Pediatric Catheter Ablation

- From History to Future Developments -

Thomas Paul

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Pediatric Intensive Care Medicine
Georg August University Medical Center
Göttingen, Germany

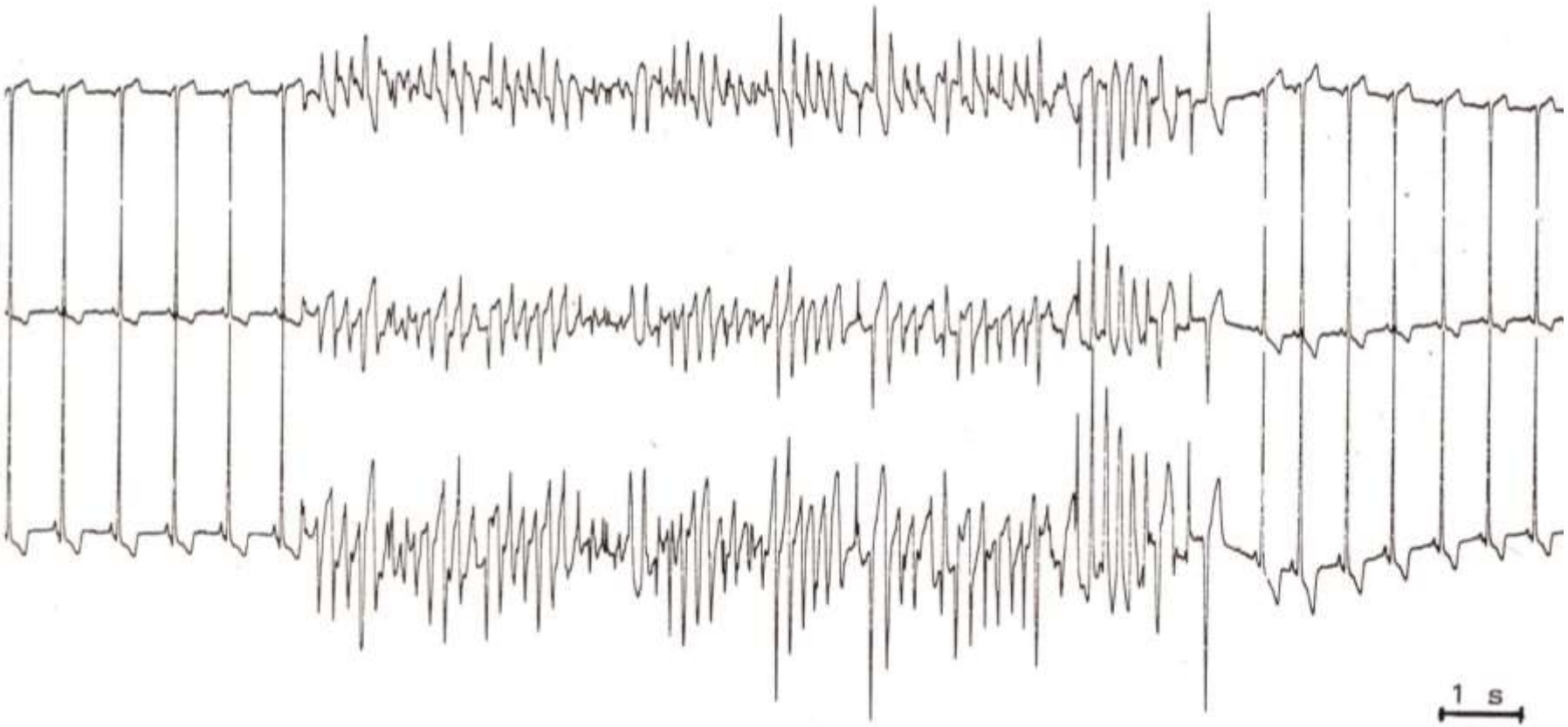
Prague, September 21, 2017

UNIVERSITÄTSMEDIZIN GÖTTINGEN UMG

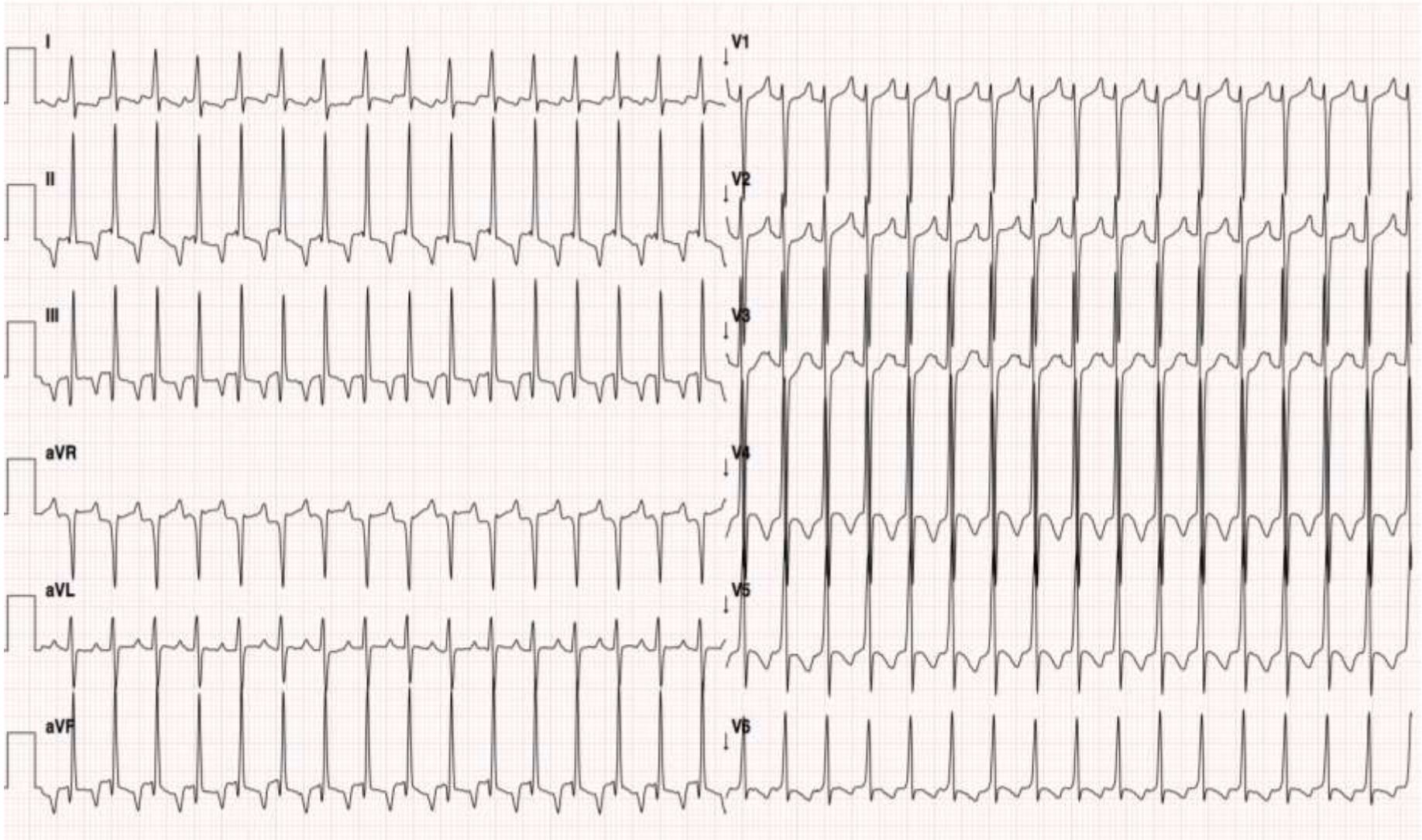
Herz Zentrum Göttingen

Amiodarone Toxicity

Torsades de Pointes on dl-Sotalol



PJRT



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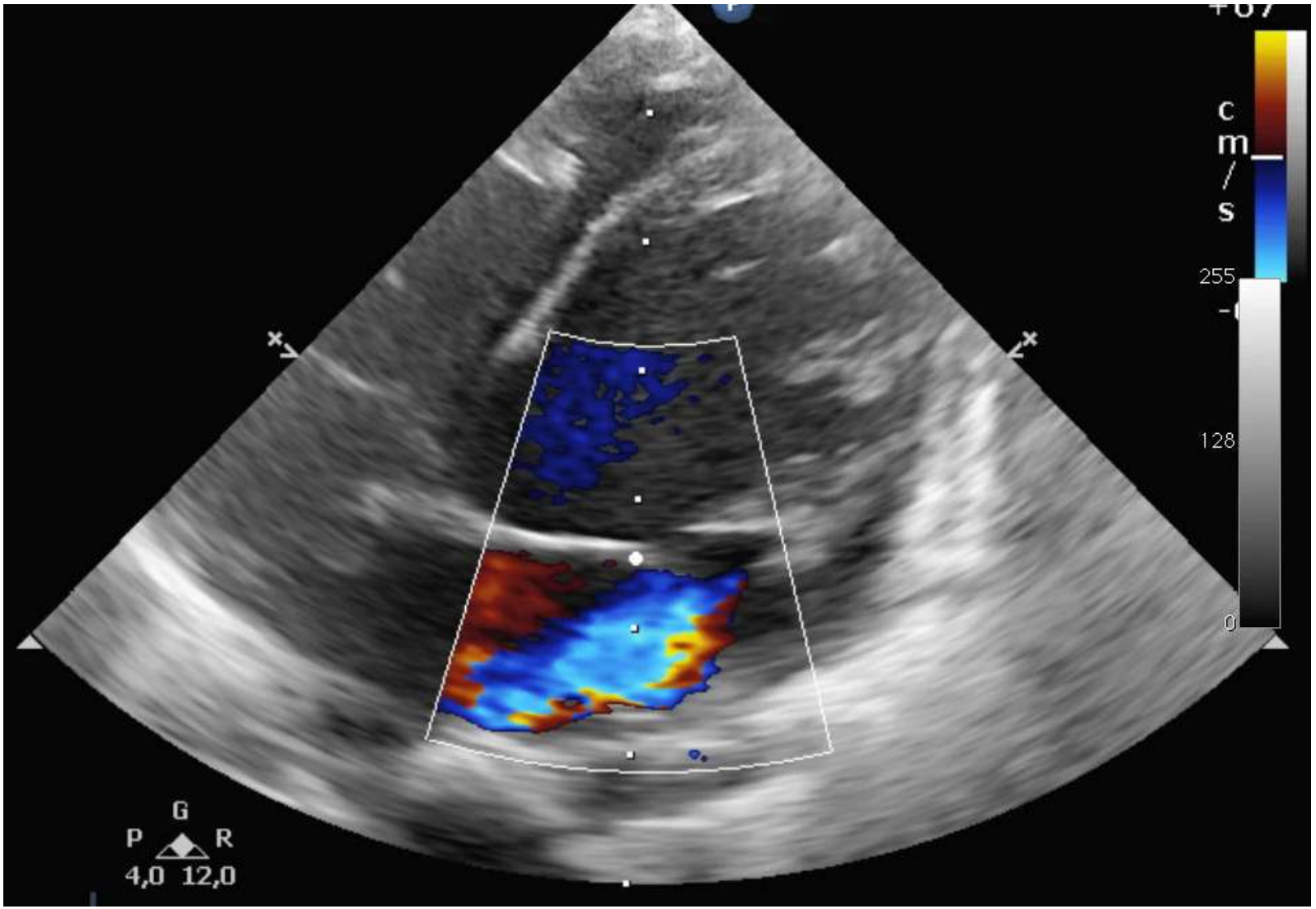
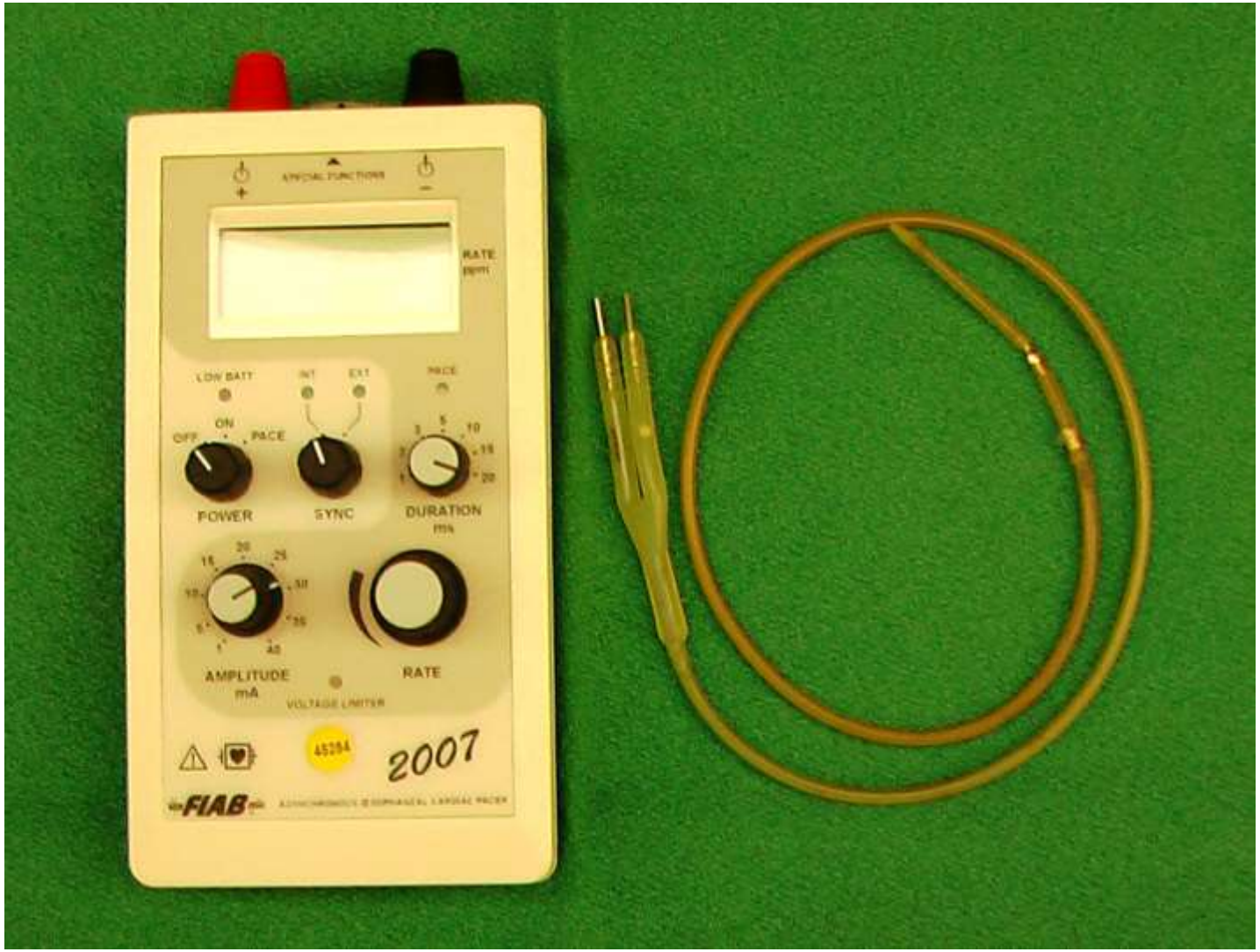


Transesophageal Recording and Pacing



International Journal of Cardiology, 25 (1989) 7–14
Elsevier

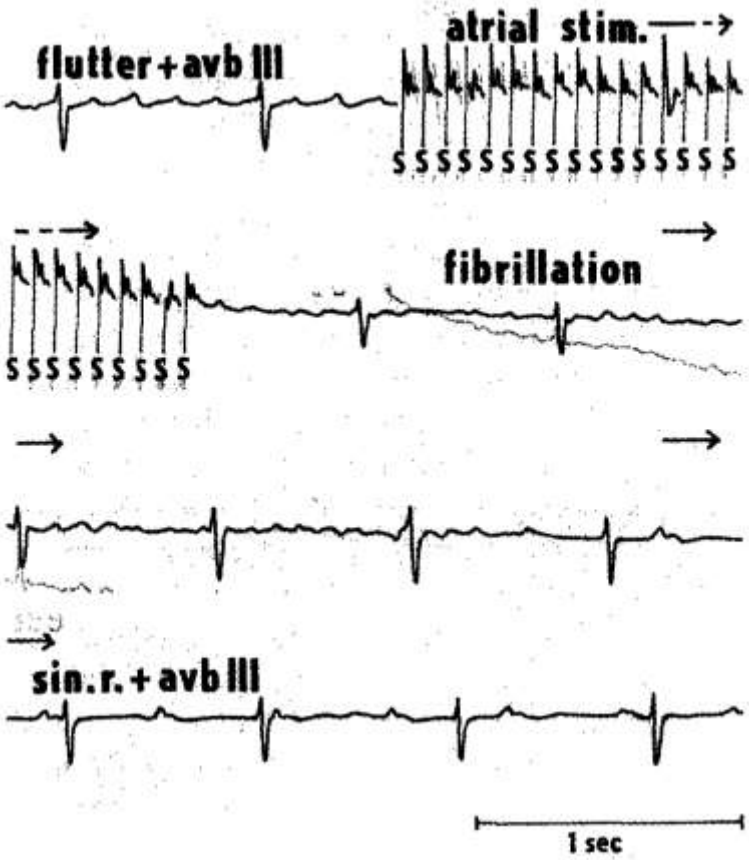
CARDIO 00936

Diagnostic and therapeutic use of transesophageal atrial pacing in children

Jan Janoušek

Center of Pediatric Cardiology and Cardiac Surgery, Prague, Czechoslovakia

(Received 23 September 1988; revision accepted 25 May 1989)



Texas Children´s Hospital

Paul C. Gillette
1944-2013

Arthur „Tim“ Garson, Jr.
1948*

Pediatric Cardiac Dysrhythmias

Edited by
Paul C. Gillette, M.D.
Arthur Garson, Jr., M.D.

