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Circular Mapping Catheter Entrapment in the Mitral Valve Apparatus: A Previously Unrecognized Complication of Focal Atrial Fibrillation Ablation

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Circular Mapping Catheter Entrapment in MV Apparatus. Radiofrequency catheter ablation of focal atrial fibrillation triggers within the pulmonary veins is a rapidly developing therapy that relies on both recent technologies and evolving techniques. We describe the entrapment of a circular mapping catheter within the mitral valve apparatus after transseptal catheterization and mapping of the left atrium and pulmonary veins. The occurrence of this previously unreported complication stresses the need for continual monitoring and reporting of adverse effects from new devices and procedures to better inform patients and physicians of the benefits and risks of electrophysiologic interventions. *(J Cardiovasc Electrophysiol, Vol. 13, pp. 819-821, August 2002)*

atrial fibrillation, electrophysiologic study, mapping, mitral valve, pulmonary vein isolation, radiofrequency catheter ablation/adverse effect/instrumentation

Introduction

Radiofrequency (RF) catheter ablation of focal arrhythmogenic triggers, particularly the isolation of electrical activity within the pulmonary veins (PVs), represents a rapidly developing method for treatment of paroxysmal atrial fibrillation (AF).[1,2] The introduction of circumferential mapping catheters that are deployed via the transseptal approach in the left atrium and positioned at the PV ostia have greatly facilitated the identification of electrical foci that are targeted for ablation.[3] Although circular mapping catheters represent a major breakthrough in the catheter ablation of AF, use of these devices are not without risk. This report describes a previously unpublished major complication involving entrapment of the distal tip of a circular mapping catheter in the mitral valve apparatus during focal AF ablation. Entanglement of the circular spine during maneuvers to dislodge the tip ultimately disrupted the mitral valve and necessitated surgical treatment. Recognition and understanding of this potentially adverse reaction associated with use of circular mapping catheters during focal AF ablation may prevent future recurrence of this complication.

Case Report

A 49-year-old woman with a 6-year history of highly symptomatic paroxysmal AF lasting an average 8 to 16 hours in duration and occurring twice per week was referred to our hospital for management. She had not responded to antiarrhythmic drug therapy with flecainide, propafenone, sotolol, and amiodarone. She had undergone dual-chamber pacemaker implant 4 years earlier at another hospital for bradycardia in the setting of amiodarone use. Attempts to maintain sinus rhythm with overdrive atrial pacing (AAI 80 beats/min) also failed. A transesophageal echocardiogram performed before the procedure demonstrated mild left atrial dilation, no evidence of intracardiac thrombus, structurally normal heart valves, and normal left ventricular systolic function. Computed tomography with contrast enhancement was performed before the procedure to assess the patient's PV anatomy and ostial dimensions, which were normal.

After obtaining informed written consent, a PV isolation procedure was performed using techniques described by Haissaguerre et al.[3,4] Via the right femoral vein, a deflectable 7-French decapolar catheter (Biosense Webster, Diamond Bar, CA, USA) with 2.0-mm interelectrode distance and 5.0-mm intraelectrode distance) was positioned into the coronary sinus, and fixed-curve 6-French quadripolar catheters with 2-5-2 mm interelectrode spacing (Biosense Webster) were placed in the His-bundle position and right ventricular apex. Double transseptal catheterization was performed under fluoroscopic guidance with a Brockenbrough-1 needle and two separate long vascular 8-French sheaths (SL1; Daig Corp., Minnetonka, MN, USA). An activated clotting time of 250 to 350 seconds was maintained with intravenous heparin after transseptal sheath tip placement in the left atrium was confirmed with contrast injection and intracardiac pressure waveform monitoring. Selective angiography of the left superior (LS), right superior (RS), left inferior (LI), and right inferior (RI) PVs was performed with a deflectable tip 8.2-French guide catheter (Naviport; Cardima, Inc., Freemont, CA, USA) to define the PV ostia. A 7-French 20-pole deflectable tip catheter with a 3-French distal tip, 4.5-mm bipolar interelectrode spacing, and 15-mm diameter circular configuration (Lasso catheter; Biosense Webster) and a bidirectional deflectable 7-French quadripolar ablation catheter with 2-5-2 mm interelectrode spacing and 4-mm distal cooled-tip electrode with an embedded thermocouple (Chili catheter; Cardiac Pathways-Boston Scientific, Sunnyvale, CA, USA) were inserted into the left atrium. Bipolar electrograms were filtered at 30 to 500 Hz and digitally recorded (EP Med Systems, Inc., Mount Arlington, NJ, USA). Pacing was performed from the coronary sinus with a clinical stimulator. Initial electrophysiologic evaluation revealed no spontaneous or inducible atrial premature beats or AF. We then proceeded to segmentally electrically isolate each of the

