventricular nodal reentrant tachycardia in children

Harald Bertram, Britta Windhagen-Mahnert, Regina Bökenkamp, Thomas Kriebel, Matthias Peuster, Gerd Hausdorf, Thomas Paul

Department of Pediatric Cardiology and Pediatric Intensive Care Medicine, Childrens Hospital, Hannover Medical School, Hannover, FR Germany

Abstract Atrioventricular nodal reentrant tachycardia was proven during electrophysiologic study in 41 children, aged from 3.7 to 16 years, who were referred for catheter ablation of symptomatic supraventricular tachycardia. Using an abbreviated combined anatomical and electrogram-guided approach for selective ablation of the slow pathway, a steerable ablation catheter was placed at the inferior region of the vestibule of the tricuspid valve close to the orifice of the coronary sinus, with the intention of recording a multicomponent local atrial electrogramm during sinus rhythm. If application of radiofrequency current of 500 kHz at 70°C at this site did not result in a slowly accelerated junctional rhythm, at a rate of less than 120 beats per minute, the catheter was stepwise advanced up to a position midway towards the apex of the triangle of Koch for additional applications of energy. Ablation was achieved in 35 of the patients. In 6 patients, the slow pathway was modulated such that the tachycardia could no longer be induced. The number of applications of energy ranged from 1 to 19, with a median of 6 applications. The mean period of fluoroscopy was reduced to 15.6 (4.3 to 39.8) minutes, while the overall duration of the catheterization procedures ranged from 88 to 280 (mean 173.2) minutes. In none of the patients did we observe permanent high grade atrioventricular block. During follow-up over a mean of 4.1 years, two patients had recurrence of tachycardia, corresponding to a 95% rate of success in the midterm. We conclude that selective radiofrequency ablation of the slow pathway using the abbreviated anatomical and electrophysiological approach is a safe and curative therapeutic approach in children with atrioventricular nodal reentrant tachycardia. Periods required for fluoroscopy can be significantly reduced, and mid-term results are excellent.

Keywords: nodal reentrant tachycardia, interventional catheterisation, catheter ablation, children

ATRIOVENTRICULAR NODAL REENTRANT tachycardia is a common cause of paroxysmal supraventricular tachycardia seen in children and adults.[1–5] In the past, only pharmacological and surgical options had been available for treatment. In the early 1990s, catheter ablation using radiofrequency current was successfully performed in adults with drug-resistant tachycardia.[4–10] In the beginning, a superior approach was used to ablate the fast pathway, which carried a considerable risk of induction of complete atrioventricular block.[7,10–14] Today, the inferior approach, targeting the slow pathway, is the method of choice for catheter ablation of atrioventricular nodal reentrant tachycardia.[4,5,14–16] Different techniques have been described using anatomical and electrogram-guided mapping,[4,5,7,17–19] including strategies used in adults to reduce the times required for ablation and fluoroscopy.[17]

Correspondence to: Harald Bertram, MD, Department of Pediatric Cardiology and Pediatric, Intensive Care Medicine, Hannover Medical School, Carl-Neuberg-Str. 1, D-30625 Hannover, FR Germany. Tel: + 49 511 5323220; Fax: + 49 511 5329038; E-mail: Bertram.Harald@ mh-hannover.de

Accepted for publication 6 September 2000

Experience in children is limited to small numbers of patients, and follow-up is similarly limited in most studies.[20–23] The purpose of this study, therefore, was to present our experience with an abbreviated combined anatomical and electrophysiological approach to selective ablation of the slow pathway ablation in children and adolescents with atrioventricular nodal reentry tachycardia.