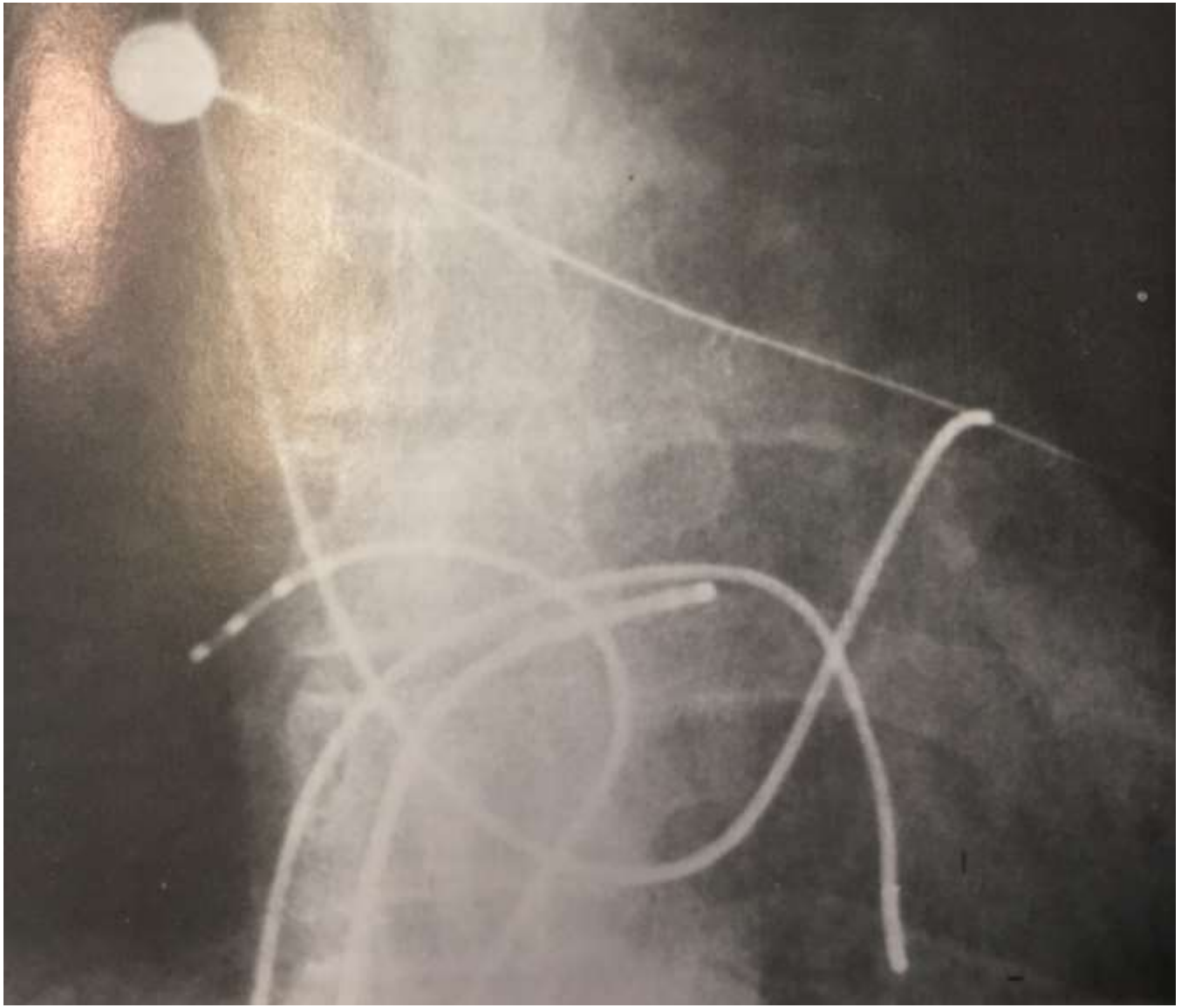
CLINICAL
CARDIOLOGY
MONOGRAPHS

Accessory Atrioventricular Pathway

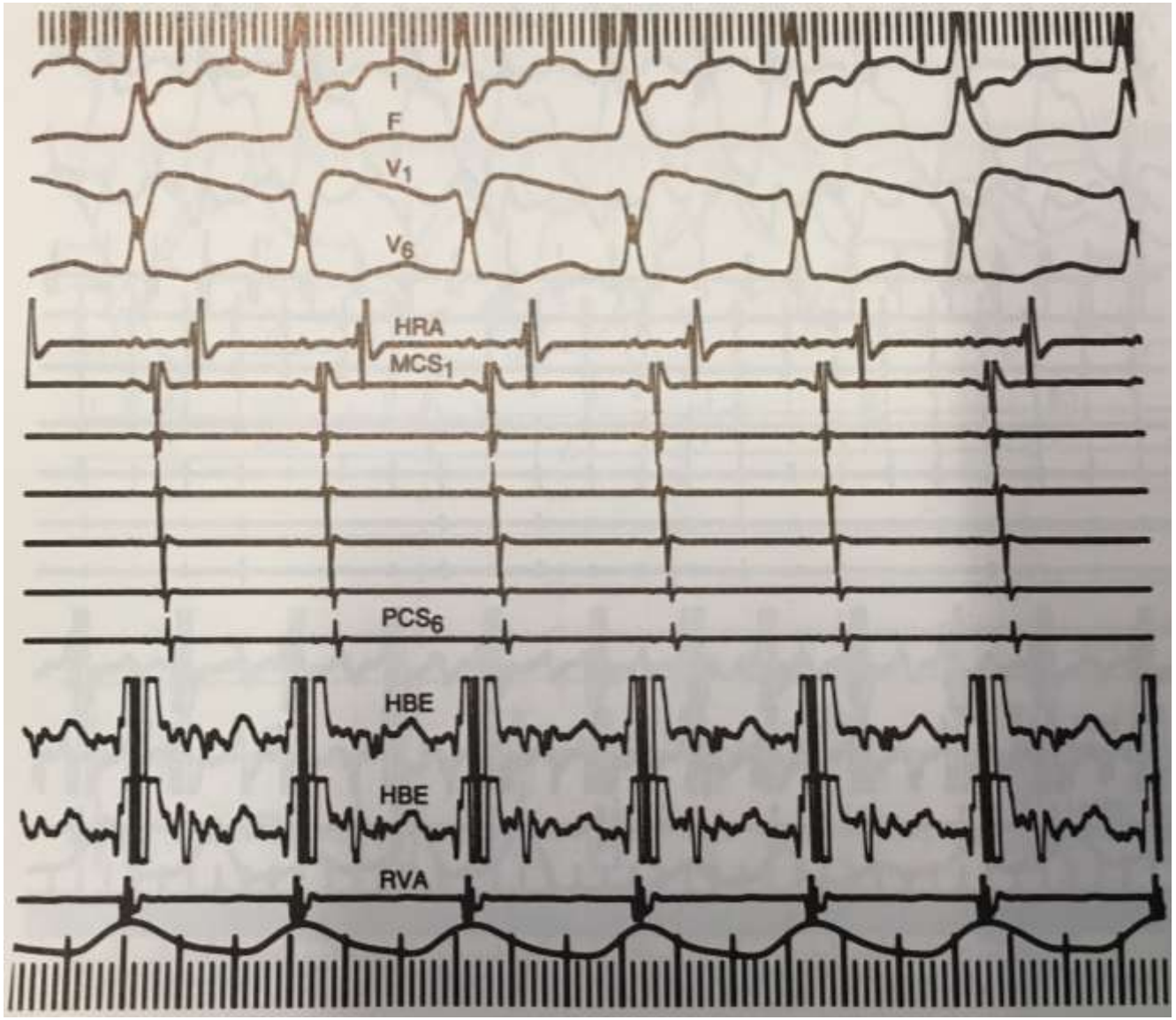
Basso C et al., Circulation 2001

Electrode Catheters by USCI/Bard

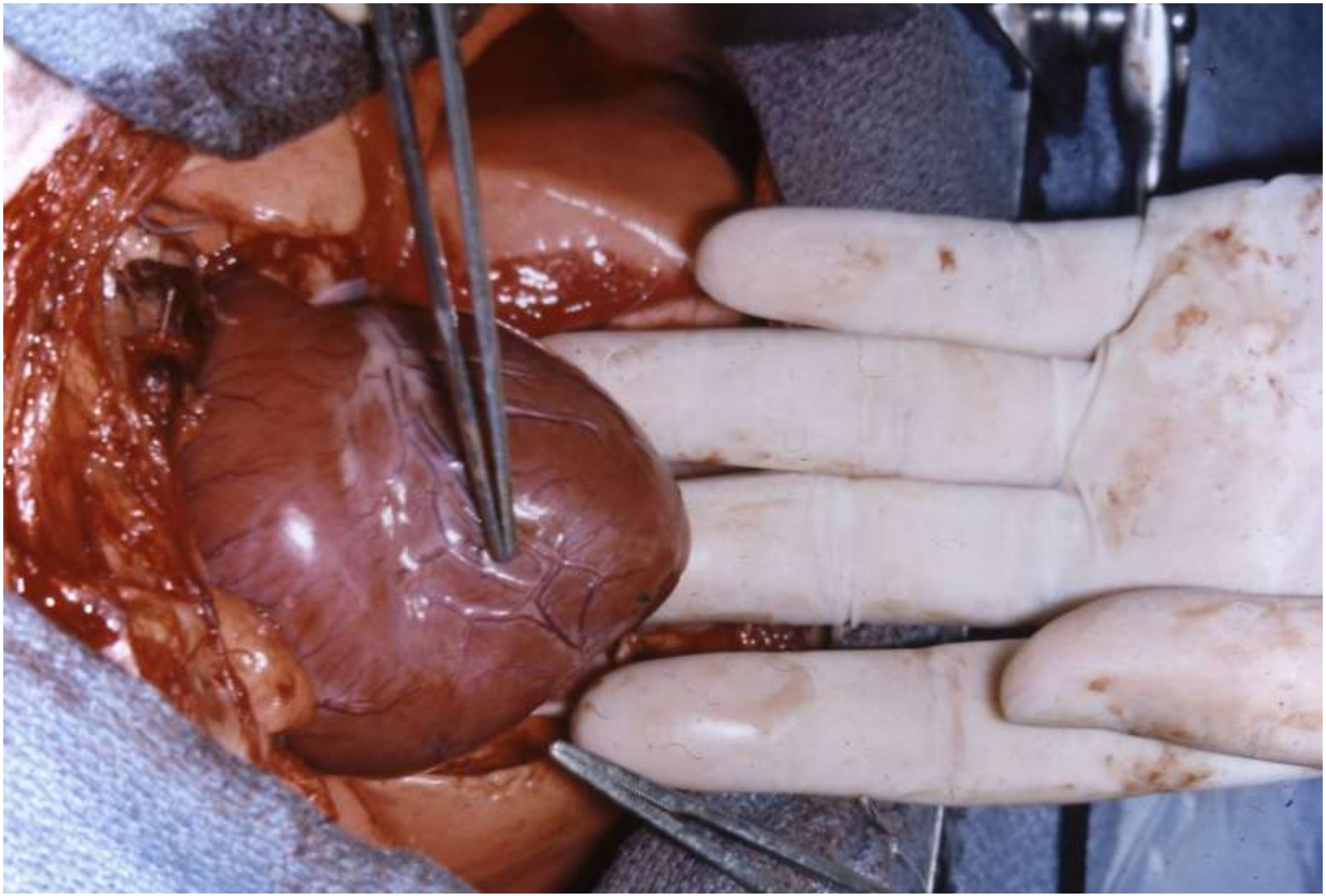
Electrophysiological Study in the 1980ies



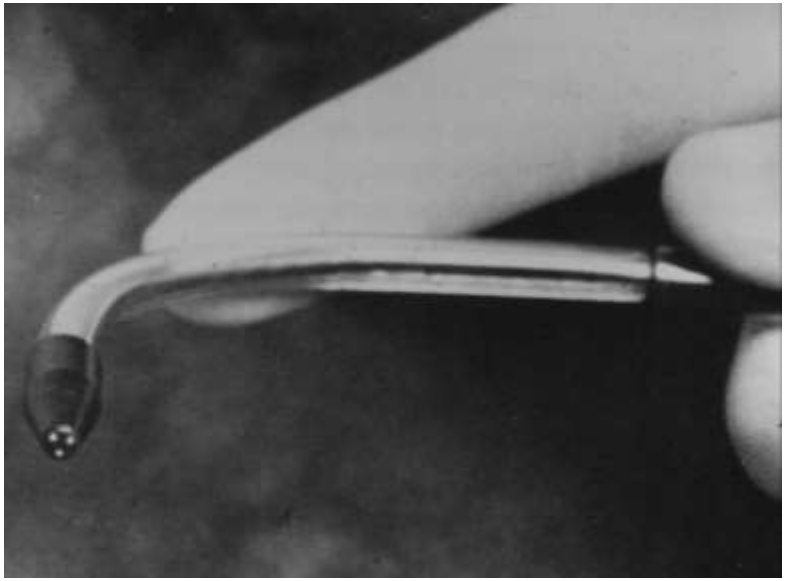
Endocardial Mapping

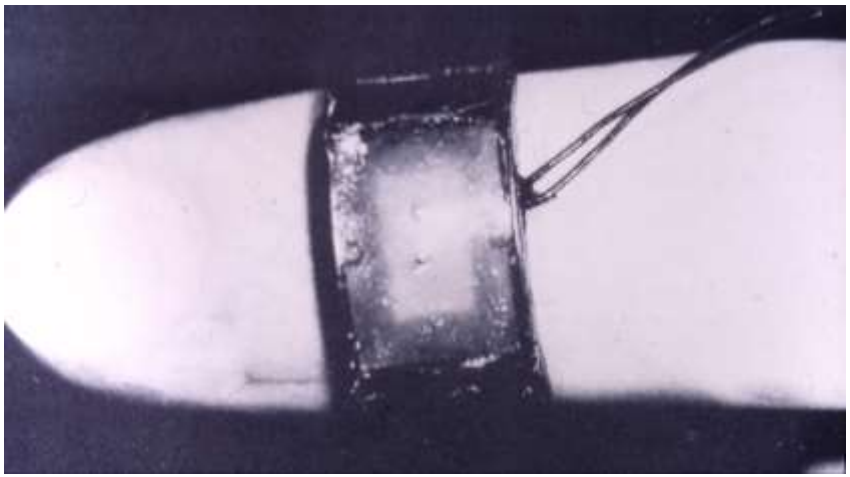


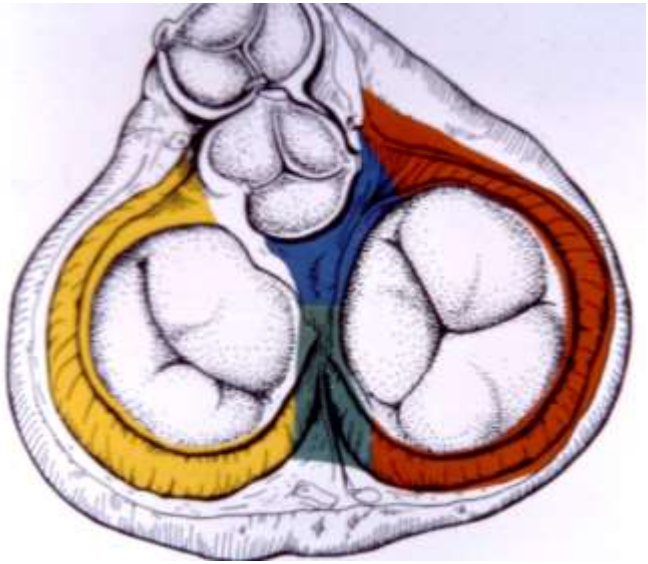
Surgical WPW Ablation

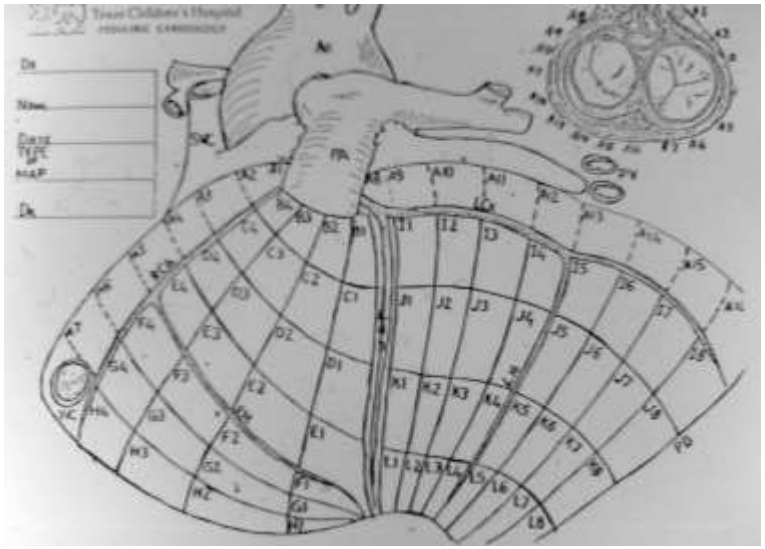


Surgical WPW Ablation

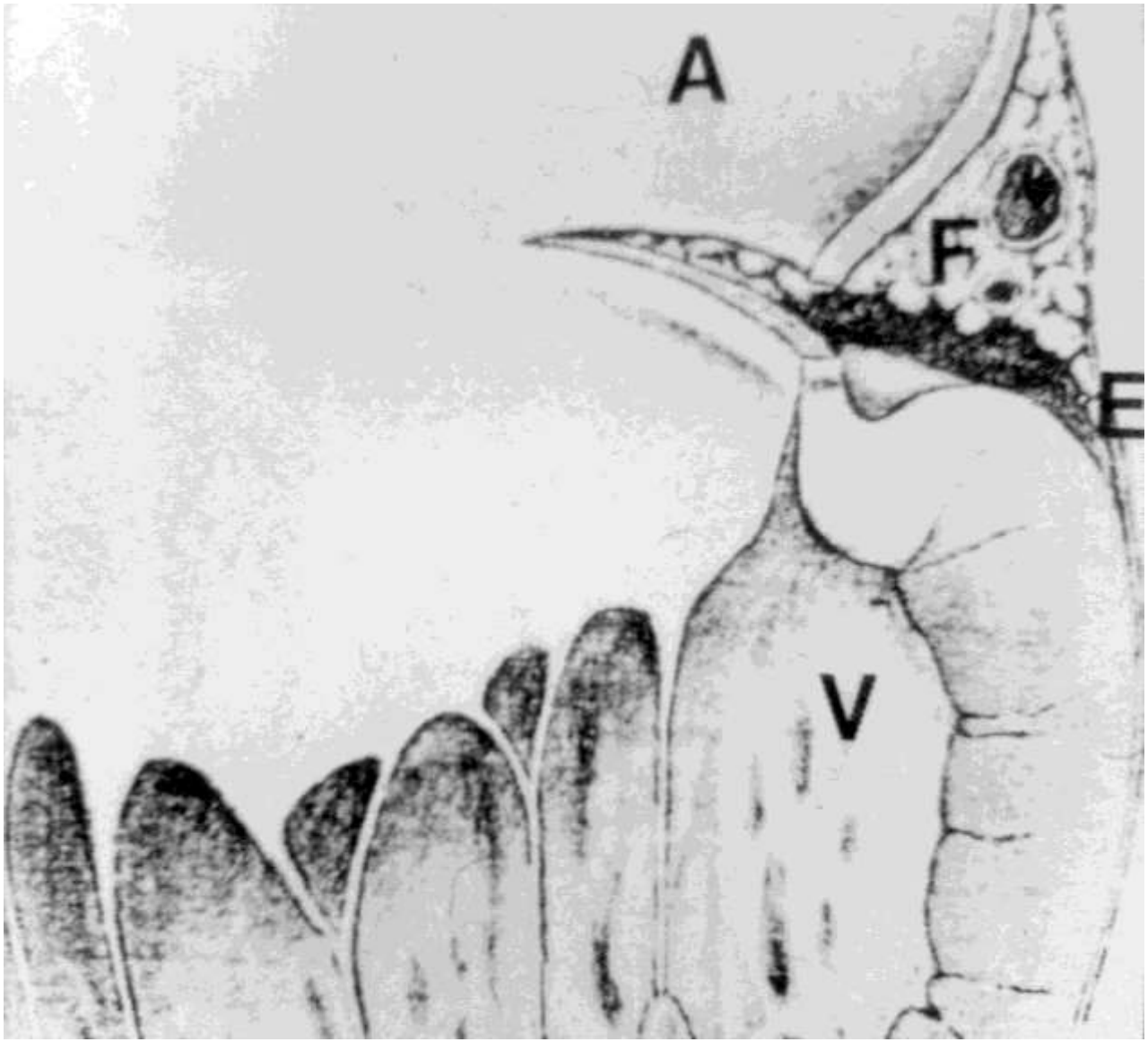








Surgical WPW Ablation



Surgical Treatment of Supraventricular Tachycardia in Infants and Children

PAUL C. GILLETTE, MD, FACC*
ARTHUR GARSON, Jr., MD
JOHN D. KUGLER, MD
DENTON A. COOLEY, MD, FACC
ALEX ZINNER
DAN G. McNAMARA, MD, FACC

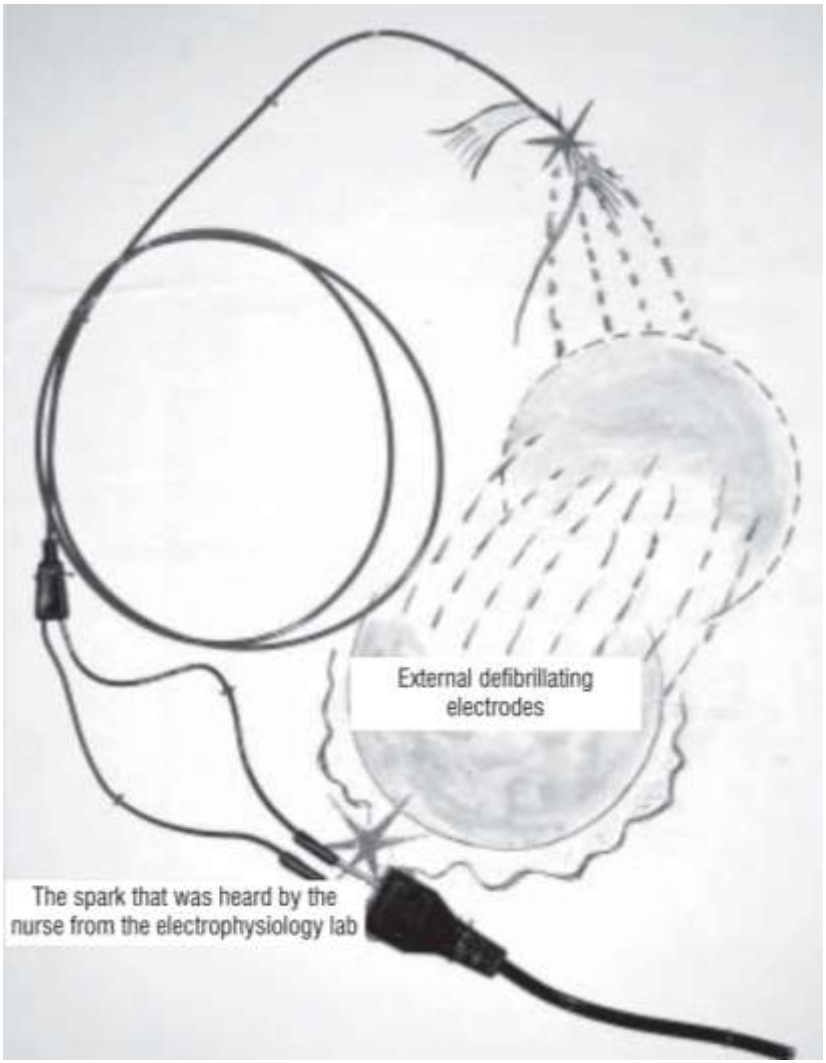
Houston, Texas

The technique, indications and results of surgical division of accessory atrioventricular connections in 10 infants and children with drug-resistant supraventricular tachycardia are described. The patients ranged in age from 6 months to 15 years. Four patients had associated congenital heart disease. Division of accessory connections were performed on free wall pathways in nine patients (seven right atrial, two left atrial) and on a septal pathway in one patient. Four patients had both anterograde and retrograde conduction over the accessory connection (manifest Wolff-Parkinson-White conduction) whereas six had only retrograde conduction (concealed Wolff-Parkinson-White conduction). The manifest Wolff-Parkinson-White conduction was abolished by surgical division in all four patients. In 8 of the 10 patients the procedure stopped the attacks of paroxysmal supraventricular tachycardia for follow-up periods ranging from 9 months to 3 1/2 years; no patient receives medication to date.

Am J Cardiol 1980

First DC Ablation in Man

Vedel J and Fontaine G 1979



Fontaine G, Cardiol J 2009

Junctional automatic ectopic tachycardia: New proposed treatment by transcatheter His bundle ablation

Three infants with junctional automatic ectopic tachycardia (JET) were seen over an 8-month period. Each had decreased left ventricular function. Two were treated with amiodarone, which together with propranolol reduced the tachycardia rate 10 to 40 bpm, but did not result in sinus rhythm. One patient died suddenly at home, as had 50% of our patients with JET treated with conventional medication. Two patients were treated by transcatheter ablation of the bundle of His and implantation of an atrial synchronous pacemaker. Neither has had subsequent tachycardia or required drugs. One patient resumed sinus rhythm and does not use his pacemaker. The other patient has complete AV block and continues to use her pacemaker. This aggressive approach to this lethal dysrhythmia offers hope for prevention of the former bad prognosis. (AM HEART J 106:619, 1983.)