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four PVs by targeting the earliest site of PV activity. Cooled-tip RF energy (Cardiac Pathways) was delivered within 5 mm of the PV ostium during 60-second applications with a target temperature of 37°C and maximum power of 30 W. Elimination of ostial PV potentials and entrance block into the PV during CS pacing were considered evidence of electrical isolation of the PV.

The Lasso catheter (Biosense Webster) was positioned under fluoroscopic guidance via a transseptal sheath within the left atrium and PV ostia using only clockwise motion as specified by the manufacturer.[5] The LS PV followed by the LI PV were electrically isolated. Because of difficulty rotating the circular mapping catheter to the RS PV, an attempt was made to exchange the mapping and ablation catheters in their respective transseptal sheaths. Initial efforts to remove the Lasso catheter from the transseptal sheath, met resistance from the distal catheter tip. Maneuvers using both counterclockwise and clockwise rotation were unsuccessful in freeing the tip. It was observed that only the first 50% of the circular portion of the catheter tip could be withdrawn into the sheath and pulsatile motion could be appreciated. Fluoroscopy confirmed that the circular spine of the Lasso catheter was near the AV valve ring and that the tip was deflected toward the mitral valve when the catheter body was withdrawn into the sheath. A transthoracic echocardiogram demonstrated the presence of mild mitral regurgitation that varied in Doppler flow patterns with catheter manipulation, which was consistent with entrapment of the catheter tip in the mitral valve apparatus. After deliberation with interventional cardiology consultants, simultaneous rotation with gentle manual traction was applied to the catheter, which opened the loop and freed the tip.

Upon removal of the catheter, it was immediately apparent that attempts to free the circular spine of the mapping catheter had disrupted the mitral valve apparatus, resulting in acute mitral insufficiency in our patient. A repeat echocardiogram revealed a flail posterior mitral valve leaflet and severe mitral regurgitation. After coronary angiography and stabilization of the patient in the coronary care unit, the patient underwent open heart surgery. Intraoperative examination of the mitral valve apparatus showed that the leaflets were intact; however, the posterior leaflet was completely flail due to severing of two chordae tendineae and avulsion of the posteromedial papillary muscle near its base. Mitral valve repair could not be accomplished, and mitral valve replacement with a mechanical heart valve was required.

Discussion

Paroxysmal AF, initiated by ectopic beats originating in the PVs, can be treated successfully by RF catheter ablation.[2,6,7] Circumferential mapping catheters have been developed for identifying focal triggers or electrophysiologic breakthrough sites that propagate conduction from the distal PV to the left atrium. These catheters are commonly used to locate and assess ostial PV potentials during mapping and to define endpoints for ablation by demonstrating electrical isolation of the PV from the left atrium.[3,4] Perhaps the single greatest advance in the technique of focal AF ablation has been the introduction of circular mapping catheters that facilitate an anatomically based approach to mapping of the PVs. The application of circular mapping catheters has quickly gained acceptance and widespread use for focal AF ablation throughout the world. Reported complications during focal AF ablation include vascular access site bleeding, aspiration pneumonia, embolization of air to the coronary arteries, cerebrovascular and systemic thromboembolization, PV stenosis, PV thrombosis, pericarditis, pericardial tamponade, and phrenic nerve paralysis.[4,7,8] Entrapment of a circular mapping catheter in the mitral valve apparatus during focal AF ablation is a serious and previously unreported complication.