Materials and methods

Patients

From 1992 to July 1999, 41 out of 220 children referred for interventional treatment of paroxysmal supraventricular tachycardia to the Department of Pediatric Cardiology and Pediatric Intensive Care at Hannover Medical School underwent radiofrequency catheter ablation for atrioventricular nodal reentrant tachycardia. The population included 26 females and 15 males with a mean age of 9.6 ± 3.6 years, ranging from 3.7 to 16 years, and a mean body weight of 41.9 kg ± 14.6, ranging from 16.7 to 64.4 kg. All children had recurrent episodes of symptomatic paroxysmal tachycardia documented by electrocardiograms. Three patients had experienced recurrent syncopes. All patients had been treated with antiarrhythmic medication, including 6 patients with two antiarrhythmic drugs. Two patients had been receiving amiodarone. Of the 41 patients, 39 had a structural normal heart. One patient had scimitar syndrome, and another patient suffered from complete transposition with pulmonary atresia and ventricular septal defect, and had been palliated by construction of a modified Blalock-Taussig shunt.

Electrophysiologic study and application of radiofrequency current

Written informed consent was obtained from all patients older than 14 years, and from the parents of younger patients before the procedure. Antiarrhythmic drugs were discontinued 5 half-livs before the procedure. Cooperative patients were studied under local anaesthesia. In the remaining patients, sedation was achieved by administration of repeated doses of ketamine (1–2 mg/kg) and midazolam (0.1 mg/kg). Electrode catheters were introduced percutaneously via the femoral veins and the left antecubital vein. Intravenous heparin was given at an initial dose of 100 U/kg at the onset of the procedure. Quadripolar electrode catheters (6 F Josephson type, Bard/USCI, Billerica, MA) were positioned at the His bundle and in the right ventricular apex. A decapolar electrode catheter (6 F, Cournand type, Bard/USCI, Billerica, MA) was positioned in the coronary sinus via the left antecubital vein (Figure 1). A steerable 7 F mapping and ablation catheter (Marinr, Cardiorhythm/ Medtronic, Minneapolis, MN) was positioned in the high right atrium at the beginning of the procedure. Surface electrograms (lead I, avF, V1 and V6) and intracardiac electrograms were simultaneously recorded and displayed using a multichannel system (Cardioscript 9000, Picker, München, FR Germany; Cardiolab, Prucka Engineering, Houston, USA). The stimulation protocol consisted of programmed atrial and ventricular stimulation as described previously.[2] If tachycardia could not be induced, atropine (0.01 mg/kg) and, if required, subsequently orciprenaline (0.01 mg/kg) were given and programmed stimulation was repeated.

Dual nodal physiology was inferred from prolongation of the A2H2 interval (interval from low right atrium to His bundle signal) to 50 msec or greater during placement of single atrial extrastimuli with increasing prematurity (10 msec) into an atrial paced rhythm (usually at 500 msec).[2,24] After evaluation of the mode of induction of the tachycardia, sinus rhythm was restored. The tip of the steerable 7 French mapping and ablation catheter was directed to the inferior region of the vestibule of the tricupid valve below the orifice of the coronary sinus (Figure 1)[15,16] with the intention to record a late fractionated, M-shaped local atrial electrogram (Figure 2) with 20–30 % of the size of the local ventricular signal.[16,19,20,23] During sinus rhythm, radiofrequency current (500 kHz, generator HAT 300, Dr. Osypka GmbH, Grenzach-Wyhlen, Germany) was delivered under temperature guidance with a target temperature of 70°C and maximal power output of 30 Watts for 30 seconds in the unipolar mode against a plate electrode placed under the back of the patients. If an accelerated junctional rhythm, with a ventricular rate of less than 120/min, occurred during discharge of energy (Figure 3), programmed atrial stimulation was repeated. If the tachycardia could still be induced, the tip of the ablation catheter was moved stepwise and slightly superior by approximately 3 mm, respectively, and applications of current repeated until the catheter was positioned midway between the inferior margin of the vestibule and the apex of the triangle of Koch.[16,17] Prior to every discharge, care was taken to ensure absence of a signal from the His bundle at the ablation catheter. If junctional tachycardia with a ventricular rate of greater than 150 beats per minute, and/or block of ventriculoatrial conduction was encountered, reflecting heating of the compact atrioventricular node during application of current, discharge was immediately stopped.