Paul C. Gillette, M.D., Arthur Garson, Jr., M.D., Co-burn J. Porter, M.D., David Ott, M.D., Pat McVey, R.N., Alex Zinner, and Henry Blair, C-C.P.T.
Houston, Texas

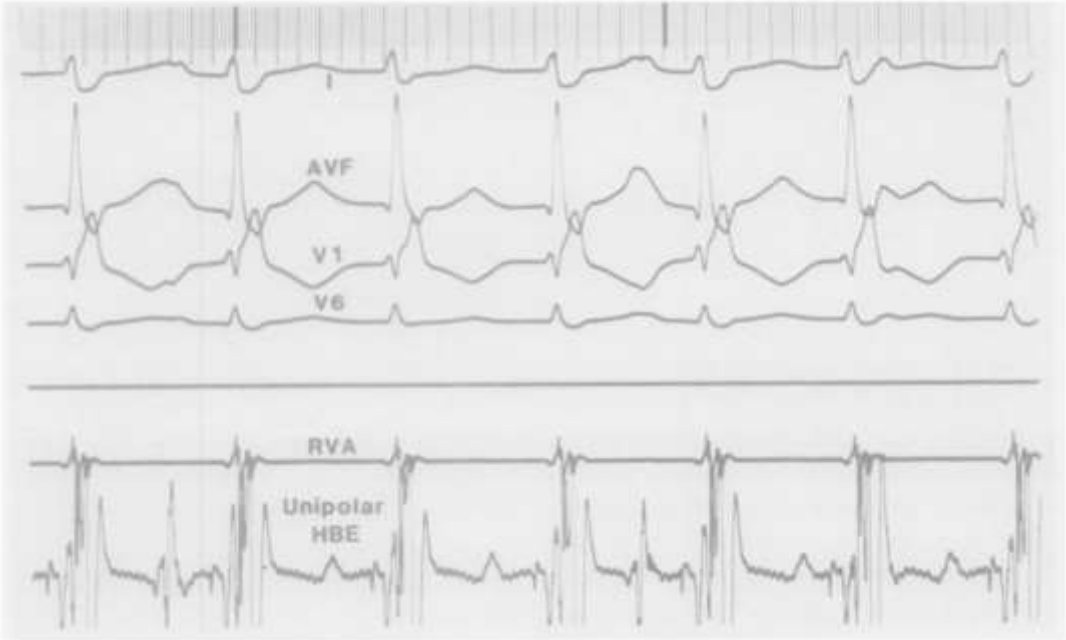
American Heart Journal

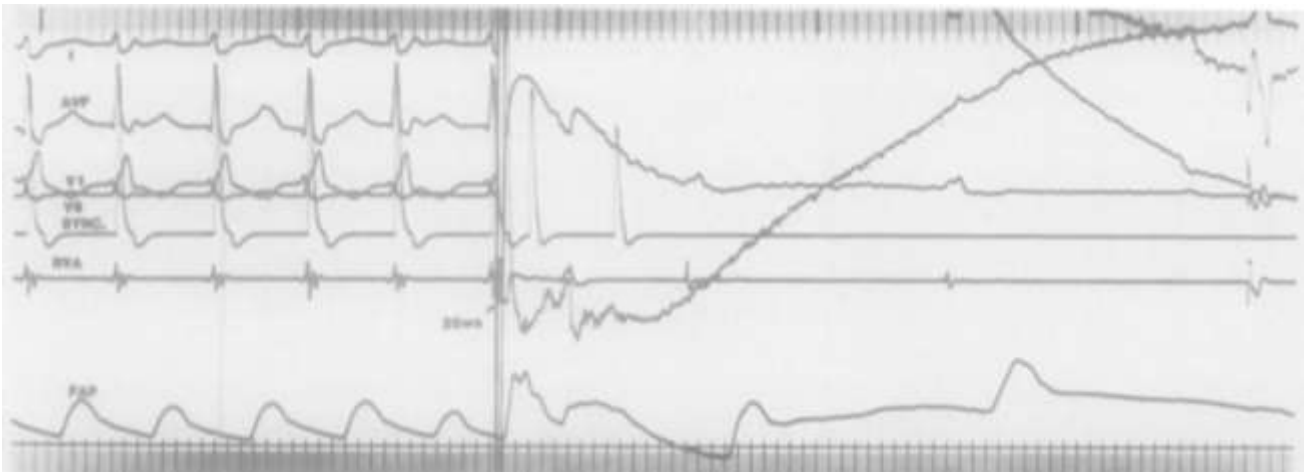
Founded in 1925

October 1983 Volume 106, Number 4, Part 1

His Bundle Ablation by DC Application for JET

Gillette PC et al., Am Heart J 1983



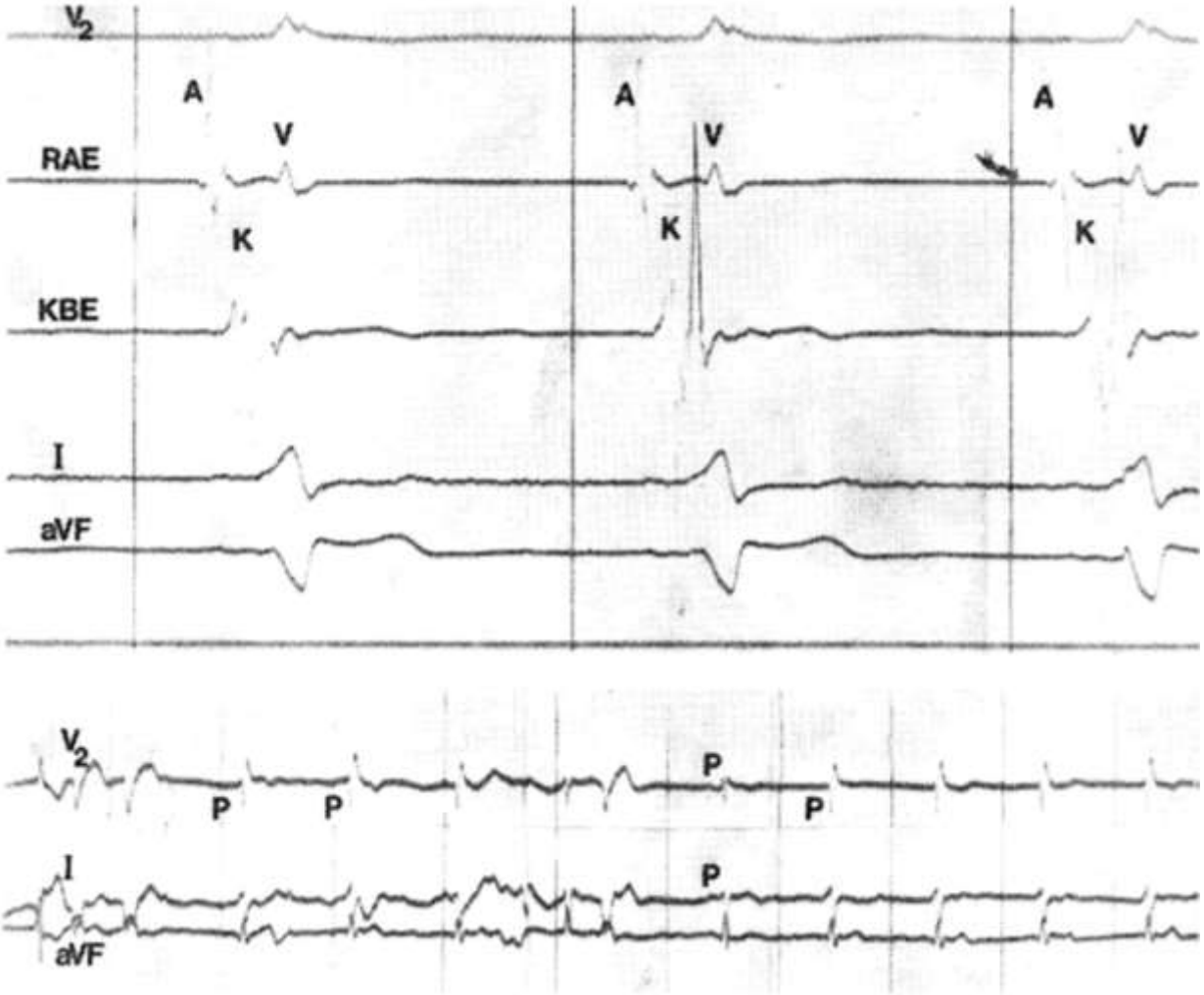


Lothar Schmitz and Helmut Weber 1983

Department of Pediatric Cardiology, Göttingen, Germany

Courtesy by L. Schmitz

CATHETER TECHNIQUE FOR CLOSED-CHEST ABLATION OF AN ACCESSORY ATRIOVENTRICULAR PATHWAY



HELMUT WEBER, M.D.
LOTHAR SCHMITZ, M.D.
University of Göttingen

3400 Göttingen,
Federal Republic of Germany

Percutaneous intracardiac direct-current shocks in dogs: arrhythmogenic potential and pathological changes*

H. Weber, L. Schmitz, R. Dische and G. Rahlf

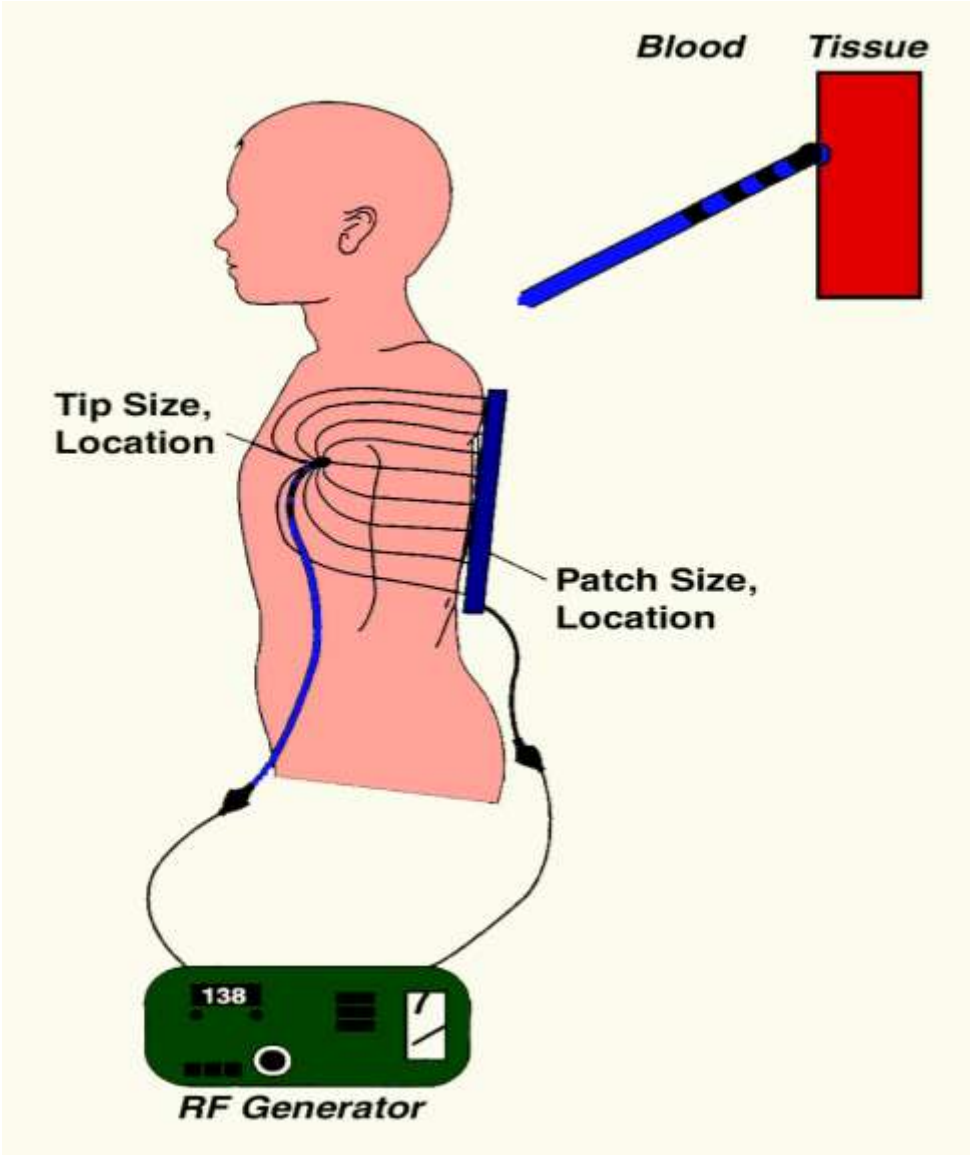
Department of Paediatric Cardiology and Department of Pathology, University of Goettingen, Goettingen, F.R.G.

Figure 2 Subacute lesion of the AV-zone with extension to the tricuspid valve and parietal thrombus formation after a 250 Joule shock.

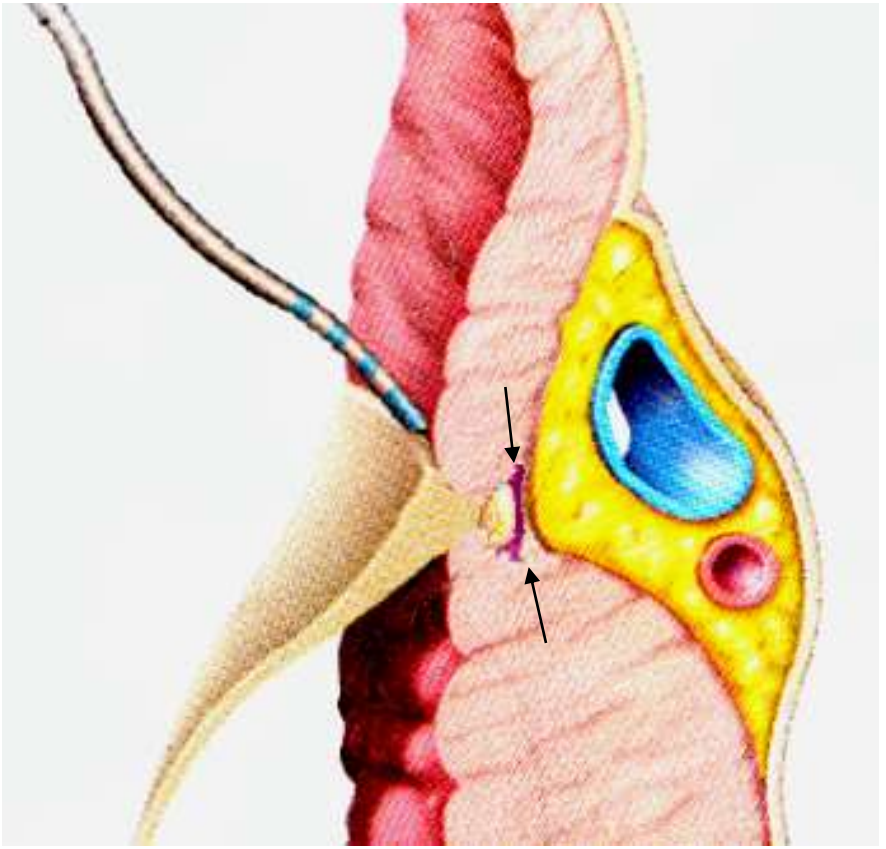
Figure 3 Chronic lesion with subendocardial fibrosis of the right atrium following a 200 Joule shock.

Eur Heart J 1986

Radiofrequency Catheter Ablation

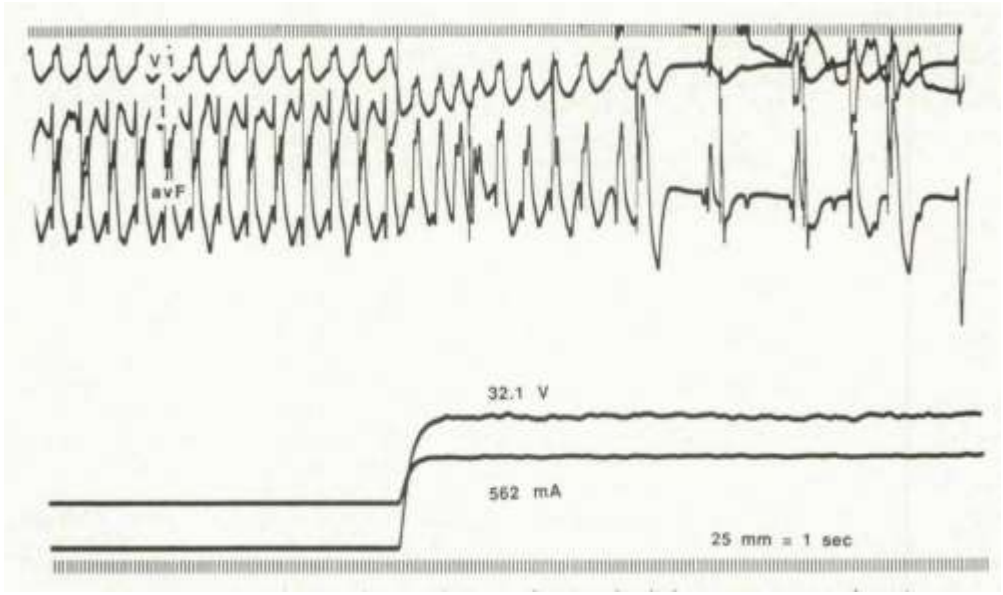


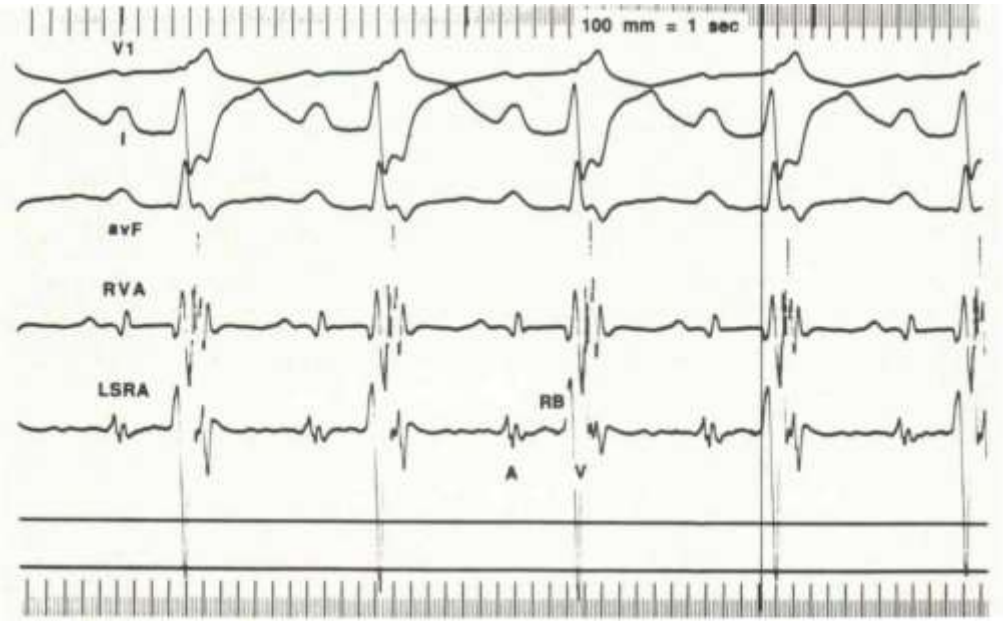
Radiofrequency Catheter Ablation of Accessory Atrioventricular Pathways