A review of the literature reveals that catheter entrapment in the mitral valve apparatus has been reported in association with catheter ablation procedures. The first report of catheter entrapment in the mitral valve apparatus was described during RF ablation of a left-sided accessory pathway.[9] During retrograde aortic mapping of the mitral annulus, entanglement of the mapping catheter in the mitral apparatus caused chest pain and acute mitral regurgitation during attempts to remove the catheter from the left ventricle. The catheter was successfully freed from the mitral valve under echocardiographic guidance and the patient's mitral regurgitation subsequently resolved. Entrapment of a steerable catheter in the chordae of the anterior mitral valve leaflet during intracardiac mapping in another patient required open heart surgery to remove the catheter.[10] The 1995 North American Society for Pacing and Electrophysiology (NASPE) Survey reported a 0.04% incidence of mitral valve damage during RF ablation of accessory pathways.[11] The actual incidence of mitral valve complication during mapping or ablation may be underestimated because adverse effects during ablation procedures are reported voluntarily. A more recent registry and a study investigating complications of RF ablation did not report mitral valve injury, but these data precede the development of newer ablation techniques and devices used for focal AF ablation.[12,13]

Entrapment of a circular mapping catheter in the mitral valve apparatus during our focal AF ablation procedure was an unforeseen complication. As indicated by the manufacturer of the device, these circular catheters are designed for placement in the right or left atrium via a long guiding sheath.[5] A retrograde approach is contraindicated because of the risk of entrapping the catheter in the left ventricle or valve apparatus, and the catheter may not be appropriate for use in patients with prosthetic valves.[5] Either during initial deployment of the catheter through a transseptal sheath or during mapping of the inferior PVs, the circular spine of our catheter became entangled in the chordae tendineae while the body of the catheter remained in the left atrium. Once caught in the mitral valve apparatus, attempts to maneuver the catheter with clockwise and counterclockwise motion may have further entangled the circular spine and prevented removal of the catheter tip. Despite attempts to remove the catheter under fluoroscopic and echocardiographic guidance, the design, relative stiffness, and entrapment of the preformed circular spine in the mitral apparatus prevented complete straightening or relaxation of the circular tip. We suspect that the abrasive nature of the 20 electrodes caused resistance, which contributed to the inability of the catheter to slide off the mitral valve apparatus. While we contemplated sending our patient directly to surgery to remove the catheter, we realized that thromboembolism was a risk after reversal of anticoagulation administered during the procedure. Hoping to prevent the need for surgical intervention, we manually extracted the catheter. Unfortunately, maneuvers to dislodge the tip disrupted the mitral valve apparatus and necessitated mitral valve replacement in our patient.

Based on our experience, several recommendations can be made that may lower the possibility of this complication

occurring in the future. First, it is essential that interventional electrophysiologists be aware of this possible adverse event. The package labeling of the current device should specifically warn users about this potential complication.[5] Second, concerted efforts should be made to always position the circular spine of the catheter in the posterior left atrium during transseptal catheterization. Third, it would be reasonable to withdraw the catheter into the sheath during repositioning or moving of the catheter between the inferior PVs. Additional modification of the catheter design by device manufacturers should be considered to facilitate straightening of the catheter tip to allow removal of the circular spine from the atrium. In the unlikely event that a catheter becomes entrapped in the mitral valve apparatus, early surgical extraction, which carries a small but unknown risk of thromboembolization, should be strongly considered before manual extraction in order to avoid mitral valve injury and preserve the mitral valve apparatus.