https://doi.org/10.1017/S1047951101000087 Published online by Cambridge University Press

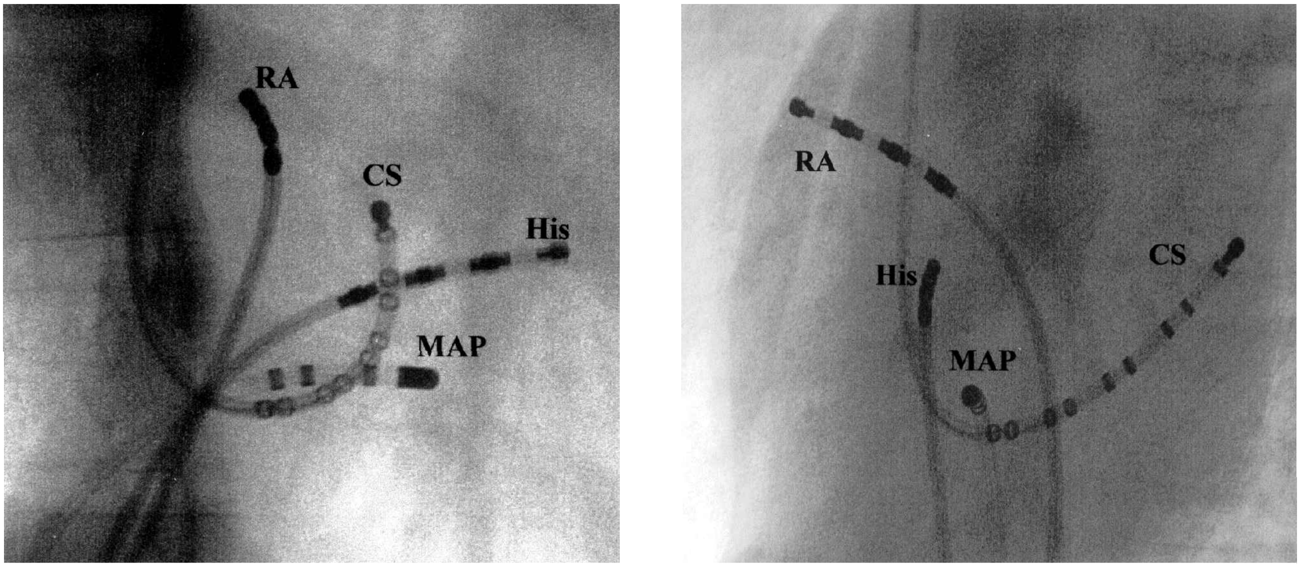

Figure 1
The position of the electrode catheters during the electrophysiological study as shown in 30° right anterior oblique (a) and 60° left anterior oblique (b) projections: 6 French quadripolar electrode catheters are positioned at the His-bundle (His) and in the right ventricular apex (RV), a 6 French decapolar catheter has been introduced into the coronary sinus (CS). The steerable 7 French mapping and ablation catheter (MAP) is positioned at the vestibule of the tricuspid valve just below the orifice of the coronary sinus.

Slow pathway ablation was defined as lack of evidence of dual nodal physiology during repeated stimulation, indicating that the patients no longer exhibited discontinous A2H2 curves after ablation. Modulation of the slow pathway was presumed when there was a persistent A2H2 jump with maximal one atrial echoimpulse, reflecting residual function of the slow pathway during programmed atrial stimulation after ablation.