RF Ablation of JET in a Ten-Month-Old Infant

Van Hare GF et al., PACE 1990





Hannover Medical School

May 1991

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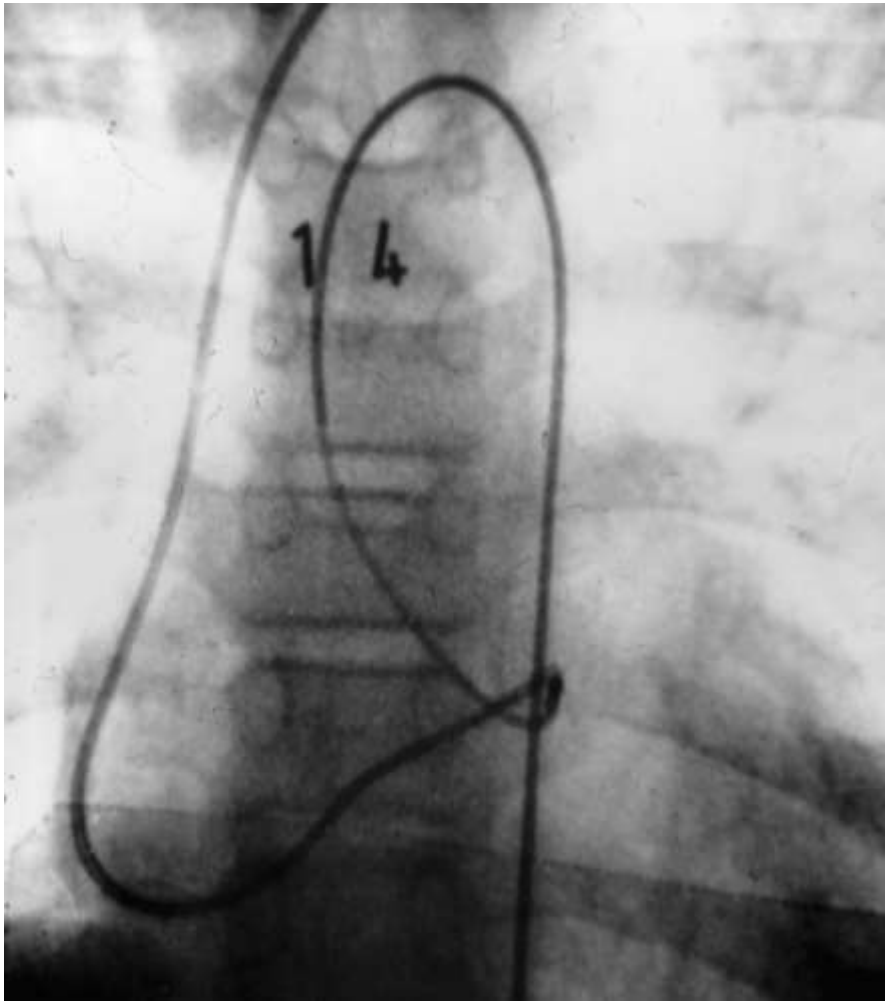
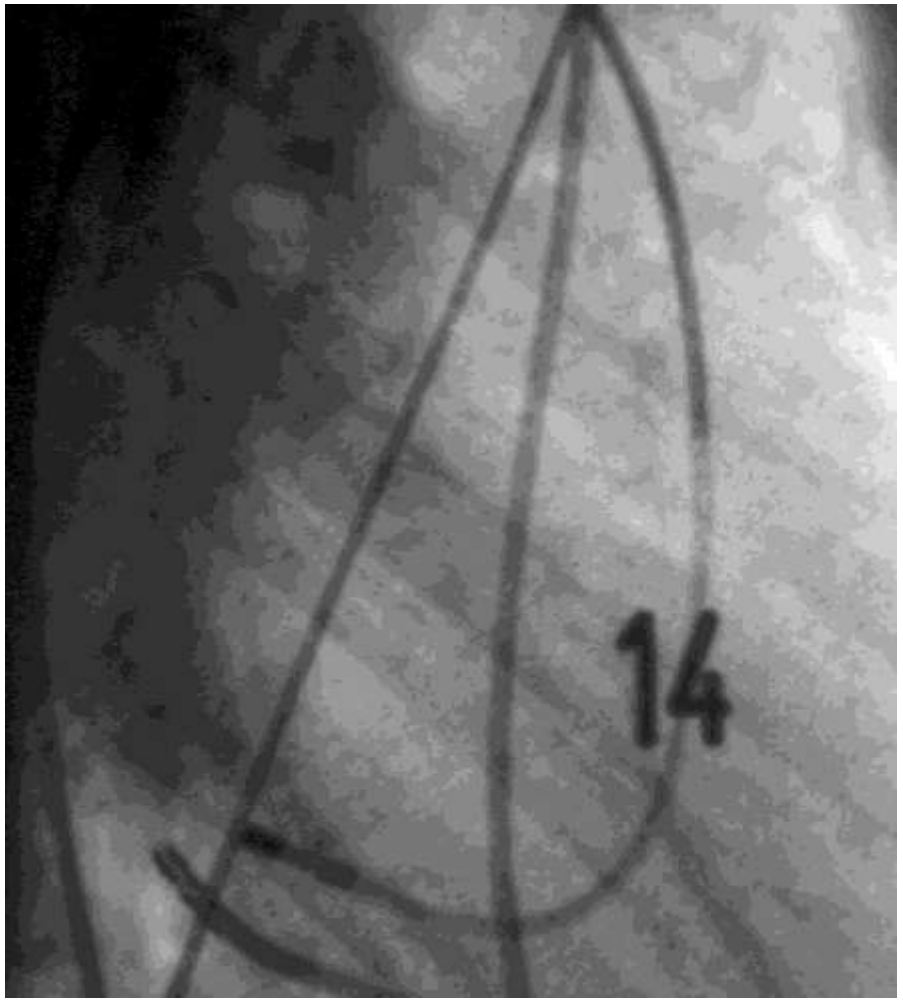
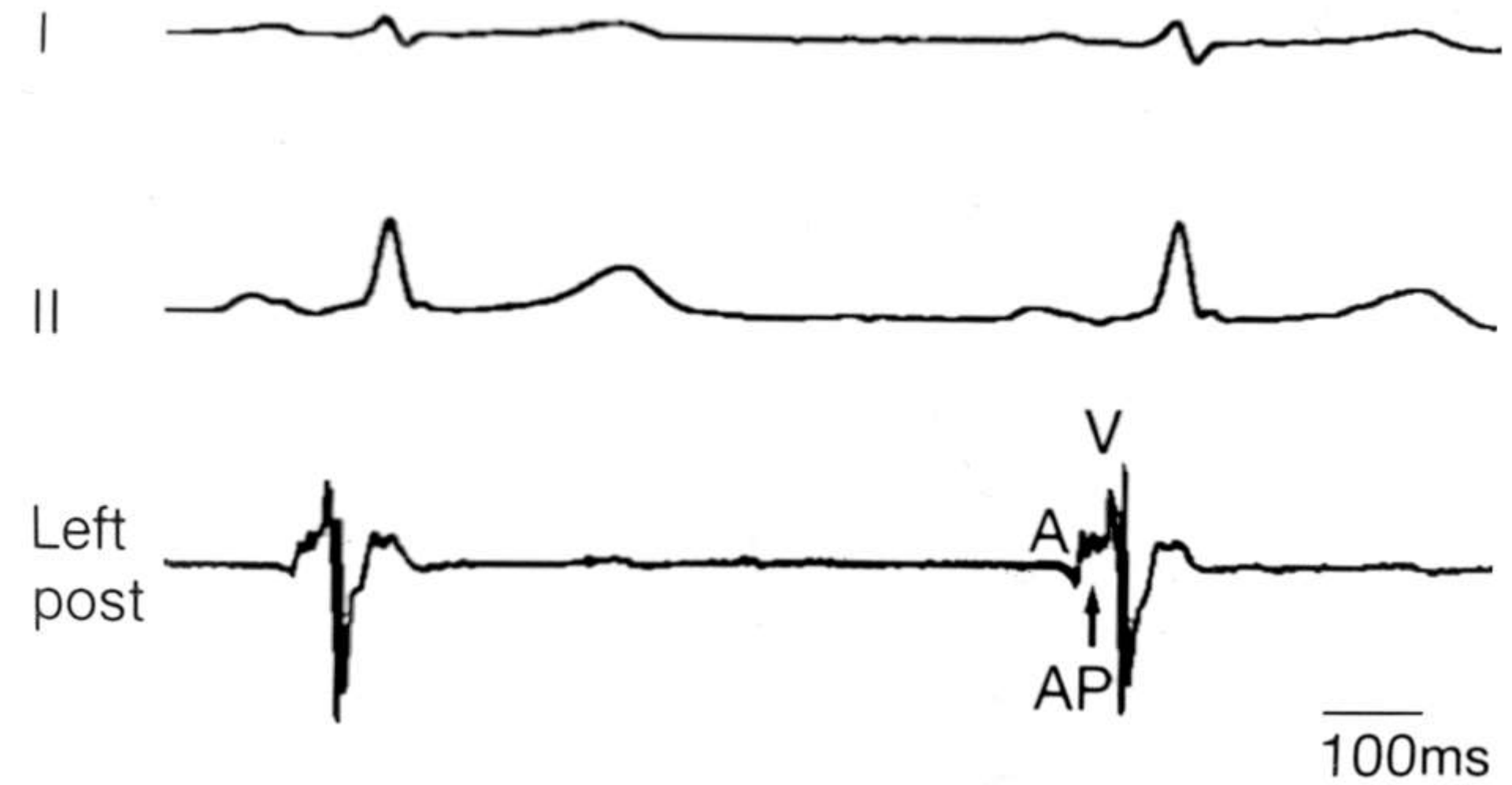




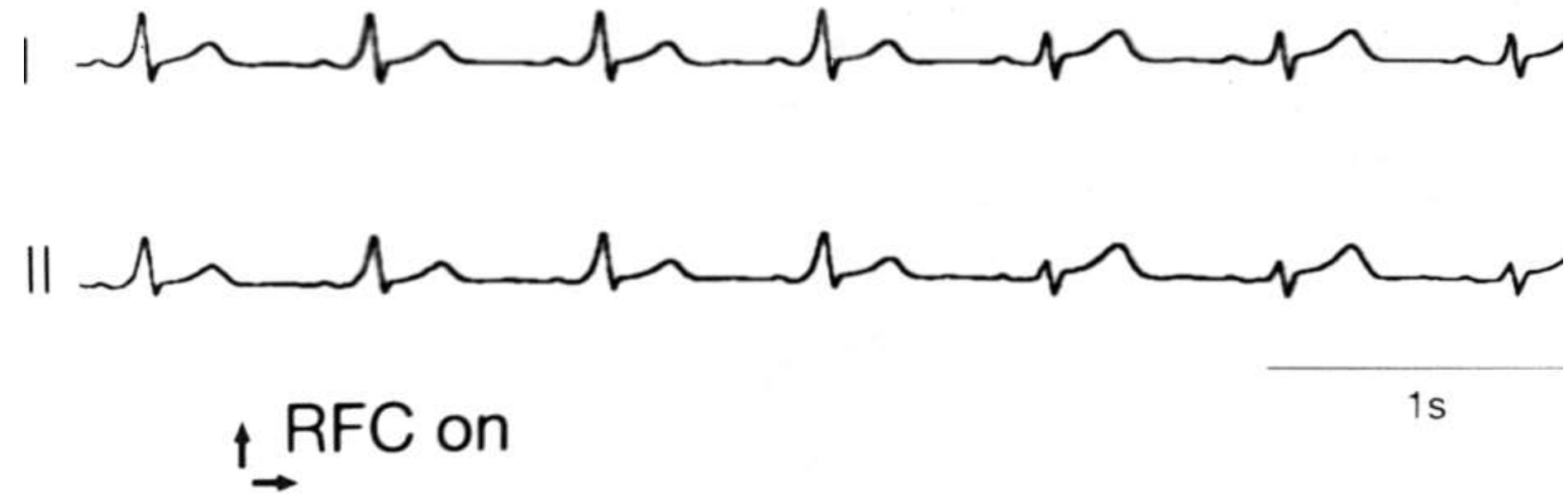
Hannover Medical School

May 1991



Hannover Medical School

May 1991



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May 1991

RADIOFREQUENCY CATHETER ABLATION FOR TACHYARRHYTHMIAS IN CHILDREN AND ADOLESCENTS

JOHN D. KUGLER, M.D., DAVID A. DANFORD, M.D., BARBARA J. DEAL, M.D., PAUL C. GILLETTE, M.D., JAMES C. PERRY, M.D., MICHAEL J. SILKA, M.D., GEORGE F. VAN HARE, M.D., AND EDWARD P. WALSH, M.D., FOR THE PEDIATRIC ELECTROPHYSIOLOGY SOCIETY*

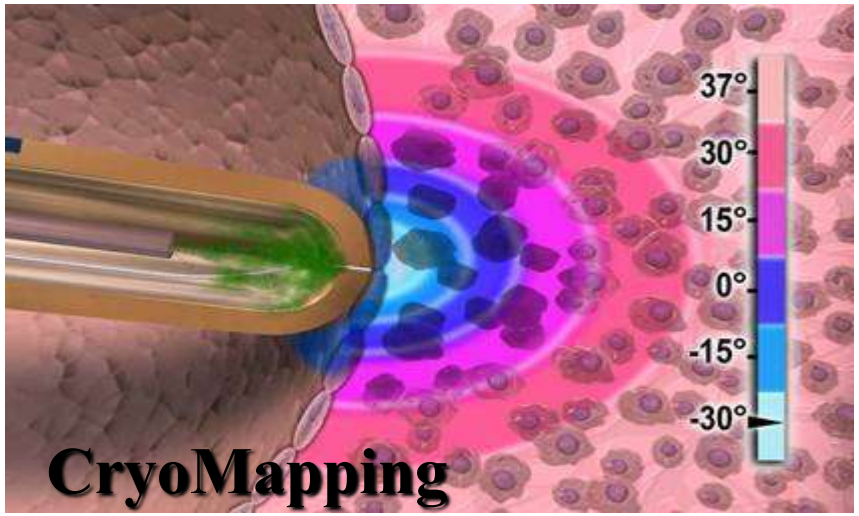
Abstract *Background.* Although radiofrequency catheter ablation has been used extensively to treat refractory supraventricular tachycardia in adults, few data are available on its safety and efficacy in children and adolescents. We reviewed registry data obtained from 24 centers to evaluate the indications, early results, complications, and short-term follow-up data in young patients who underwent this procedure.

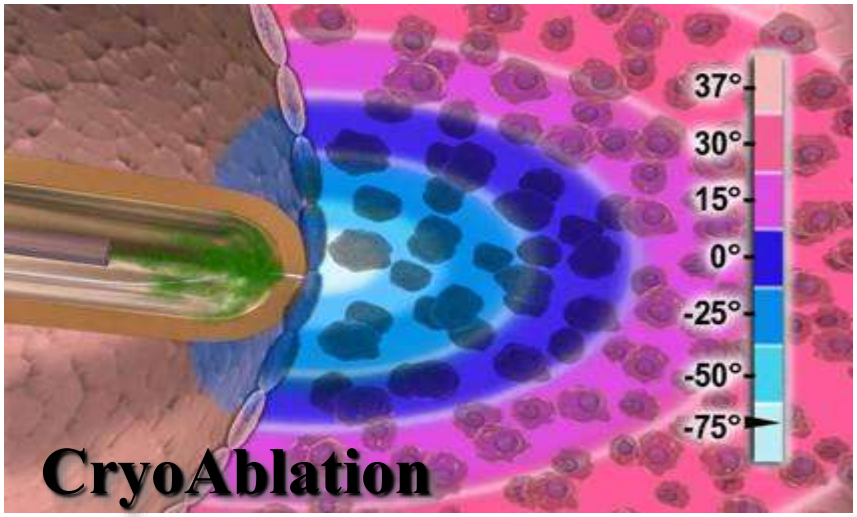
Methods. Standardized data were submitted for 652 patients who underwent 725 procedures between January 1, 1991, and September 1, 1992. The mean length of follow-up was 13.5 months.

Results. The median age of the patients was 13.5 years, and 84 percent of them had structurally normal hearts. The initial success rates for ablation of atrioventricular accessory pathways (508 of 615 procedures) and atrioventricular-node reentry (63 of 76 procedures) were both 83 percent. Greater institutional experience in performing ablation in children and location of the accessory pathway in the left free wall correlated with greater likelihood of sustained success. Conversely, a right free-wall pathway, the presence of other heart disease, and higher body weight were all associated with a lesser chance of sustained success. Recurrences of arrhythmia accounted for 45 percent of the failures overall in the series. Atrial ectopic-focus tachycardia had the highest recurrence rate. The total complication rate was 4.8 percent (35 of 725 procedures), and the only variables that independently correlated with a higher complication rate were very low weight and less institutional experience.

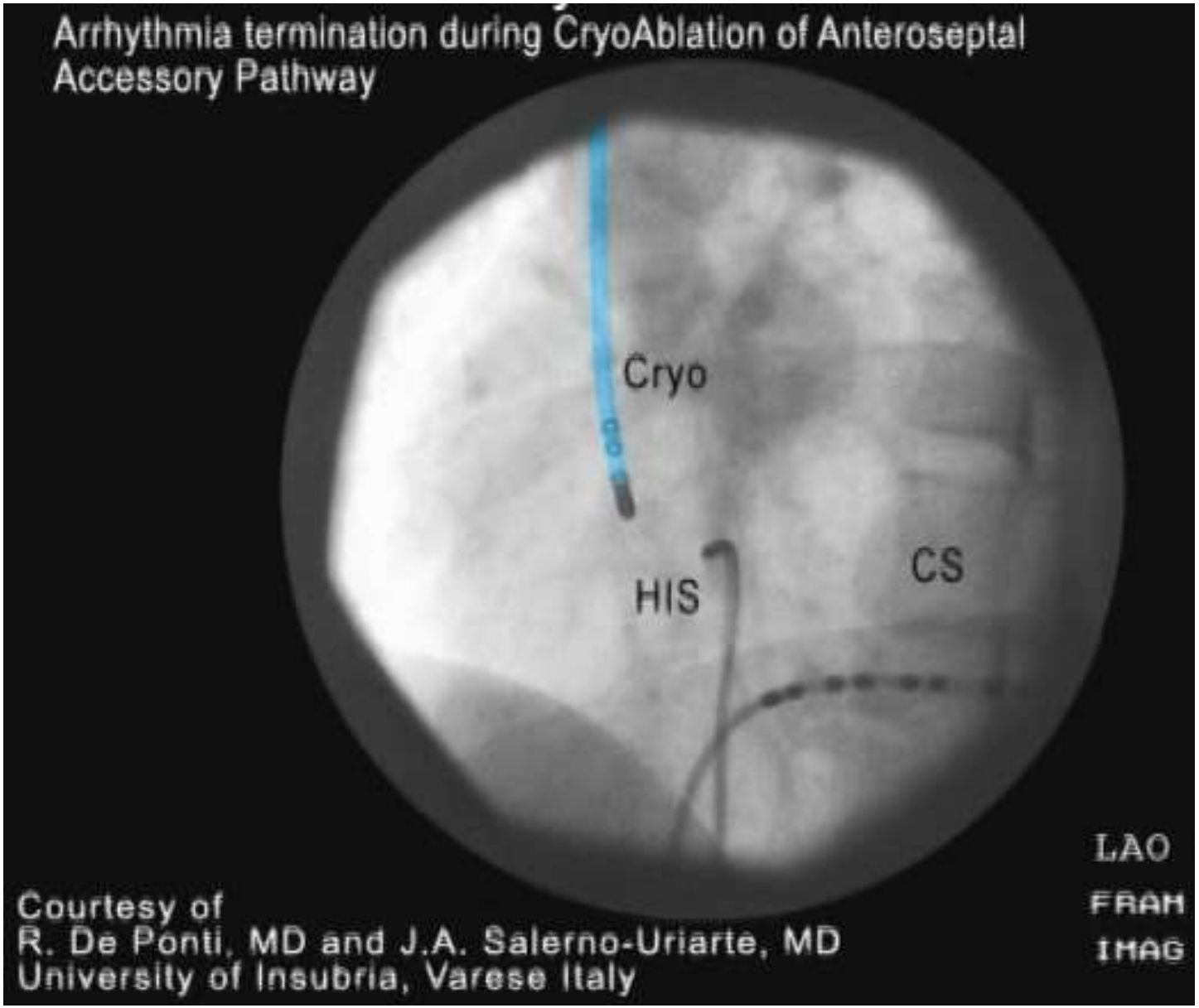
Conclusions. These early results suggest that radiofrequency catheter ablation has a good success rate and a low complication rate in pediatric patients, especially when it is carried out in experienced pediatric cardiology centers. (N Engl J Med 1994;330:1481-7.)