References

1. Fuster V, Ryden LE, Asinger RW, Cannom DS, Crijns HJ, Frye RL, Halperin JL, Kay GN, Klein WW, Levy S, McNamara RL, Prystowsky EN, Wann LS, Wyse DG, Gibbons RJ, Antman EM, Alpert JS, Faxon DP, Gregoratos G, Hiratzka LF, Jacobs AK, Russell RO, Smith SC, Alonso-Garcia A, Blomstrom-Lundqvist C, De Backer G, Flather M, Hradec J, Oto A, Parkhomenko A, Silber S, Torbicki A: ACC/AHA/ESC guidelines for the management of patients with atrial fibrillation: Executive summary. A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines and the European Society of Cardiology Committee for Practice Guidelines and Policy Conferences (Committee to Develop Guidelines for the Management of Patients With Atrial Fibrillation), developed in collaboration with the North American Society of Pacing and Electrophysiology. J Am Coll Cardiol 2001;38:1231-1266.
2. Haissaguerre M, Jais P, Shah DC, Takahashi A, Hocini M, Quiniou G, Garrigue S, Le Mouroux A, Le Metayer P, Clementy J: Spontaneous initiation of atrial fibrillation by ectopic beats originating in the pulmonary veins. N Engl J Med 1998;339:659-666.
3. Haissaguerre M, Shah DC, Jais P, Hocini M, Yamane T, Deisenhofer I, Chauvin M, Garrigue S, Clementy J: Electrophysiological breakthroughs from the left atrium to the pulmonary veins. Circulation 2000;102:2463-2465.
4. Haissaguerre M, Jais P, Shah DC, Garrigue S, Takahashi A, Lavergne T, Hocini M, Peng JT, Roudaut R, Clementy J: Electrophysiological end point for catheter ablation of atrial fibrillation initiated from multiple pulmonary venous foci. Circulation 2000;101:1409-1417.
5. Biosense Webster: Instructions for use of the Biosense Webster Lasso deflectable circular mapping catheter. Biosense Webster, Diamond Bar, CA, 5/2001:3-4.
6. Chen SA, Hsieh MH, Tai CT, Tsai CF, Prakash VS, Yu WC, Hsu TL, Ding YA, Chang MS: Initiation of atrial fibrillation by ectopic beats originating from the pulmonary veins: Electrophysiological characteristics, pharmacological responses, and effects of radiofrequency ablation. Circulation 1999;100:1879-1886.
7. Gerstenfeld EP, Guerra P, Sparks PB, Hattori K, Lesh MD: Clinical outcome after radiofrequency catheter ablation of focal atrial fibrillation triggers. J Cardiovasc Electrophysiol 2001;12:900-908.
8. Yu WC, Hsu TL, Tai CT, Tsai CF, Hsieh MH, Lin WS, Lin YK, Tsao HM, Ding YA, Chang MS, Chen SA: Acquired pulmonary vein stenosis after radiofrequency catheter ablation of paroxysmal atrial fibrillation. J Cardiovasc Electrophysiol 2001;12:887-892.
9. Conti JB, Geiser E, Curtis AB: Catheter entrapment in the mitral valve apparatus during radiofrequency ablation. PACE 1994;17:1681-1685.
10. Mandawat MK, Turitto G, El-Sherif N: Catheter entrapment in the mitral valve apparatus requiring surgical removal: An unusual complication of radiofrequency ablation. PACE 1998;21:772-773.
11. Scheinman MM: NASPE survey on catheter ablation. PACE 1995;18:1474-1478.
12. Scheinman MM, Huang S: The 1998 NASPE prospective catheter ablation registry. PACE 2000;23:1020-1028.
13. Chen SA, Chiang CE, Tai CT, Cheng CC, Chiou CW, Lee SH, Ueng KC, Wen ZC, Chang MS: Complications of diagnostic electrophysiologic studies and radiofrequency catheter ablation in patients with tachyarrhythmias: An eight-year survey of 3,966 consecutive procedures in a tertiary referral center. Am J Cardiol 1996;77:41-46.