After the procedure, patients were monitored for two additional days in the hospital. In all patients, we obtained surface electrocardiograms and a 24-hour Holter monitor recording. All patients had cross-sectional echocardiograms performed before discharge to exclude adhesive intraatrial thrombus. Aspirin in a dosage of 2–3 mg/kg was given orally once a day for the following 6 months. During follow-up, patients were seen by their referring pediatric cardiologist, or at our institution on an outpatient basis every 6 months. Follow-up examinations included physical examination, cross-sectional echocardiography, surface electrocardiography, and 24-hour Holter monitoring.

Results

In all 41 children we were able to demonstrate dual nodal physiology during the electrophysiological study. Discontinous A2H2 curves could be found in 38 of the 41 patients, with three children having smooth curves. In none of the patients did we find additional A2H2 jumps, reflecting triple nodal physiology.[2] We induced atrioventricular nodal reentrant tachycardia of the slow-fast type in all the patients. The mean tachycardia cycle length was 305 ± 35, with a range from 230 to 400 msec. In all 41 patients, either a slowly accelerated junctional rhythm or premature junctional beats were observed during discharge of energy at successful sites. The accelerated junctional rhythm lasted between 3 and 14 seconds and disappeared suddenly under continued delivery of energy. The mean number of radiofrequency pulses applied was 7.0 ± 3.7, with a range from 1 to 19, and a median of 6. In none of the patients could we still induce the tachycardia at the end of the electrophysiologic study. In 35 of the 41 patients, ablation of the slow pathway was achieved as exemplified by absence of discontinuos A2H2 curves after delivery of energy. In the remaining 6 children, the slow pathway was modulated, since discontinous A2H2 curves persisted with a maximum of one single fast pathway echo beat.

Mean fluoroscopy time was 15.6 ± 7.2, with a range from 4.3 to 39.8 minutes, and the catheterization procedures took from 88 to 280, with a mean of 173 ± 44 minutes. One patient had transient third degree atrioventricular block during discharge, which persisted for 4 minutes and returned to sustained sinus rhythm subsequently. Two children developed first degree block after the procedure. In none of the patients did we encounter

https://doi.org/10.1017/S1047951101000087 Published online by Cambridge University Press

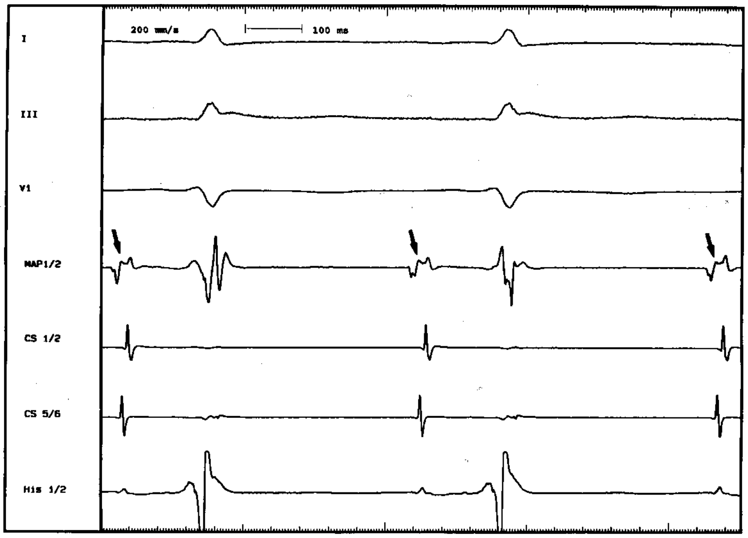

Figure 2.
Electrograms during mapping before application of radiofrequency energy: surface electrograms (I, III, V1) are displayed together with endocardial bipolar recordings from the tip of mapping and ablation catheter (MAP 1/2), the coronary sinus catheter (CS 1/2, CS 5/6), and the His bundle catheter (His 1/2). With the tip electrodes of the ablation catheter (MAP 1/2) positioned at the vestibule of the tricuspid valve as shown in Figure 1, a fractionated M-shaped local atrial electrogram with a duration of 33 msec can be recorded during sinus rhythm.