Cryoenergy

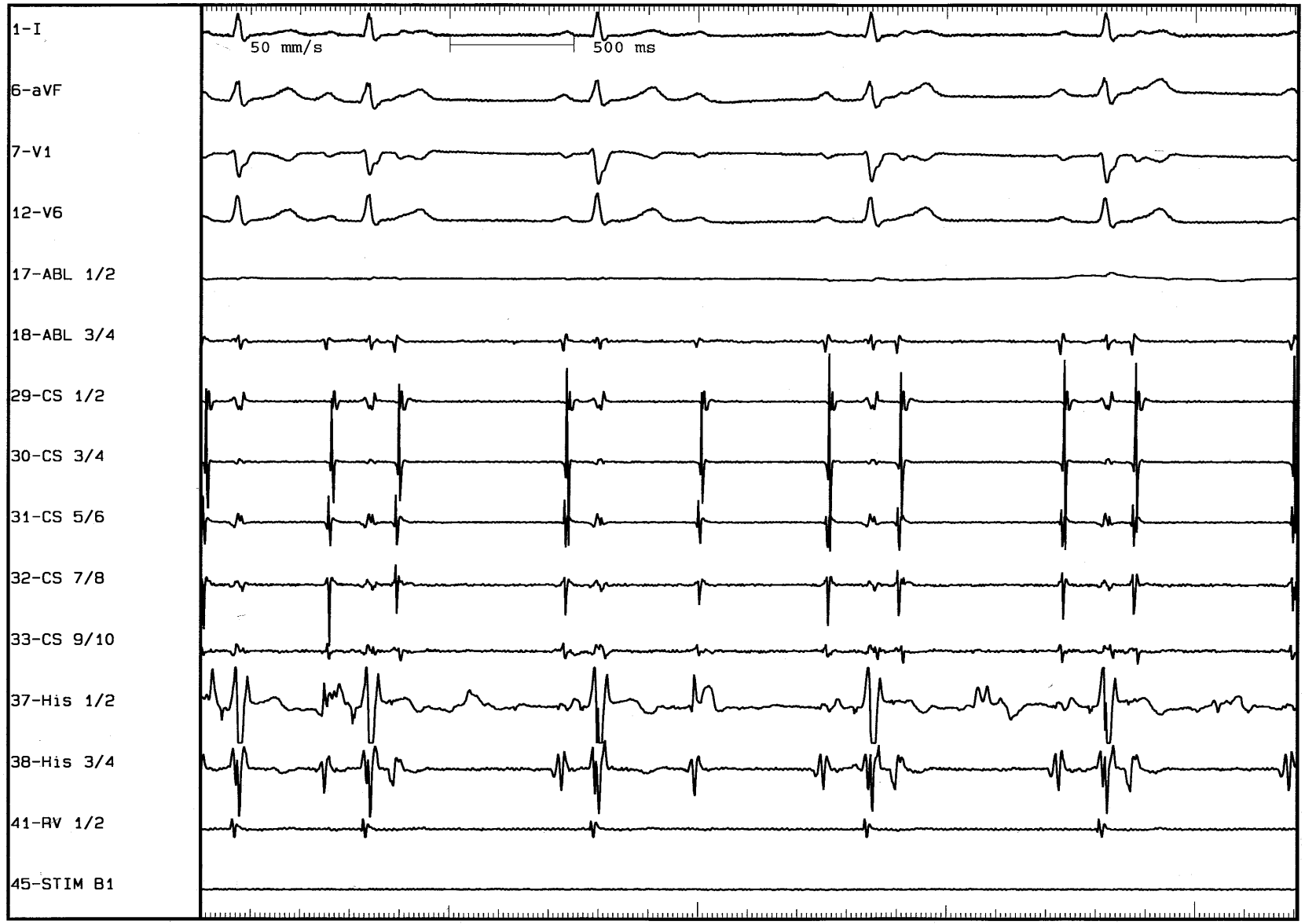




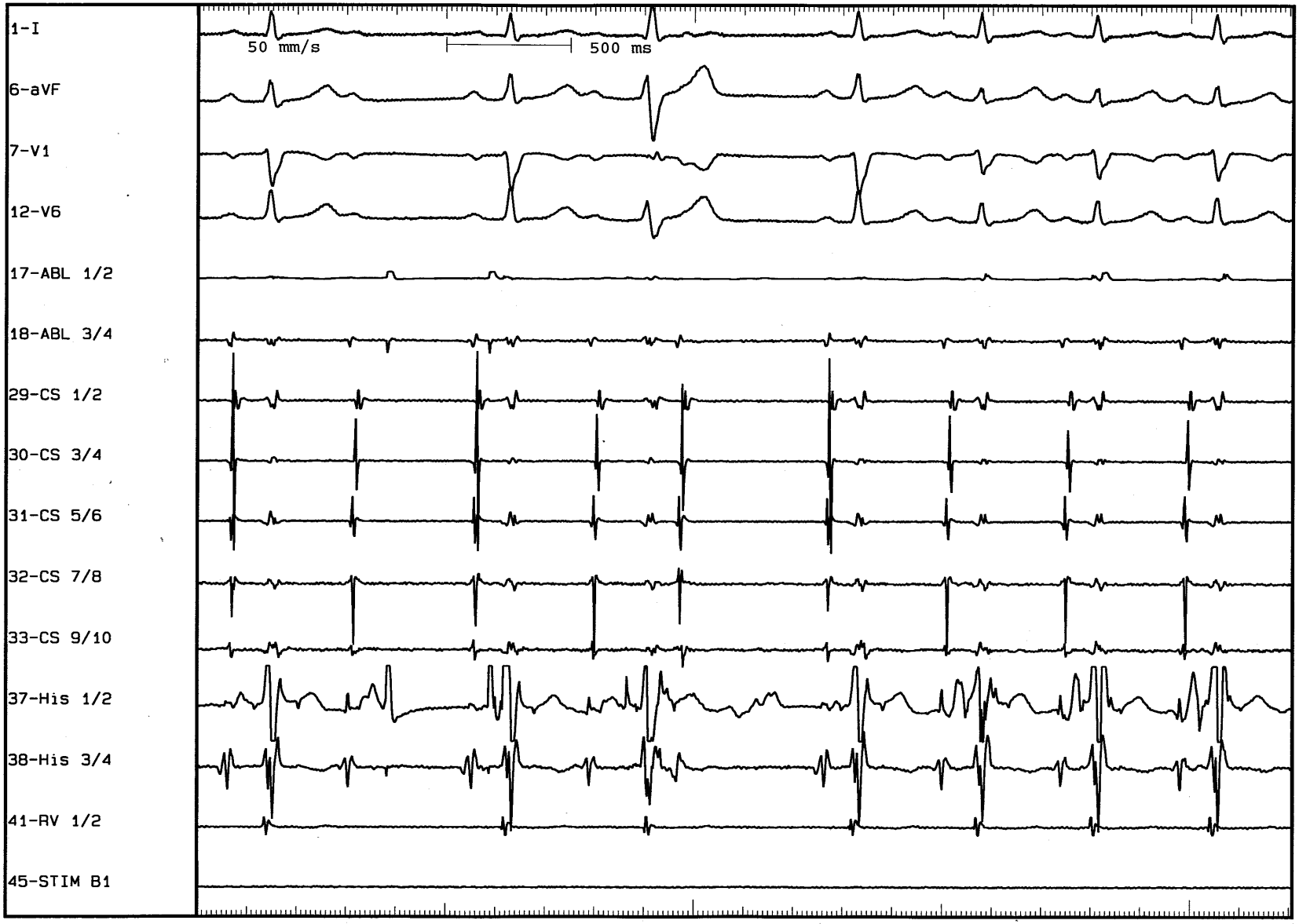
Cryoadhesion



Cryomapping at -35 C

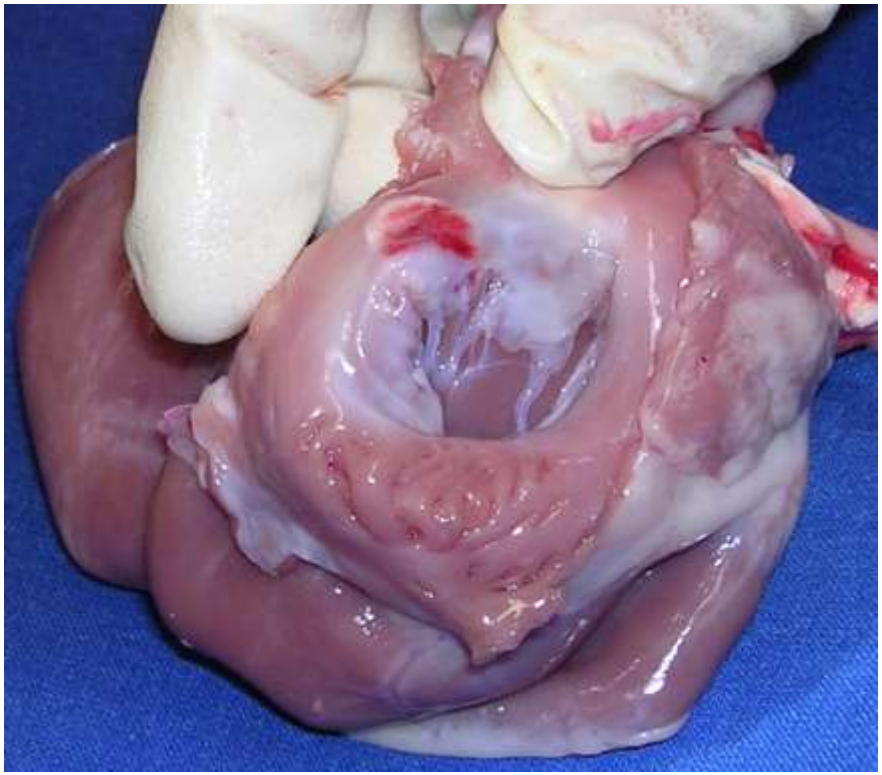


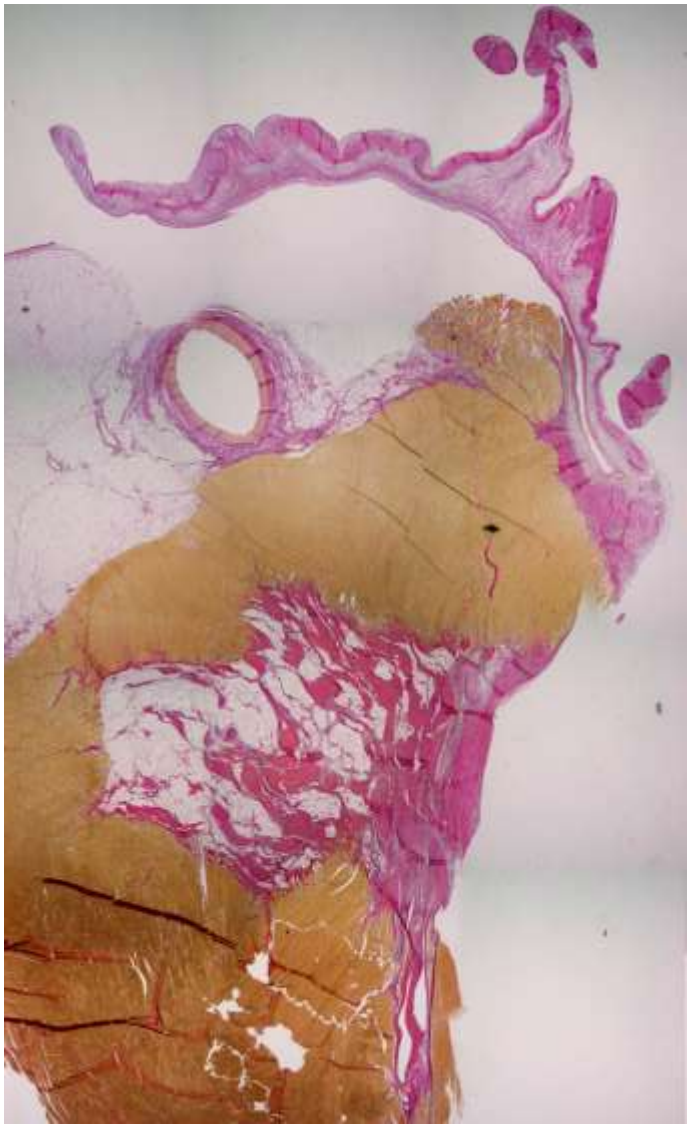
Stop Cryomapping



Cryoablation at Growing Myocardium: No Evidence of Coronary Artery Obstruction or Intimal Plaque Formation Early and Late after Energy Application

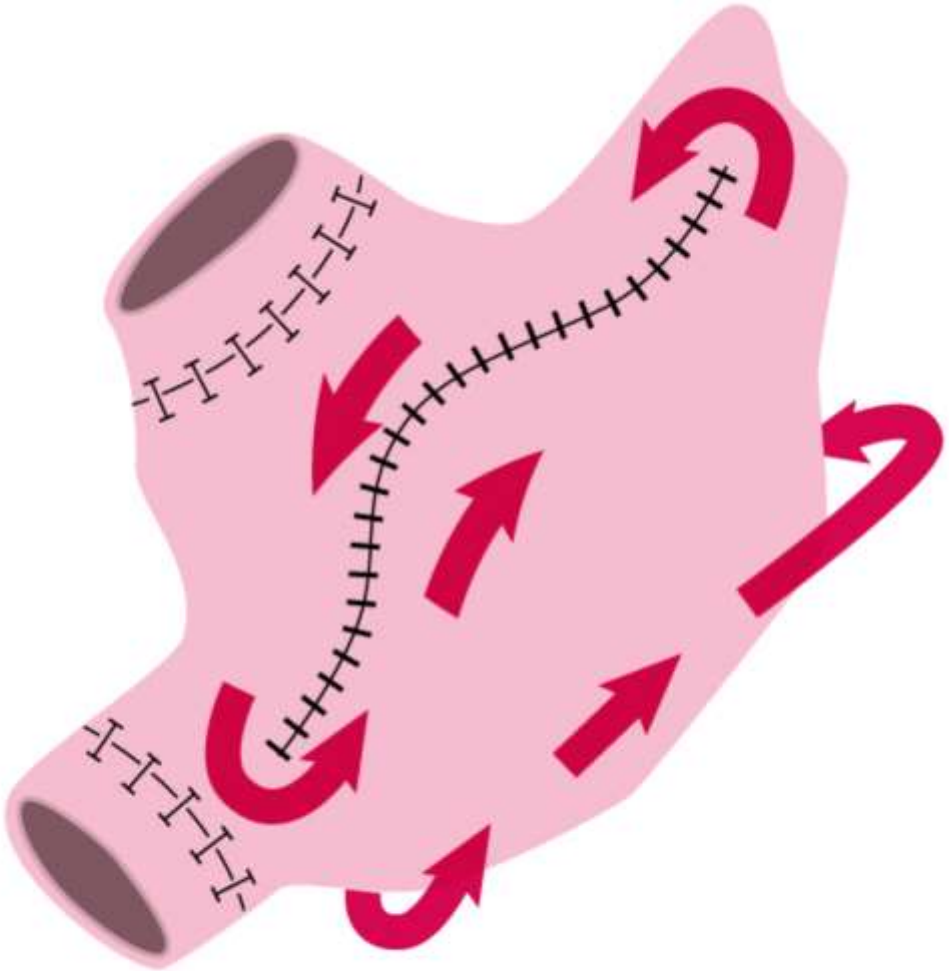
THOMAS KRIEBEL, M.D.,* HANS-PETER HERMANN, M.D.,† HEIKE SCHNEIDER, M.D.,* MAJA KROLL, M.D.,* JAKOB SELLE,* ANNA OVERWAUL,* MATTHIAS SIGLER, M.D.,* and THOMAS PAUL, M.D.*



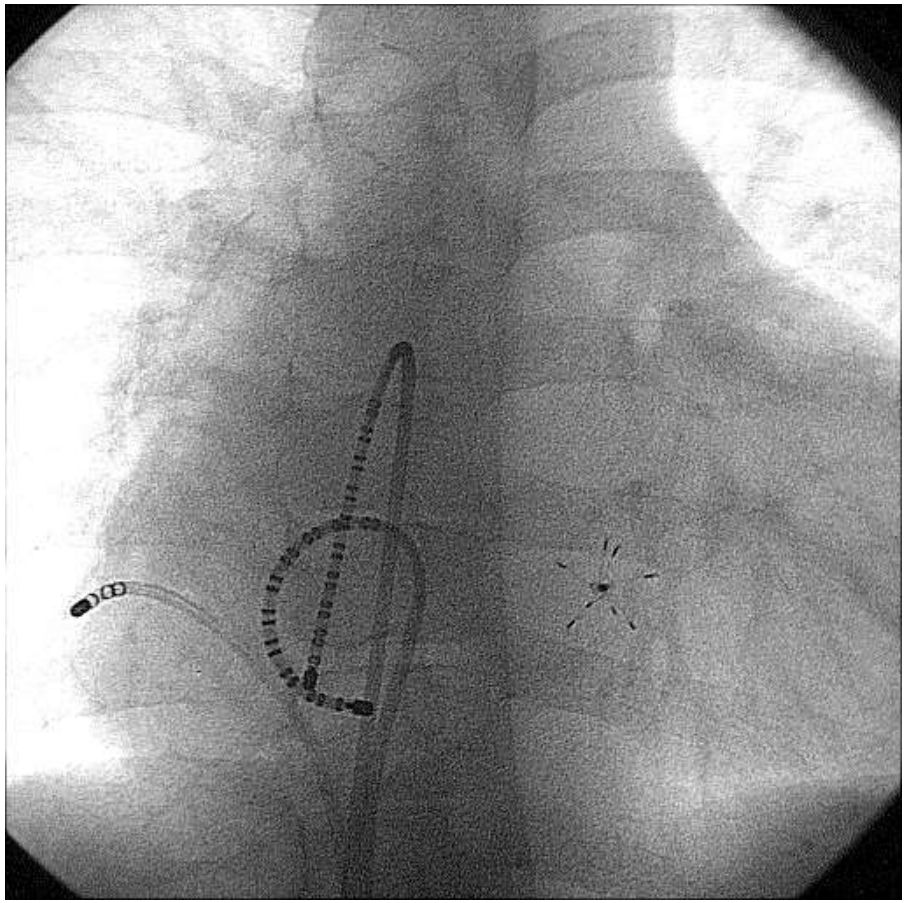


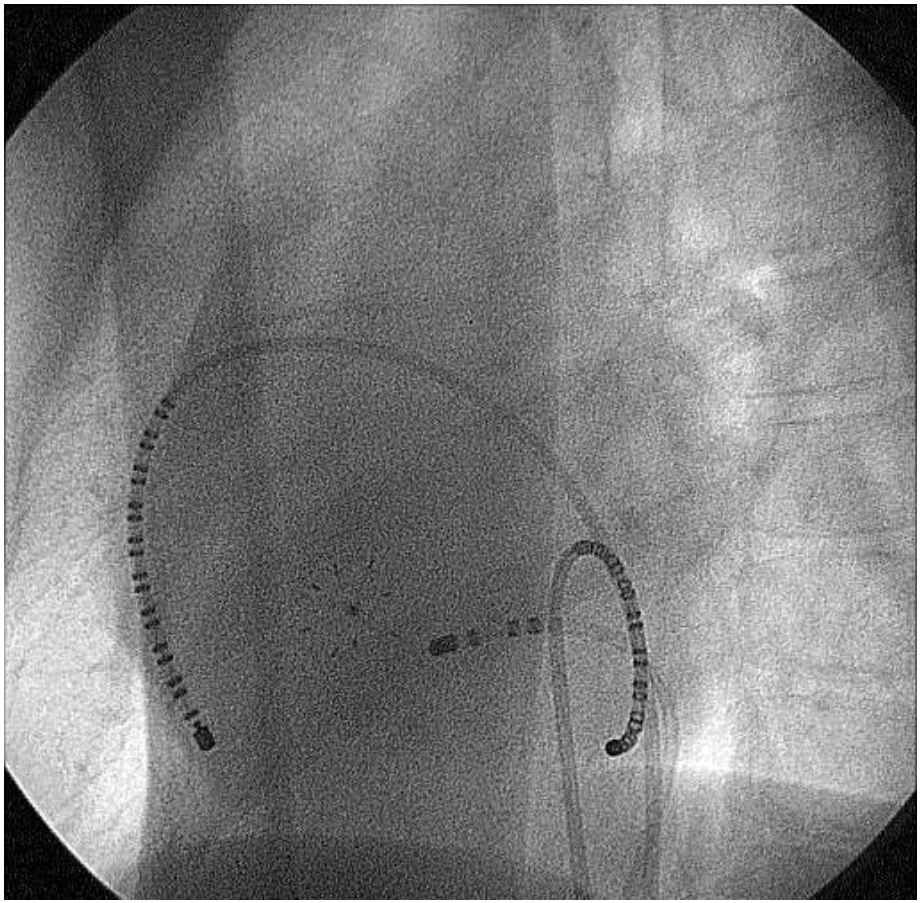
J Cardiovasc Electrophysiol 2009

Atrial Reentrant Tachycardias

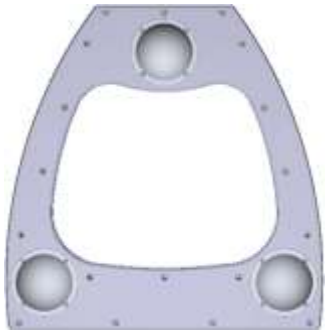


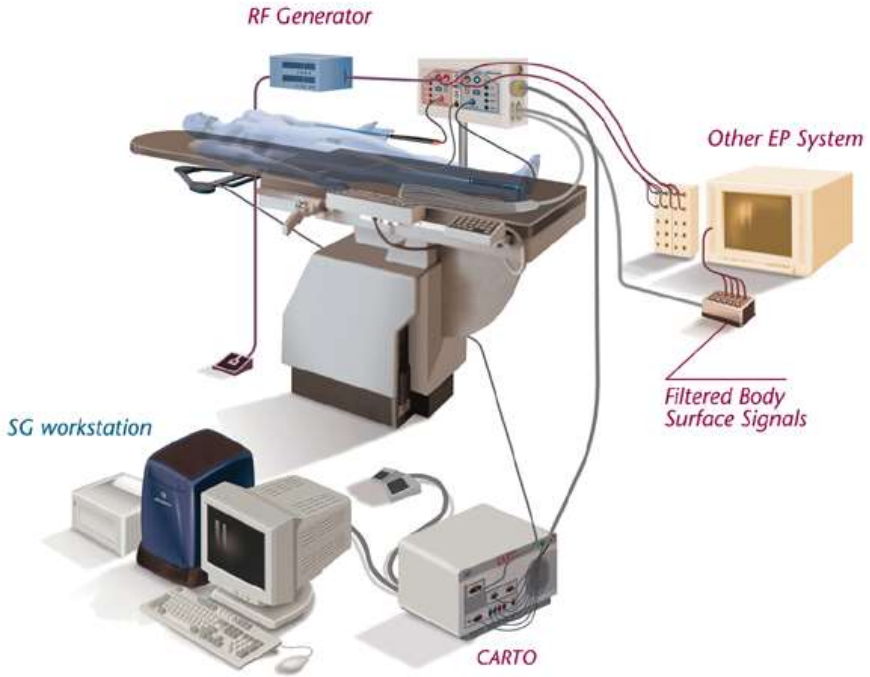
Conventional Contact Mapping
Post Fontan Procedure