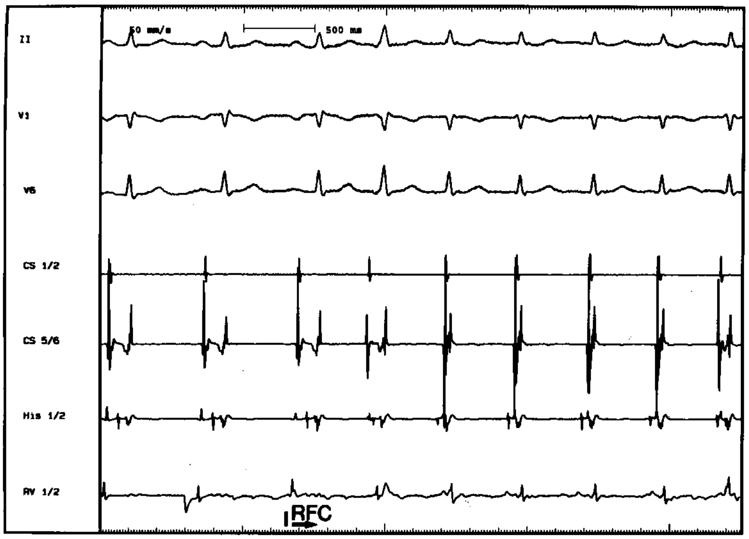

Figure 3.
Surface electrograms (II, V1, V6) and endocardial recordings from the coronary sinus catheter (CS 1/2, CS 5/6), the His bundle catheter (His 1/2), and the right ventricular catheter (RV 1/2) during application of radiofrequency current (RFC). Energy discharge (bar, arrow) immediately induces a slowly accelerated junctional rhythm with a ventricular rate of 115 beats per minute lasting for 9 seconds.

permanent high grade atrioventricular block, nor other complications observed, including problems with vascular access.

During a mean follow-up period of 4.2 ± 1.4 years, and with a range from 12 months to 8.2 years, we noted no further serious sequels. Two patients, both having had only modulation of the slow pathway, had recurrences of supraventricular tachycardia two and three months after the ablation procedure, respectively. All other patients remain free of supraventricular tachycardia without antiarrhythmic medication.

Discussion

The typical form of atrioventricular nodal reentrant tachycardia results from a reentrant circuit consisting of anterograde conduction via a slow pathway and retrograde conduction via a fast pathway.[2,4] Due to high success, and low complications, the inferior approach with several modifications of the ablation technique targeting the slow pathway became the treatment of choice in adults.[4,5,13,14,16,18,19,25,26] These promising results in adults lead to the application of radiofrequency catheter ablation to younger patients.[1,20–23,27] To the best of our knowledge, an abbreviated interventional approach such as presently described, emphasizing primarily anatomic guidance of the mapping and ablation catheter, has yet to be reported from an institution dealing primarily with children.

Rate of success

This study demonstrates the efficacy of ablation or modification of the slow pathway in the largest study thus far reported from a single centre dealing

https://doi.org/10.1017/S1047951101000087 Published online by Cambridge University Press

with children with atrioventricular nodal reentrant tachycardia. Despite the use of an abbreviated combined anatomic and electrophysiological approach, we eliminated the tachycardia in all our patients during the procedure. The mid-term rate of success reaches 95%, covering a mean follow-up of 4.2 years. These results are comparable or superior to other reports of ablation of the slow pathway in children, the previous reports describing fewer patients and having shorter periods of follow-up.[20–22] Recently, low temperature and low energy radiofrequency modulation of slow pathways has been reported with comparable levels of efficacy and safety.[23] With this approach, it was speculated that the size of the lesion might be reduced, but no data were provided. As the number of patients and follow-up were limited,[23] the advantages of this method compared to our standard approach using a target temperature of 70°C with maximal power output of 30 Watts remain to be determined. The large multicentric experience of the Ablation Registry of the North American Pediatric Electrophysiology Society reported an immediate success in 96% of 920 patients below 21 years of age having treatment of atrioventricular nodal reentry tachycardia between 1991 and 1996. Follow-up at 3 years revealed 71% freedom from recurrence.[1]

Safety

Electrogram-guided, as well as anatomical, approaches to ablation of the slow pathway have been shown to reduce the rates of major complications.[4,16,17,19,20] Nevertheless, recommendations have been made to restrict the procedure to patients older than 12 years of age.[2] Our data in a population with a mean age of 9.6 years demonstrate that ablation of the slow pathway can be performed in young patients with comparable safety as in adults despite the reduced size of the intracardiac dimensions.[1,4,8,21,22,25,28] Two children developed first degree atrioventricular block, but none of our young patients experienced permanent high-grade block.[2,29] The intention strictly to avoid permanent damage to the compact atrioventricular node was considered more important than the goal to achieve ablation of the slow pathway in every patient during the first procedure. Consequently, modulation of the slow pathway was accepted as result of the ablation in 6 patients.[4,17,21,22]

Clinical implications

According to the findings of Gross and coworkers[30], atrioventricular nodal reentry tachycardias diagnosed in the first year of life carry a generally benign prognosis. As the risks of catheterization are significantly higher in infants than in older children, it seems to be reasonable to start medical treatment in young children.[1,28] Radiofrequency ablation can be postponed for some years in almost all of these children.[30]

In our series, the youngest patient was 3 years of age at the time of electrophysiologic study. This patient had experienced several recurrent symptomatic episodes of supraventricular tachycardia after failure of standard antiarrhythmic drugs, and finally despite treatment with amiodarone at a maintenance dose of 15 mg/kg combined with digoxin. The mean age of our patients was 9.6 years, reflecting our general attitude to try to postpone ablation to school age. At this age, catheter ablation is a reasonable alternative to antiarrhythmic treatment.[1,20,22]

A major concern related to electrophysiologic studies with subsequent ablation in children is the long-term consequences of exposure to radiation. It has been suggested, therefore, that electrophysiologic studies and interventions in young patients should be restricted to experienced centers.[2] Modified strategies for ablation have been shown to reduce the times required for both the procedure and fluoroscopy in adults.[17] The mean time required for fluoroscopy in children undergoing ablative procedures for atrioventricular nodal reentrant tachycardias carried out in institutions dealing primarily with children ranged from 29.9 ± 20 to 53.4 ± 34 minutes.[21,23] The multicentric evaluation of the Radiofrequency Catheter Ablation Registry reported mean times for fluoroscopy below 40 minutes in patients with atrioventricular nodal reentry tachycardia in 1995 and 1996 without stating the exact figures.[1] The mean time needed for fluoroscopy in our study using an abbreviated approach was 15.6 minutes, while the mean duration for the overall procedures was 173 minutes. These figures seem to be justifiable for a curative interventional catheterization procedure in symptomatic patients.

Acknowledgements

The authors thank Martina Zutz and Alexander Rohloff, from the Cardiac Catheterization Laboratory, Department of Pediatric Cardiology and Pediatric Intensive Care Medicine, Childrens Hospital, Hannover Medical School, for their support and patience during the procedures.

References

1. Kugler JD, Danford DA, Houston K, Felix G. Radiofrequency catheter ablation for paroxysmal supraventricular tachycardia in children and adolescents without structural heart disease. Pediatric EP Society, Radiofrequency Catheter Ablation Registry. Am J Cardiol 1997; 80: 1438–1443