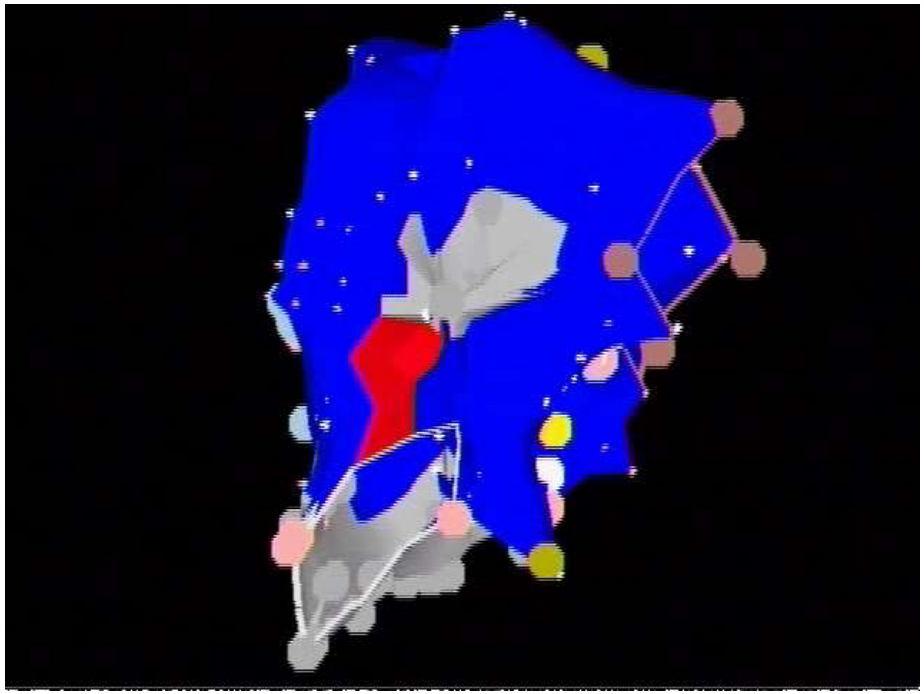
Electroanatomical Mapping Carto®

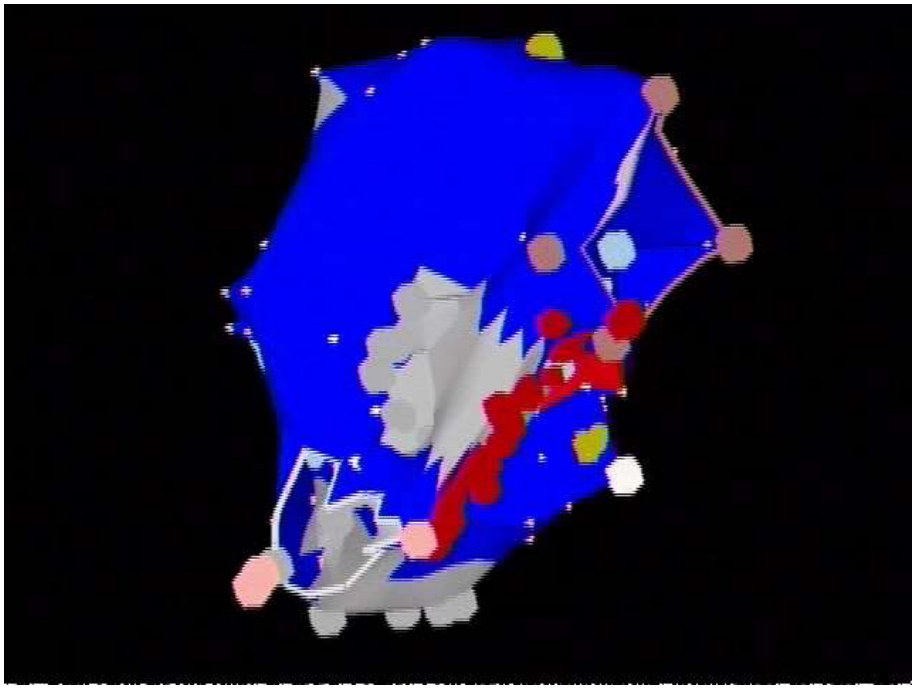




Atrial Reentrant Tachycardia After Repair of Tetralogy of Fallot

- Carto®-Mapping -



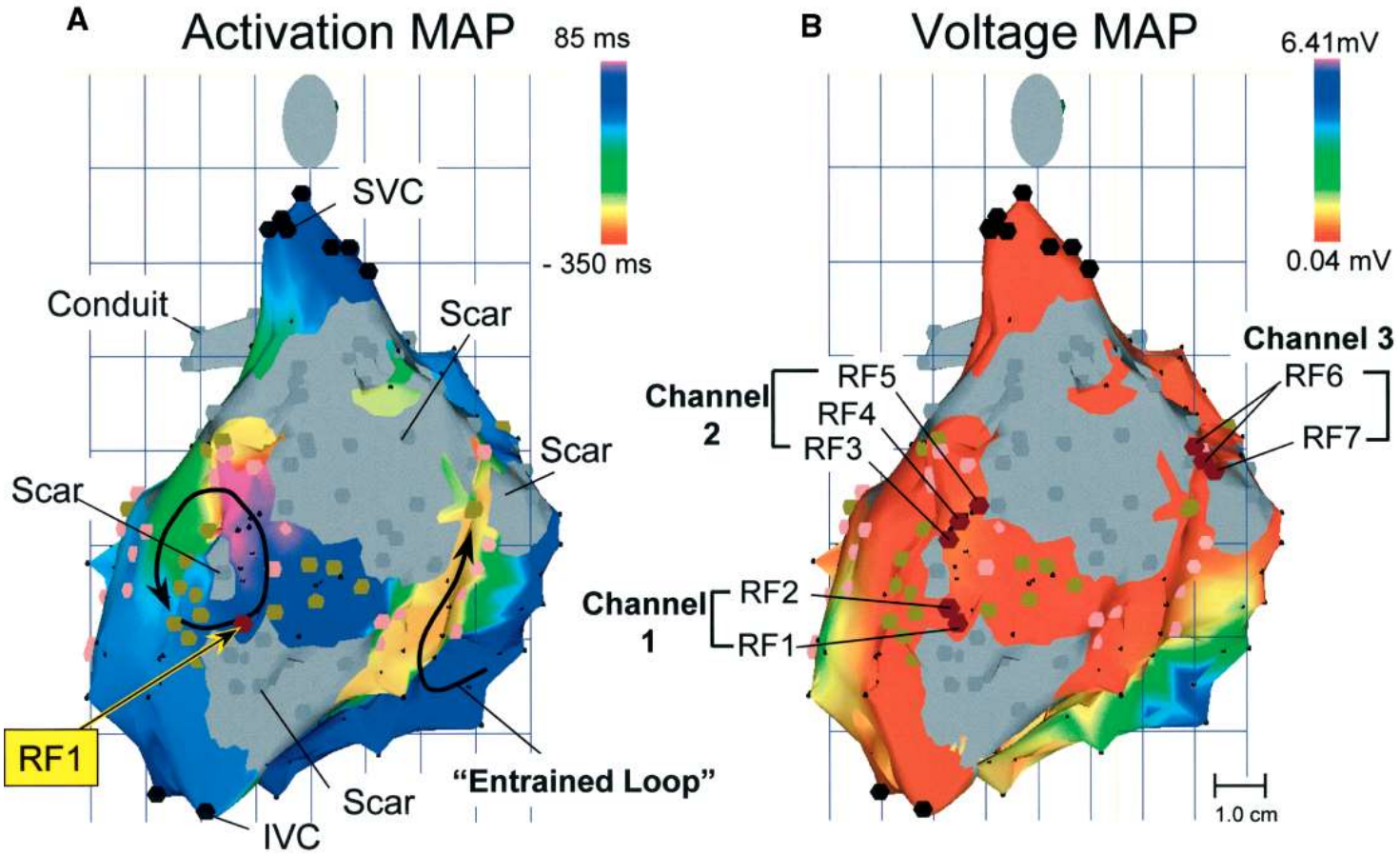


Characterization of Reentrant Circuit in Macroreentrant Right Atrial Tachycardia After Surgical Repair of Congenital Heart Disease

Isolated Channels Between Scars Allow "Focal" Ablation

Hiroshi Nakagawa, MD, PhD; Nayyar Shah, MD; Kagari Matsudaira, MD; Edward Overholt, MD; Krishnaswamy Chandrasekaran, MD; Karen J. Beckman, MD; Peter Spector, MD; James D. Calame, RN; Arun Rao, MD; Can Hasdemir, MD; Kenichiro Otomo, MD; Zulu Wang, MD; Ralph Lazzara, MD; Warren M. Jackman, MD

Right Posterior Oblique Projection



Circulation. 2001;103:699-709.

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JOURNAL OF CARDIOVASCULAR ELECTROPHYSIOLOGY, Volume 13, No. 4, April 2002

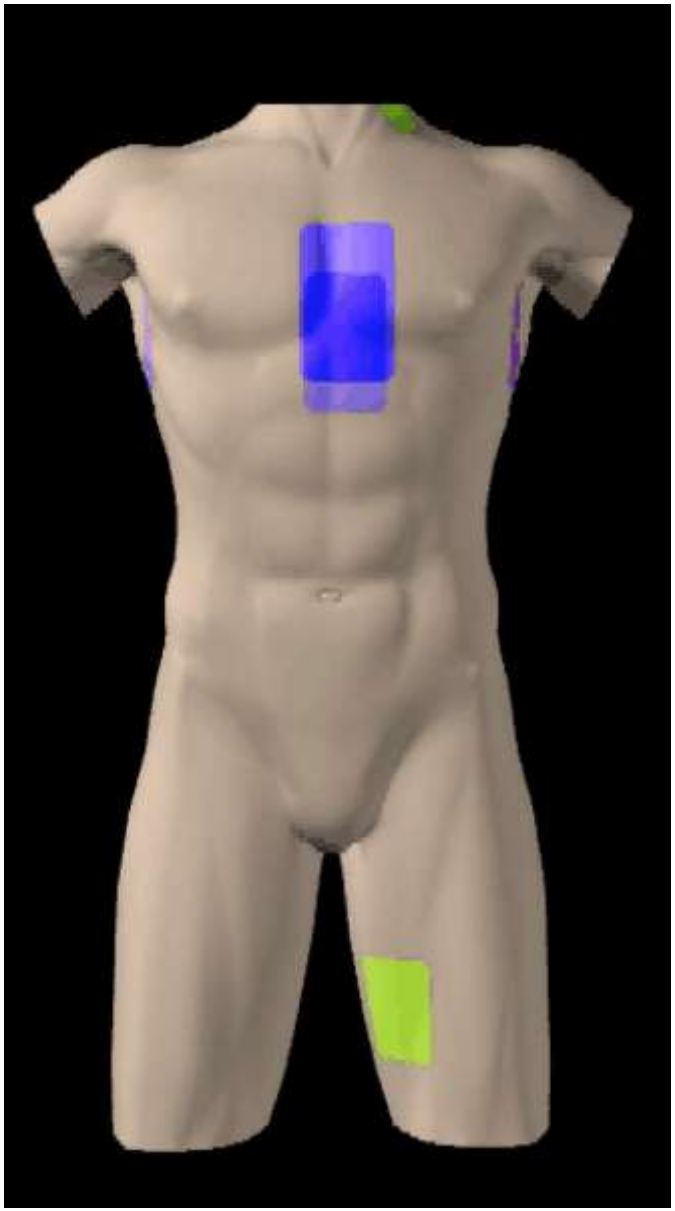
Pediatric Radiofrequency Catheter Ablation Registry Success, Fluoroscopy Time, and Complication Rate for Supraventricular Tachycardia: Comparison of Early and Recent Eras

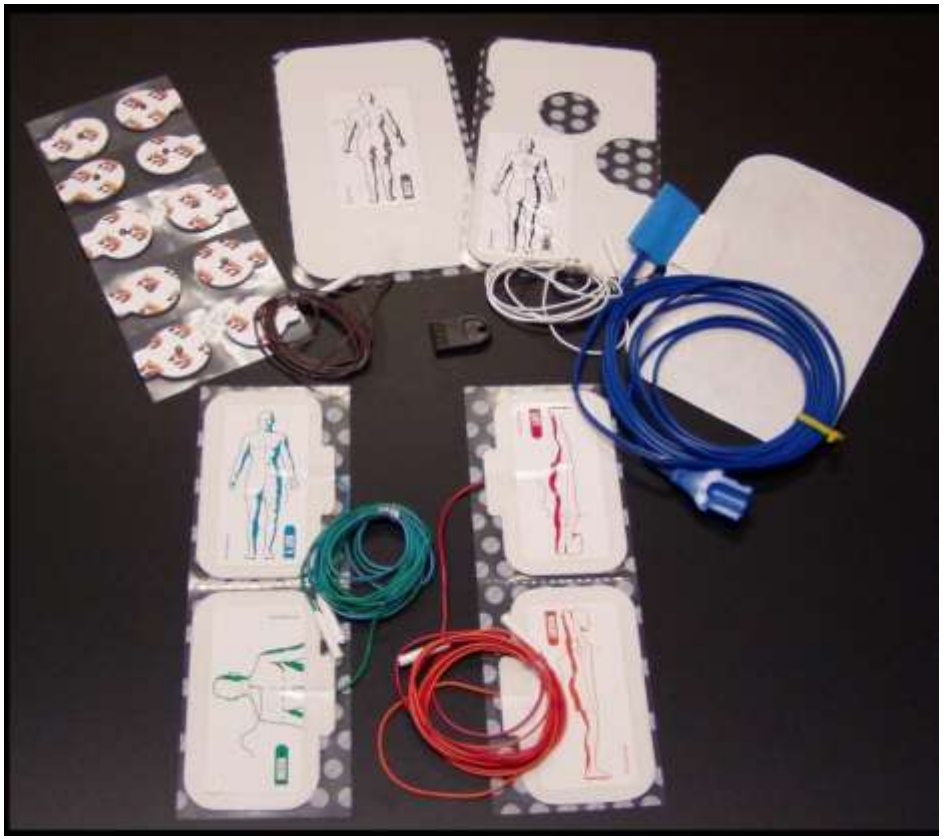
JOHN D. KUGLER, M.D., DAVID A. DANFORD, M.D.,
KRIS A. HOUSTON, R.N., B.S.N., M.A., GARY FELIX, B.S.,
and THE OTHER PARTICIPATING MEMBERS OF THE PEDIATRIC RADIOFREQUENCY ABLATION REGISTRY OF THE PEDIATRIC ELECTROPHYSIOLOGY SOCIETY

	Early Era	Late Era
N_{Total}	4,193	3,407
No. of successful ablations (%)	3,790 (90.4%)	3,245 (95.2%)
Fluoroscopy time (min)	50.9 ± 39.9	40.1 ± 35.1
Complications	178 (4.2%)	100 (3.0%)
Age (years)	12.4 ± 4.7	12.2 ± 4.6

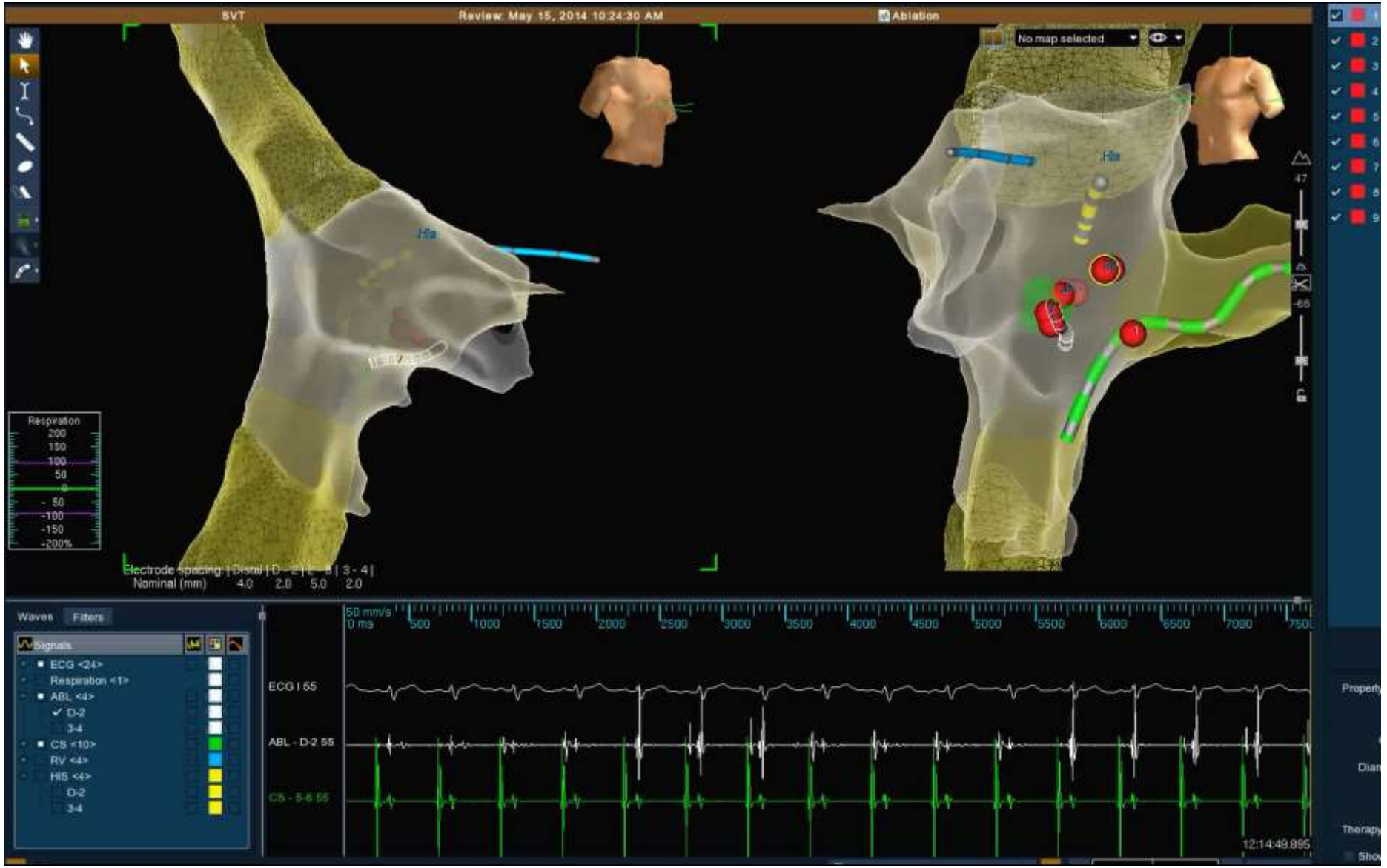
Values are given as number (%) or mean ± SD.

Ensite NavX®





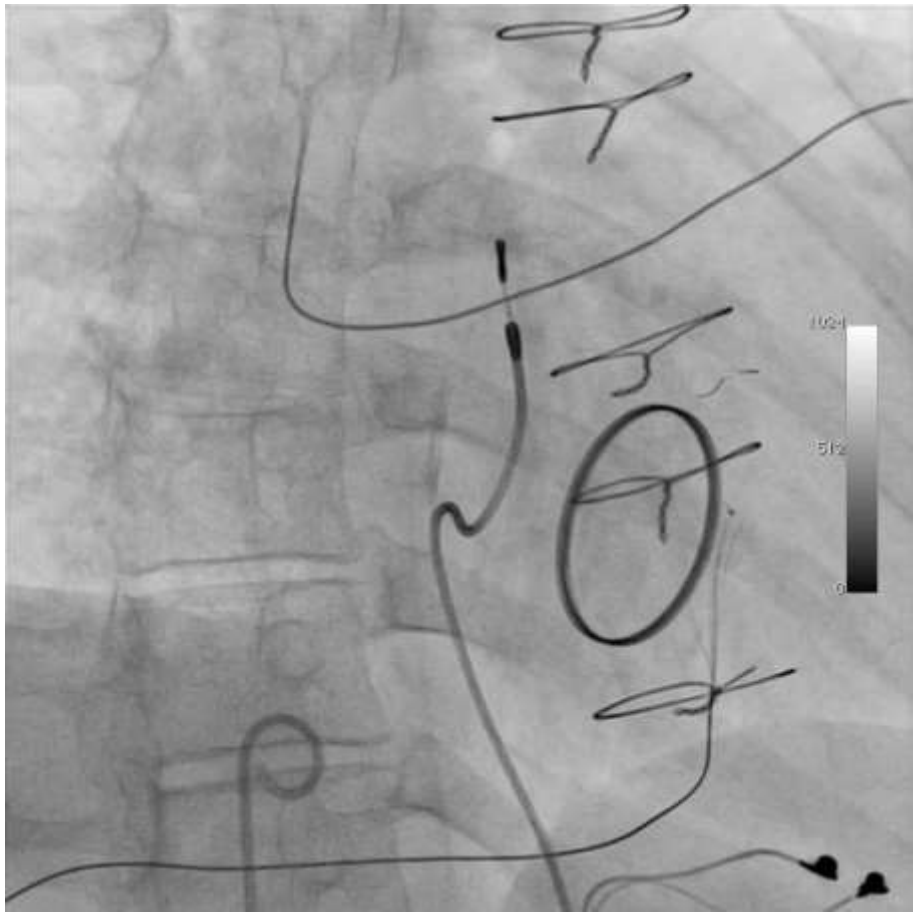
Fluoroless Endocardial Mapping

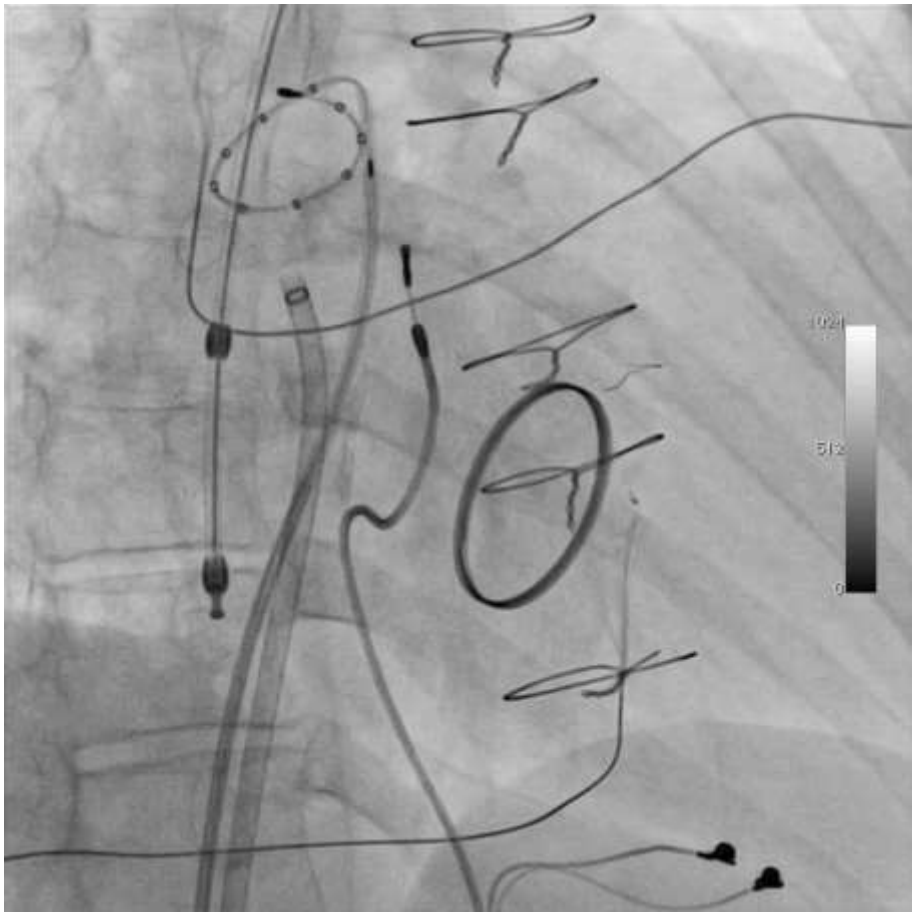


Transbaffle catheter ablation of atrial re-entrant tachycardia within the pulmonary venous atrium in adult patients with congenital heart disease