2. Van Hare GF. Supraventricular tachycardia. In: Gillette PC, Garson A (eds.) Clinical pediatric arrhythmias. 2nd edition, Saunders, Philadelphia, 1999, pp. 97–120
3. Ko JK, Deal BJ, Strasburger JF, Benson DW. Supraventricular tachycardia mechanisms and their age distribution in pediatric patients. Am J Cardiol 1992; 69: 1028–1032
4. Jackman WM, Beckman KJ, McClelland JH, Wang X, Friday KJ, Roman CA, Moulton KP, Twidale N, Hazlitt HA, Prior MI. Treatment of supraventricular tachycardia due to atrioventricular nodal reentry by radiofrequency catheter ablation of slow-pathway conduction. N Engl J Med 1992; 327: 313–318
5. Jazayeri MR, Hempe SL, Sra JS, Dhala AA, Blanck Z, Deshpande SS, Avitall B, Krum DP, Gilbert CJ, Akhtar M. Selective transcatheter ablation of the fast and slow pathways using radiofrequency energy in patients with atrioventricular nodal reentrant tachycardia. Circulation 1992; 85: 1318–1328
6. Epstein LM, Scheinmann MM, Langberg JJ, Chilson D, Goldberg HR, Griffin JC. Percutaneous catheter modification of the atrioventricular node. A potential cure for atrioventricular nodal reentrant tachycardia. Circulation 1989; 80: 757–768
7. Haissaguerre M, Warin JF, Lemetayer P, Saoudi N, Guillem JP, Blanchot P. Closed-chest ablation of retrograde conduction in patients with atrioventricular nodal reentrant tachycardia. N Engl J Med 1989; 320: 426–433
8. Hindricks G on behalf of the Multicenter European Radiofrequency Survey (MERFS). Incidence of complete atrioventricular block following attempted radiofrequency catheter modification of the atrioventricular node in 880 patients. Eur Heart J 1996; 17: 82–88
9. Hoffmann E, Mattke S, Dorwarth U, Muller D, Haberl R, Steinbeck G. Temperature controlled radiofrequency catheter ablation of AV conduction: first clinical experience. Eur Heart J 1993; 14: 57–64
10. Jackman WM, Wang X, Friday K, Fitzgerald DM, Roman C, Moulton K, Margolis PD, Bowman AJ, Kuck KH, Naccarelli GV. Catheter ablation of atrioventricular junction using radiofrequency current in 17 patients: Comparison of standard and large-tip catheter electrodes. Circulation 1991; 83: 1562–1576
11. Langberg JJ, Leon A, Borganelli M, Kalbfleisch SJ, el-Atassi R, Calkins H, Morady F. A randomized prospective comparison of anterior and posterior approaches to radiofrequency catheter ablation of atrioventricular nodal reentrant tachycardia. Circulation 1993; 87: 1551–1556
12. Chen SA, Chiang CE, Tsang WP, Hsia CP, Wang DC, Yeh HI, Ting CT, Chuen WC, Yang CJ, Cheng CC. Selective radiofrequency catheter ablation of fast and slow pathways in 100 patients with atrioventricular nodal reentrant tachycardia. Am Heart J 1993; 125: 1–10
13. Lee MA, Morady F, Kadish A, Schamp DJ, Chin MC, Scheinman MM, Griffin JC, Lesh MD, Pederson D, Goldberger J. Catheter modification of the atrioventricular junction with radiofrequency energy for control of atrioventricular nodal reentry tachycardia. Circulation 1991; 83: 827–835
14. Morady F. Fast pathway ablation for atrioventricular node reentrant tachycardia. J Am Coll Cardiol 1995; 25: 982–983
15. Wathen M, Natale A, Wolfe K, Yee R, Newman D, Klein G. An anatomically guided approach to atrioventricular node slow pathway ablation. Am J Cardiol 1992; 70: 886–889
16. Kalbfleisch SJ, Strickberger SA, Williamson B, Vorperian VR, Man C, Hummel JD, Langberg JJ, Morady F. Randomized comparison of anatomic and electrogram mapping approaches to ablation of the slow pathway of atrioventricular node reentrant tachycardia. J Am Coll Cardiol 1994; 23: 716–723