Ulrich Krause*, David Backhoff, Sophia Klehs, Heike E. Schneider, and Thomas Paul

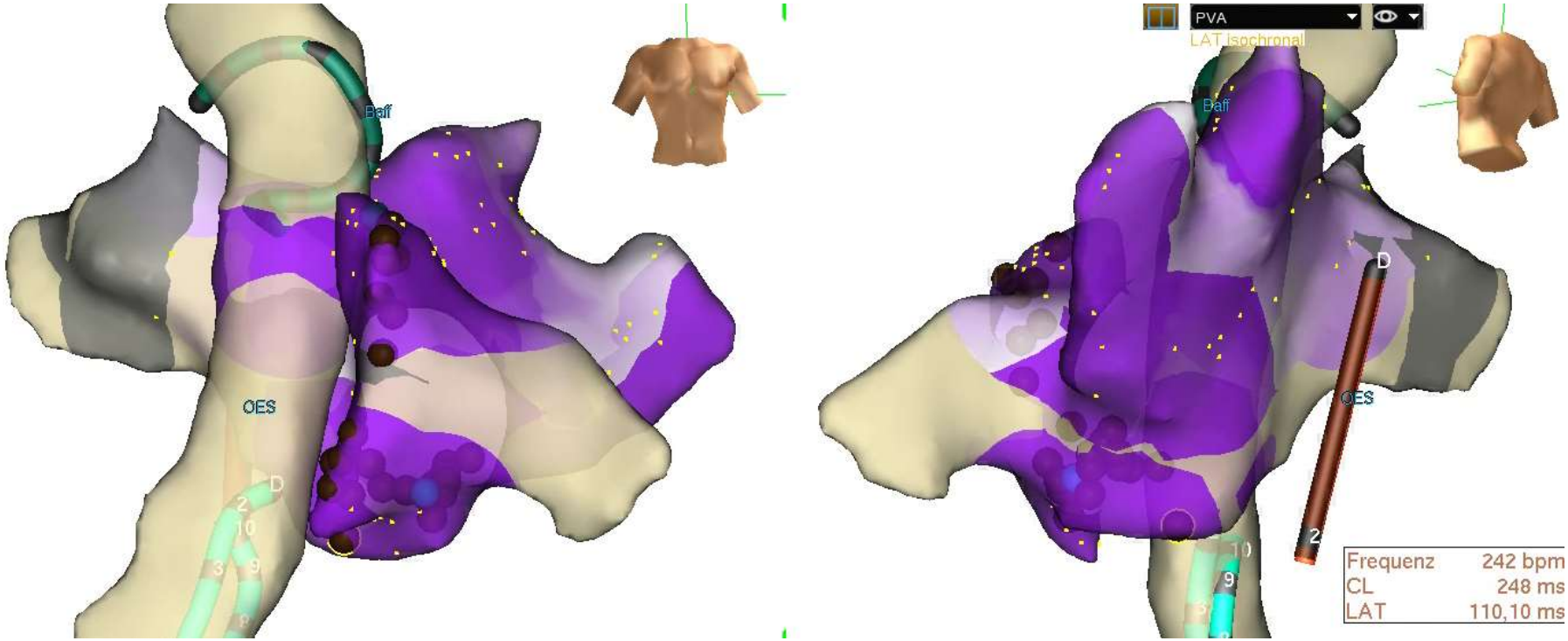
Europace 2015





22-year-old Female, single ventricle, s/p ECC Fontan, MVR, DDD, IART

NavX® Progagation Map of IART post Fontan

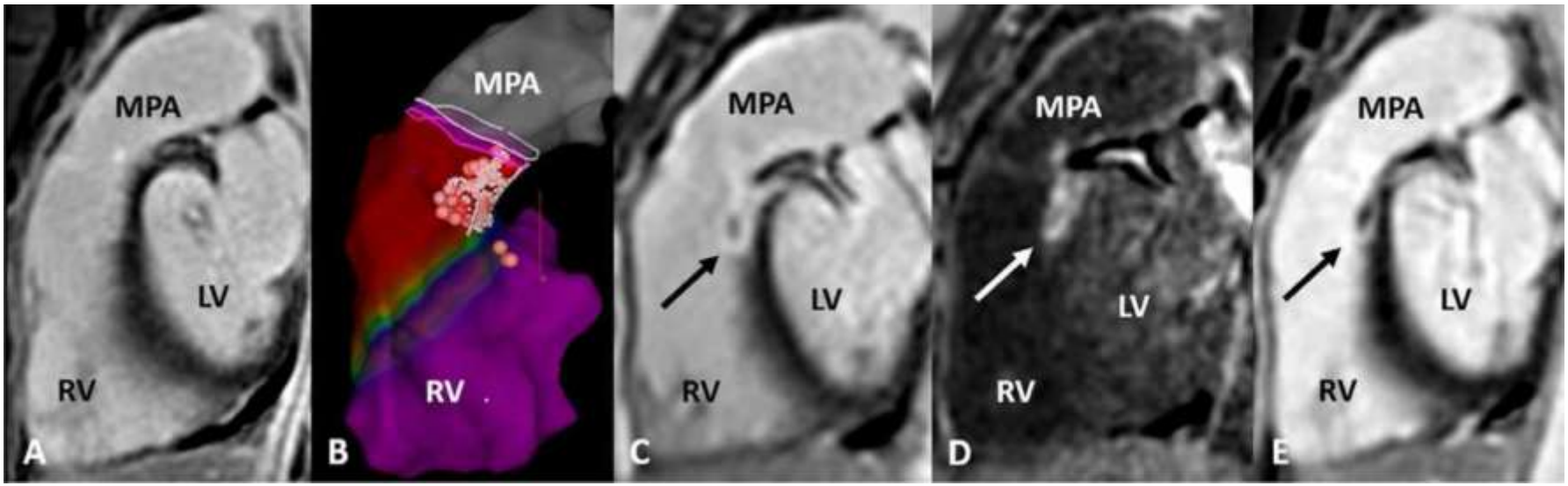


The NIH Lab at Children's National Medical Center
Washington, DC

Acute Cardiac MRI Assessment of Radiofrequency Ablation Lesions for Pediatric Ventricular Arrhythmia: Feasibility and Clinical Correlation

ELENA K. GRANT, M.B.Ch.B.,*,† CHARLES I. BERUL, M.D.,* RUSSELL R. CROSS, M.D.,* JEFFREY P. MOAK, M.D.,* KARIN S. HAMANN, R.N.C.,* KOHEI SUMIHARA, R.C.I.S.,* ILEEN CRONIN, F.N.P.,* KENDALL J. O'BRIEN, B.A.,* KANISHKA RATNAYAKA, M.D.,†,‡ MICHAEL S. HANSEN, Ph.D.,*,† PETER KELLMAN, Ph.D.,*,† and LAURA J. OLIVIERI, M.D.

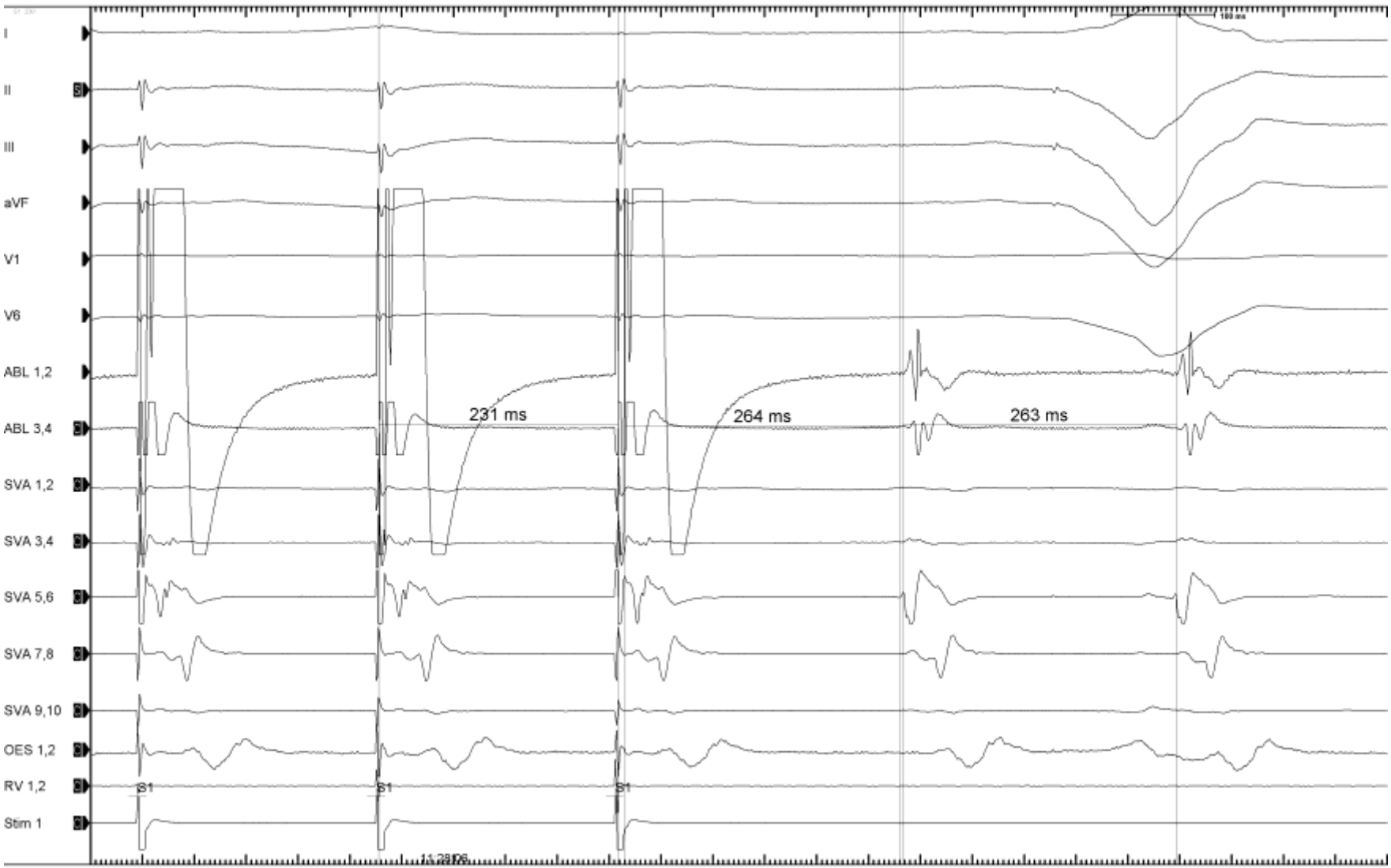
From the *Department of Cardiology, Children's National Health System, Washington, District of Columbia, USA; †Division of Intramural Research, Cardiovascular and Pulmonary Branch, National Heart Lung and Blood Institute, National Institutes of Health, Bethesda, Maryland, USA; and ‡Department of Cardiology, Rady Children's Hospital, San Diego, California, USA



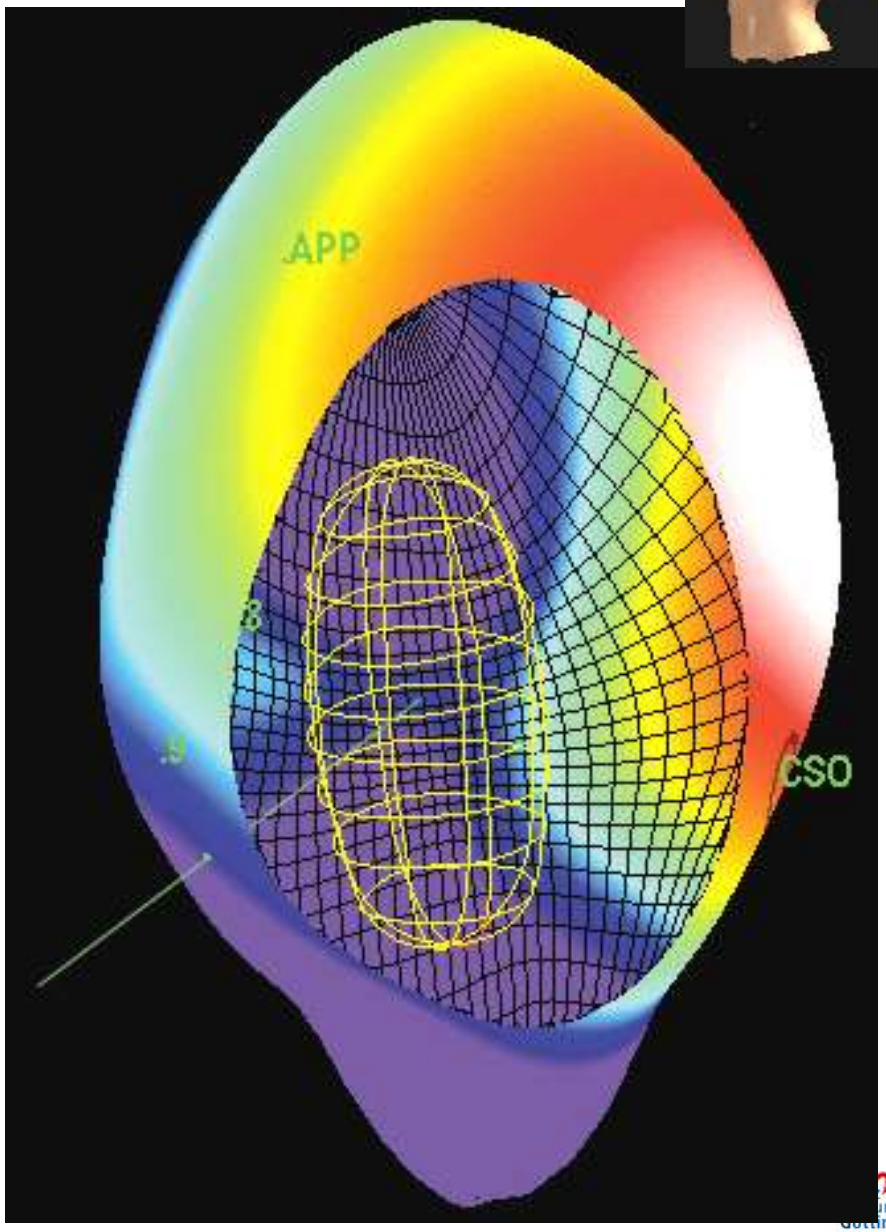
J Cardiovasc Electrophysiol 2017


H&M

Positive Entrainment in MV/IVC Isthmus



Noncontact Mapping Ensite®

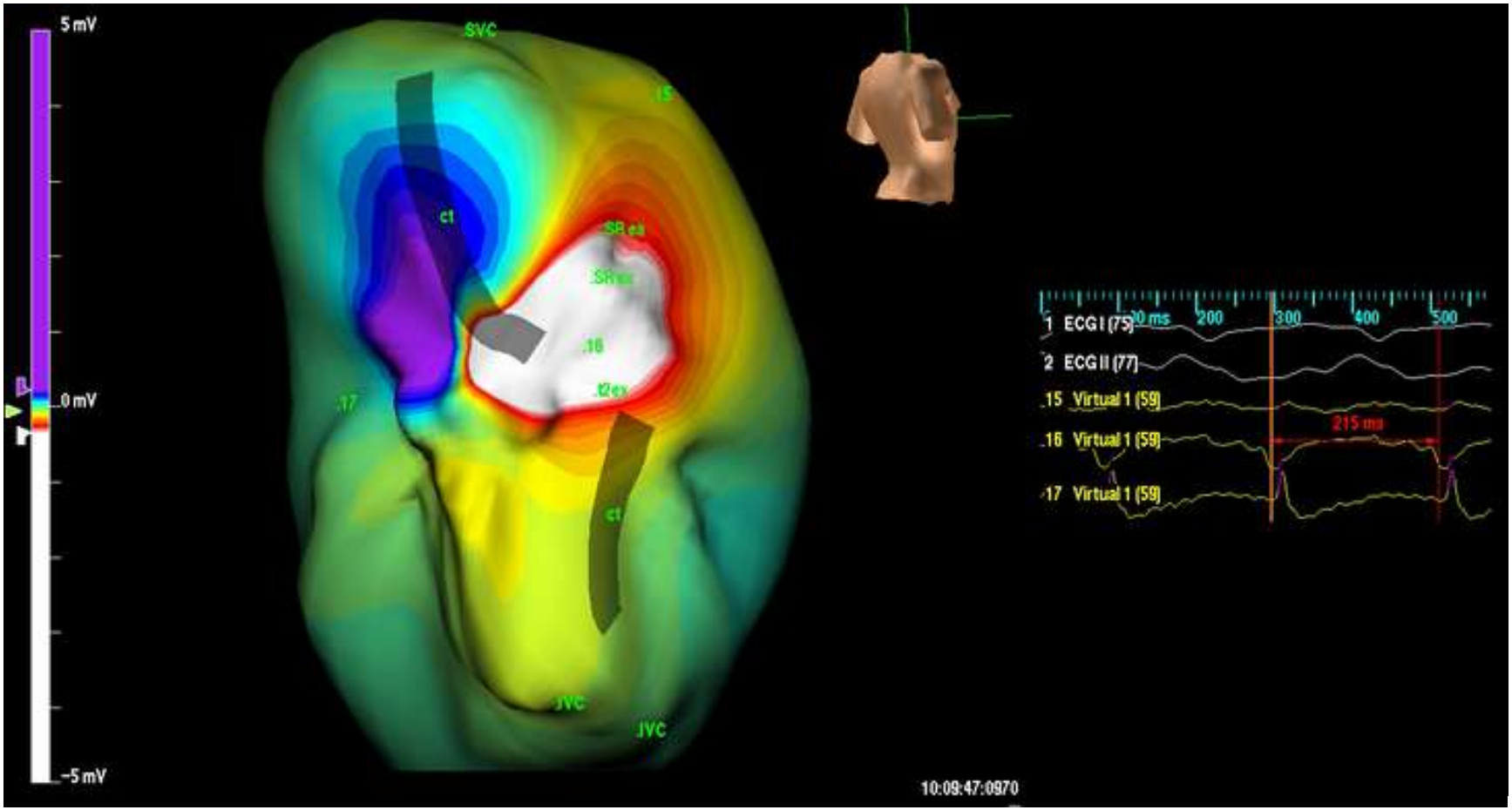


Atrial Reentrant Tachycardia After Surgery for Congenital Heart Disease

Endocardial Mapping and Radiofrequency Catheter Ablation Using a Novel, Noncontact Mapping System

Thomas Paul, MD; Britta Windhagen-Mahnert, MD; Thomas Kriebel, MD; Harald Bertram, MD; Renate Kaulitz, MD; Thomas Korte, MD; Michael Niehaus, MD; Jürgen Tebbenjohanns, MD