17. Epstein LM, Lesh MD, Griffin JC. A direct mid-septal approach to slow atrioventricular nodal pathway ablation. Pacing Clin Electrophysiol 1995; 18: 57–64
18. Kottkamp H, Hindricks G, Willems S, Chen X, Reinhardt L, Haverkamp W, Breithardt G, Borggrefe M. An anatomically and electrogram-guidedstepwise approach for the effective and safe catheter ablation of the fast pathway for elimination of atrioventricular node reentrant tachycardia. J Am Coll Cardiol 1995; 25: 974–981
19. Willems S, Shenasa H, Kottkamp H, Chen X, Hindricks G, Yli-Mayry S, Haverkamp W, Wichter T, Rotman B, Breithardt G, Borggrefe M. Temperature-controlled slow pathway ablation for treatment of atrioventricular nodal reentrant tachycardia using a combined anatomical and electrogram guided strategy. Eur Heart J 1996; 17: 1092–1102
20. Silka MJ, Halperin BD, Hardy BG, Mc Anulty JH, Kron J. Safety and efficacy of radiofrequency modification of slow pathway conduction in children < or = 10 years of age with atrioventricular node reentrant tachycardia. Am J Cardiol.1997; 80: 1364–1367
21. Teixera O, Balaji S, Case C, Gillette PC. Radiofrequency catheter ablation of atrioventricular nodal reentrant tachycardia in children. Pacing Clin Electrophysiol 1994; 17: 1621–1626
22. Dhala A, Bremner S, Deshpande S, Blanck Z, Natale A, Sra J, Jazayeri M, Akhtar M. Efficacy and safety of atrioventricular nodal modification for atrioventricular nodal reentrant tachycardia in the pediatric population. Am Heart J 1994; 128: 903–907
23. Rhodes LA, Wieland TS, Vetter VL. Low temperature and low energy radiofrequency modification of atrioventricular nodal slow pathways in pediatric patients. Pacing Clin Electrophysiol 1999; 22: 1071–1078
24. Wu D, Denes P. Mechanisms of paroxysmal supraventricular tachycardia. Arch Intern Med 1975; 135: 437–442
25. Calkins H, Yong P, Miller JM, Olshansky B, Carlson M Saul JP, Huang SK, Liem LB, Klein LS, Moser SA, Bloch DA, Gillette P, Prystowsky E. Catheter ablation of accessory pathways, atrioventricular nodal reentrant tachycardia and the atrioventricular junction: final results of a prospective, multicenter clinical trial. The Atakr Multicenter Investigators Group. Circulation 1999; 99: 262–270
26. Shen WK, Munger TM, Stanton MS, Osborn MJ, Hammill SC, Packer DL. Effects of slow pathway ablation on fast pathway function in patients with atrioventricular nodal reentrant tachycardia. J Cardiovasc Electrophysiol 1997; 8: 627–638
27. Epstein MR, Saul JP, Fishberger SB, Triedman JK, Walsh EP. Spontaneous accelerated junctional rhythm: an unusual but useful observation prior to radiofrequency catheter ablation for atrioventricular node reentrant tachycardia in young patients. Pacing Clin Electrophysiol 1997; 20: 1654–1661
28. Goldberg CS, Caplan MJ, Heidelberger KP, Dick M. The dimensions of the triangle of Koch in children. Am J Cardiol 1999; 53: 117–120
29. Mitrani RD, Klein LS, Hackett FK, Zipes DP, Miles WM. Radiofrequency ablation for atrioventricular node reentrant tachycardia. Comparison between fast (anterior) and slow (posterior) pathway ablation. J Am Coll Cardiol 1993; 21: 432–441
30. Gross GJ, Epstein MR, Walsh EP, Saul JP. Characteristics, management, and midterm outcome in infants with atrioventricular nodal reentry tachycardia. Am J Cardiol 1998; 82: 956–960.