Upper Loop ART Through Crista Gap/Atriotomy in APC Fontan Patient



Circulation. 2001;103:2266-2271

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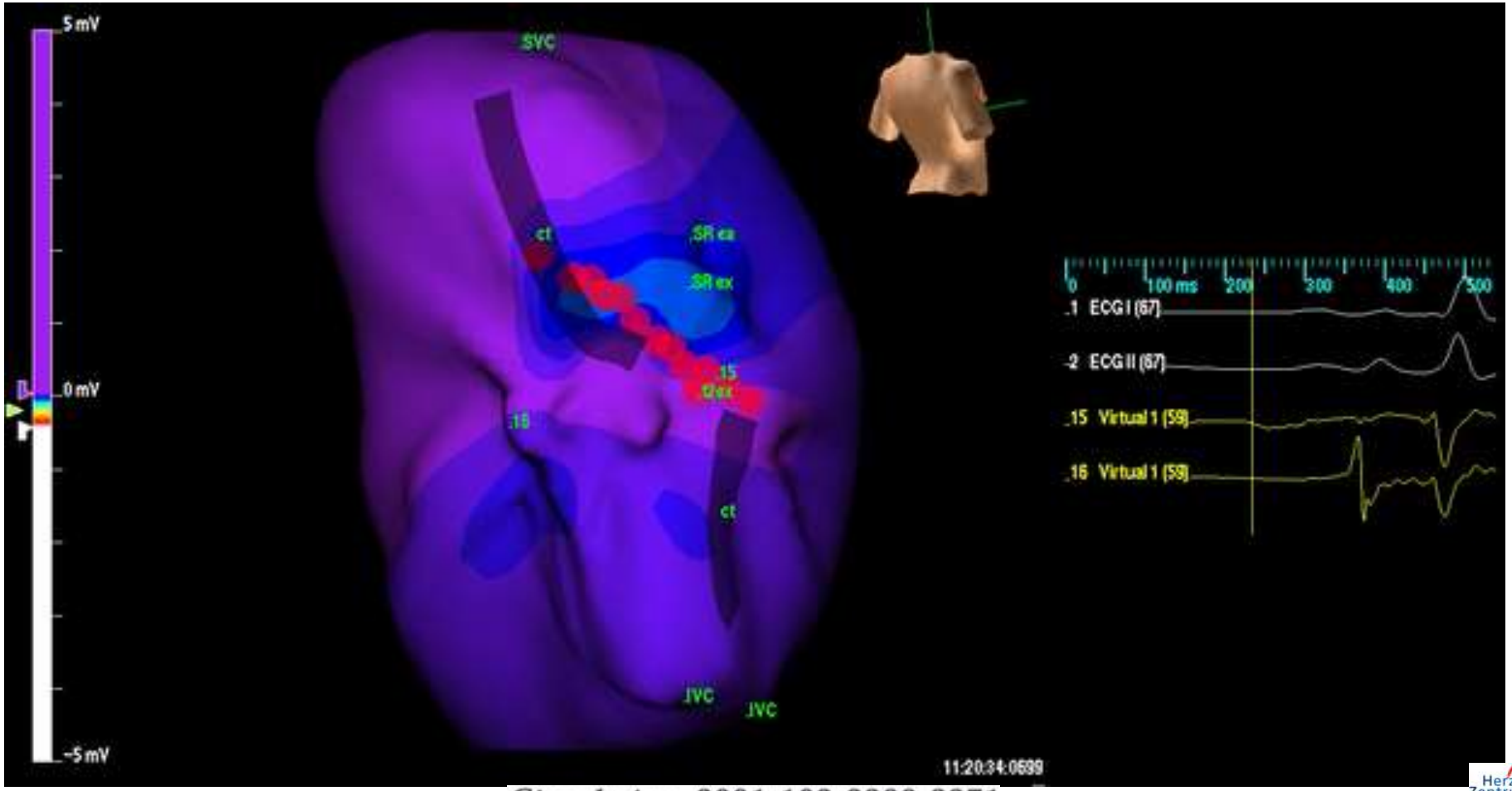
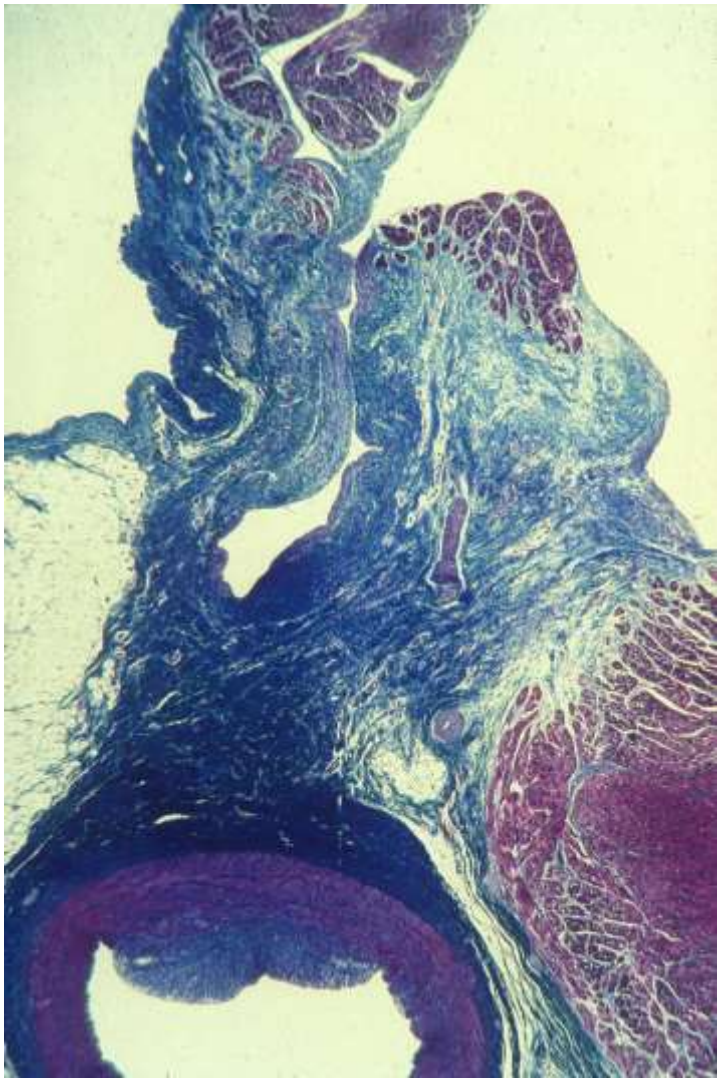
SR After RF Lesion Line



Circulation. 2001;103:2266-2271

Coronary artery involvement early and late after radiofrequency current application in young pigs

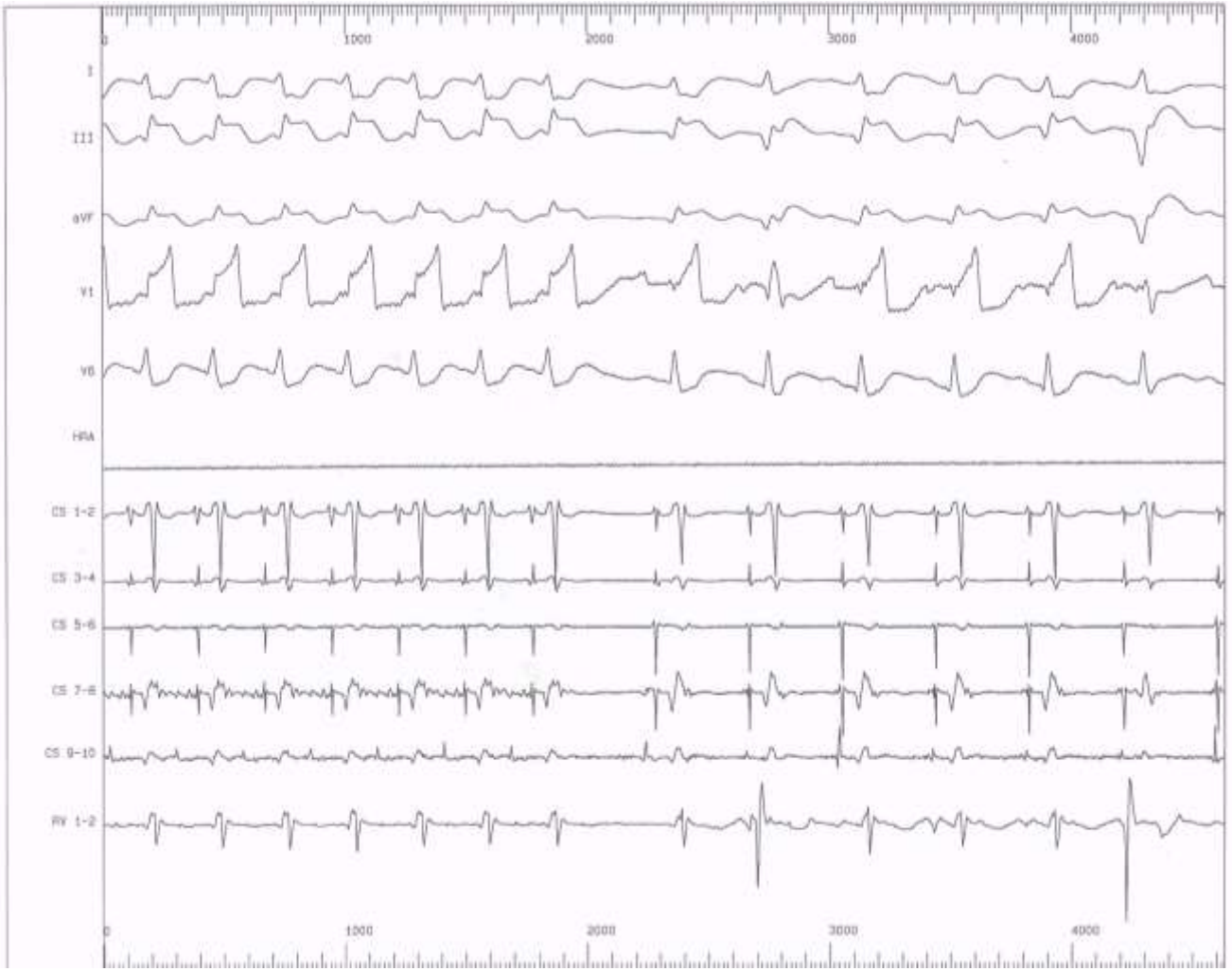
Thomas Paul, MD,[a] Regina Bökenkamp, MD,[a] Britta Mahnert, MD,[a]
and Hans-Joachim Trappe, MD[b] *Hannover, Germany*



Am Heart J 1997

Coronary Artery Stenosis After Radiofrequency Catheter Ablation of Accessory Atrioventricular Pathways in Children With Ebstein's Malformation

Harald Bertram, MD; Regina Bökenkamp, MD; Matthias Peuster, MD;
Gerd Hausdorf, MD; Thomas Paul, MD



Circulation 2001

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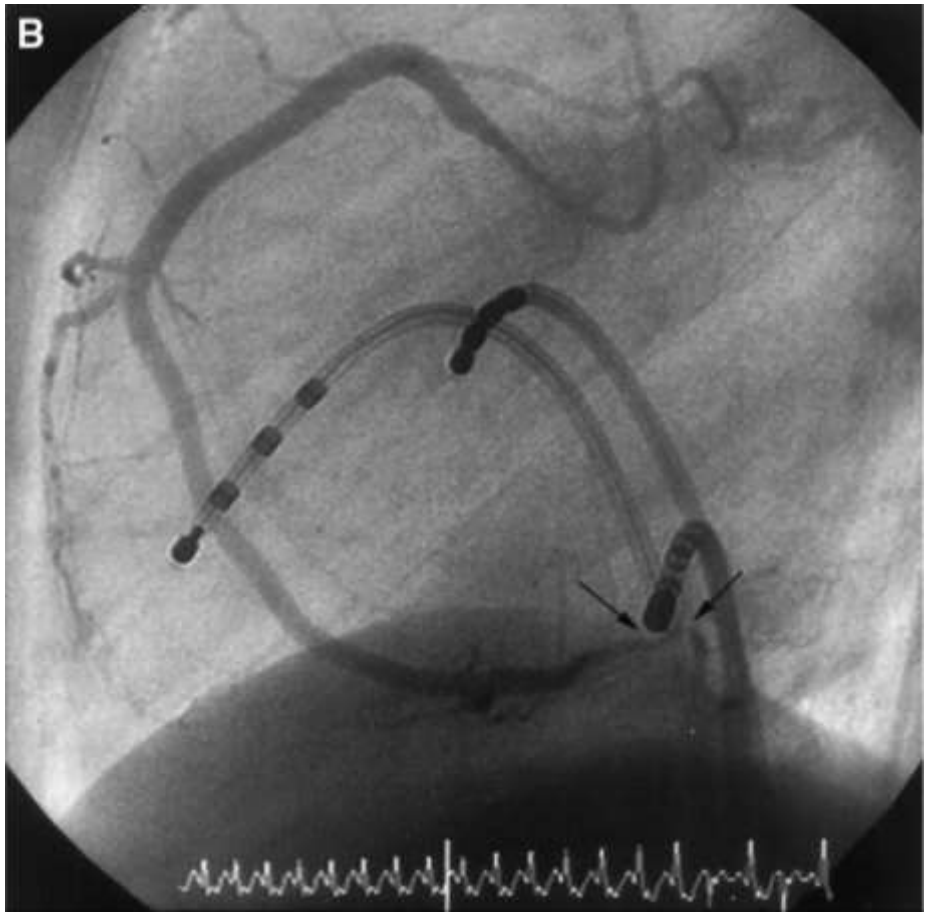
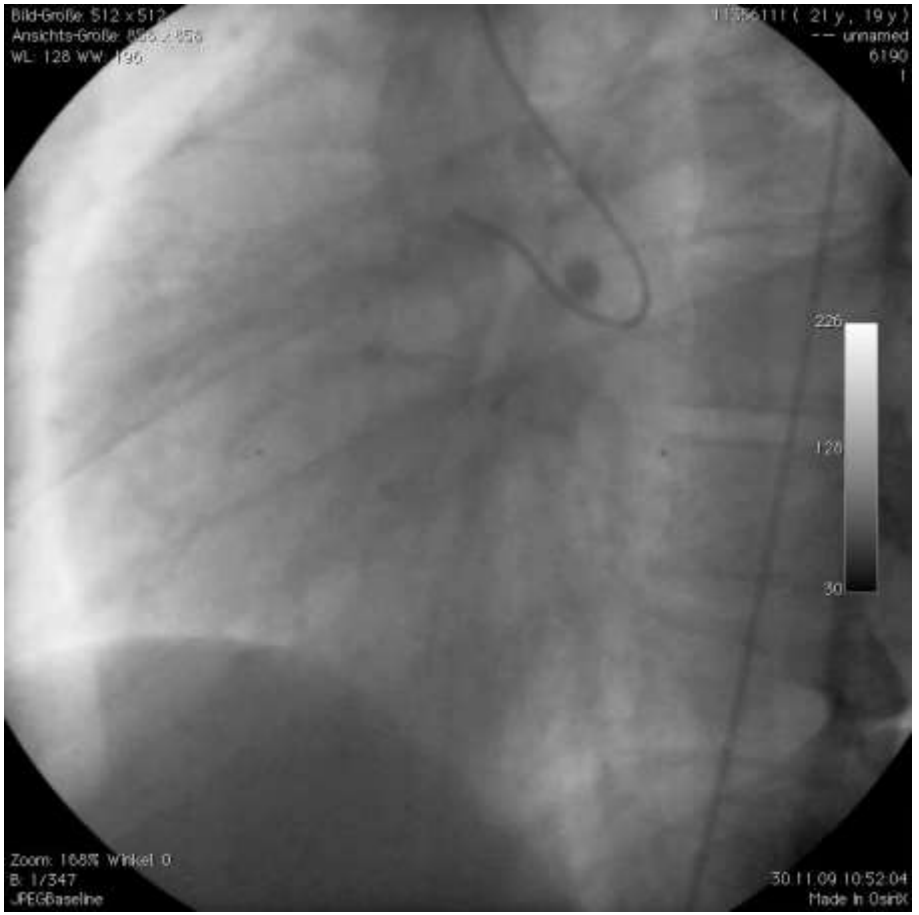
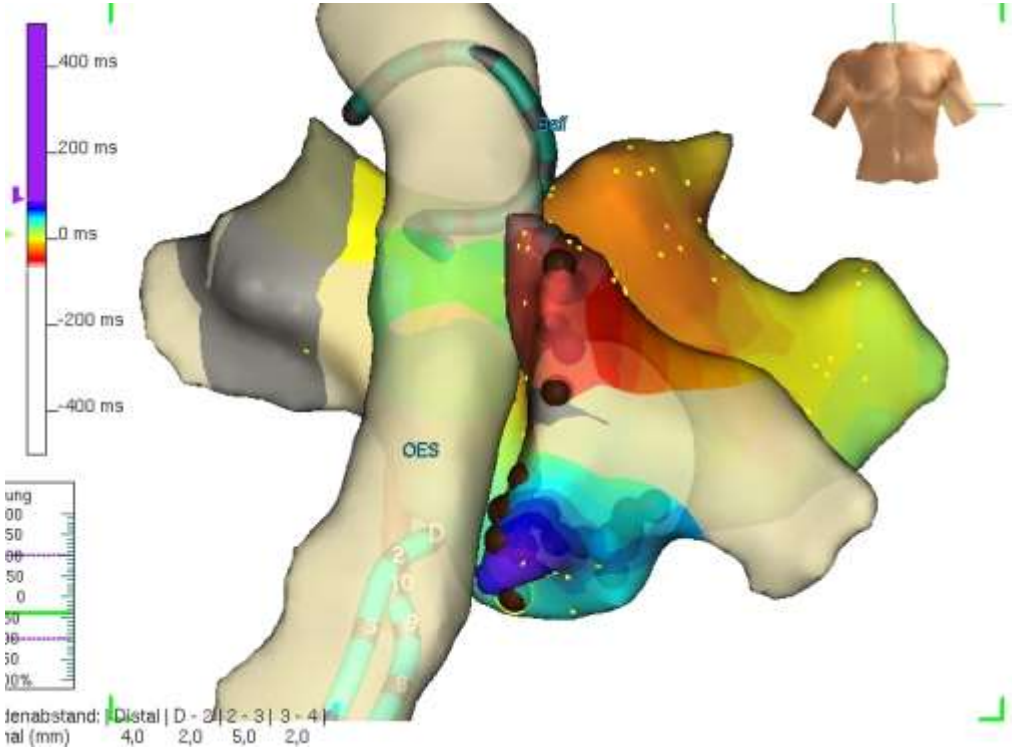
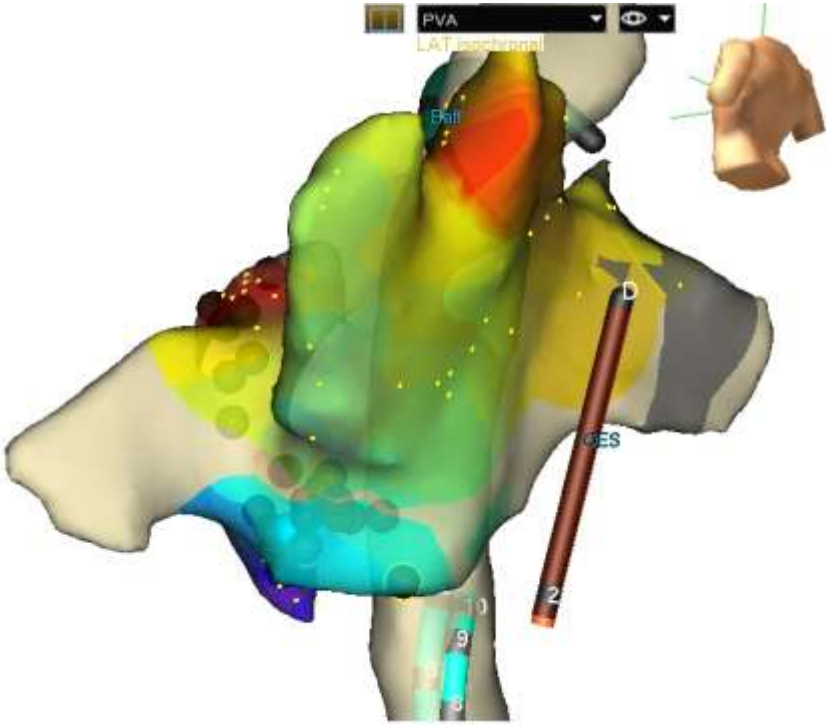




Circulation 2001

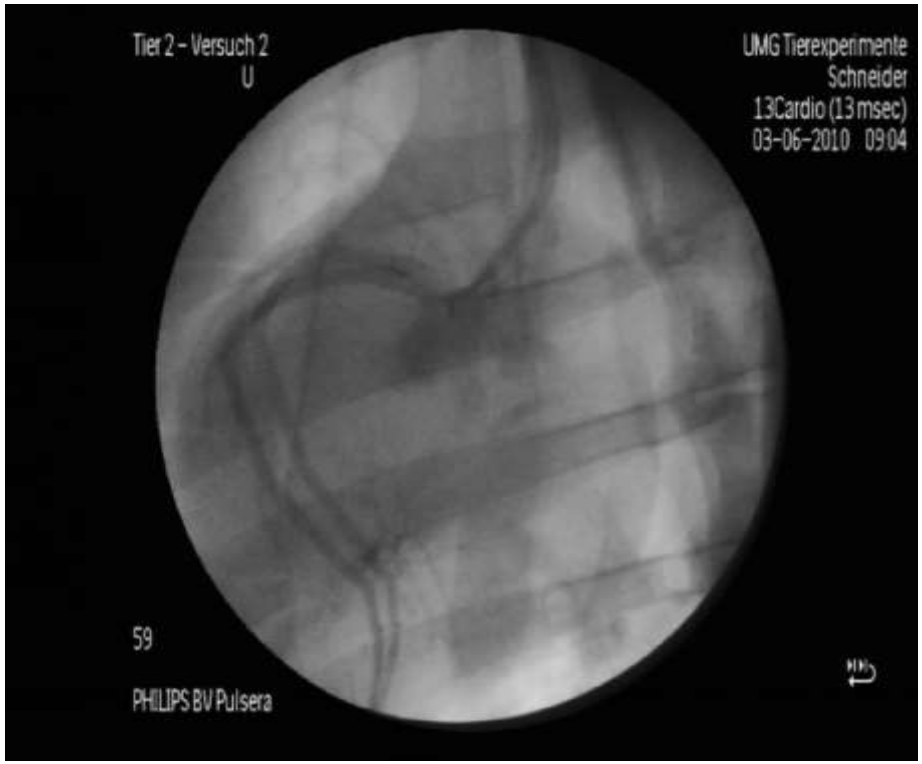
RF Lesion Lines





Double Cryoenergy Application (Freeze-Thaw-Freeze) at Growing Myocardium: Lesion Volume and Effects on Coronary Arteries Early After Energy Application. Implications for Efficacy and Safety in Pediatric Patients

HEIKE E. SCHNEIDER, M.D.,* MAJA STAHL, M.D.,* THOMAS KRIEBEL, M.D.,* WOLFGANG SCHILLINGER, M.D.,† MANFRED SCHILL, M.D.,* JOHANNES JAKOBI,* and THOMAS PAUL, M.D.*



Coronary angiography Intracoronary Ultrasound Study

No detection of significant stenosis or intimal plaque formation after 48 hours and 6 months in RCA and LCx

J Cardiovasc Electrophysiol 2013