CATHETER ABLATION

COMPLEX CASE STUDY

Subacute Development of Complete Heart Block After Radiofrequency Ablation of Persistent Atrial Fibrillation

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ABSTRACT. Perimitral reentrant flutter (PMRF) is often encountered during the radiofrequency (RF) ablation of persistent atrial fibrillation (AF) or at the time of follow-up, particularly in the setting of moderate to extensive left atrial substrate ablation. The primary target of ablation for PMRF is lateral mitral isthmus. However, some challenging cases require additional ablation at adjunctive sites such as the septal mitral isthmus, anterior left atrial wall, or intravascular coronary sinus. Anatomically, the septal mitral isthmus is located in close proximity to the left atrioventricular (AV) septum. We present a delayed case of complete AV block complicating an acutely successful RF ablation of persistent AF. This case illustrates the need for awareness of regional anatomy and the precaution that has to be taken during RF ablation near this area. It may be an under-recognized complication of the extensive atrial substrate ablation procedure.

KEYWORDS. Complete atrioventricular block, perimitral flutter, persistent atrial fibrillation, radiofrequency ablation.

Case presentation

A 60-year-old female with a history of hypertension and diabetes presented with symptomatic persistent atrial fibrillation (AF) that was refractory to treatment with dronedarone. After an extensive discussion of treatment options as well as their risks and benefits, she elected to undergo radiofrequency (RF) ablation. Dronedarone was discontinued for five half-lives prior to the procedure. In the beginning, a duodecapolar catheter was inserted into the coronary sinus (CS) with bipoles 9 and 10 situated just inside the os. Double transseptal access was obtained using the standard Brockenbrough assembly. A circular mapping catheter and a roving catheter were inserted into the left atrium. Three-dimensional electroanatomic mapping was performed with the assistance of the Nav-X mapping system (St. Jude Medical, St. Paul, MN). The four pulmonary veins (PV) were found to be moderately active electrically. Using a contiguous linear ablation line across the anterior roof and posterior left atrial wall, the four PVs and the posterior left atrial wall were electrically isolated en bloc. During the ablation, AF gradually organized into a stable flutter with proximal-to-distal CS activation sequence and tachycardia cycle length (TCL) of 213 ms (Figure 1). The entrainment pacing response from high left atrial septum and posterolateral mitral annulus demonstrated that this was a counterclockwise perimitral reentrant flutter (PMRF) (Figure 2). Linear RF ablation connecting the lateral mitral annulus to the os of the left inferior PV did not have any effect on the tachycardia. Attention was next directed to the septal isthmus, which is also a critical portion of the circuit. RF ablation at this location (up to 35 watts, 42°F) abruptly increased the TCL but did not terminate it. Subsequently, the catheter and sheath were withdrawn into the right atrium, and the roving catheter was advanced into the CS. RF ablation was begun at approximately the 4 o’clock
Figure 1: After the radiofrequency ablation of the four pulmonary veins and the posterior left atrial wall, the tachycardia organized into rapid atrial flutter with cycle length of 213 ms as shown. Note that the crista activation sequence is inconsistent with either right atrial typical or reverse-typical flutter. The duodecapolar Spiral catheter was situated just inside the os of left superior pulmonary vein, which is demonstrated to be completely isolated electrically.

Figure 2: Entrainment pacing response from high left atrial septum (Abl d) and posterolateral mitral annulus (CS 5/6) is shown. Each of the two pacing sites are marked with a red star. The two sites are nearly diametrically opposite each other on the mitral annulus. Post-pacing intervals at both sites were reproducibly within 20 ms of tachycardia cycle length. (Crista electrograms were removed to enhance the clarity of tracings.)
location on the mitral annulus (50 degrees left anterior oblique) and the catheter was slowly dragged back toward the CS os. At approximately the midway point, the tachycardia terminated into sinus rhythm and became non-inducible (Figure 3). Post procedure, the patient was uneventfully extubated and transported to the recovery room for observation overnight. Early the following morning, the patient was noted to be in complete heart block with a junctional escape rate of 30 bpm. A transvenous temporary pacing wire was urgently placed. She had not been on any atrioventricular (AV) nodal blocking drugs at any time. Native AV conduction did not return over the ensuing 72 h, and a permanent dual-chamber pacemaker was implanted.

Discussion

Zoppo et al. previously published a case report in which RF ablation at similar anatomical locations resulted in acute complete AV block requiring implantation of a permanent pacemaker. Similar to this case, the indication for RF ablation in our case was symptomatic persistent AF. However, there are two notable differences between the two cases. First, the mechanism of treated rhythm in the case published by Zoppo et al. was most likely a localized microreentry involving the left anterior septum. In our case, the RF ablation was performed to target a transitional rhythm (PMRF) that was macroreentrant in mechanism. Second, the timing of occurrence of complete AV block in our case was significantly delayed, and not observed until the following day. The anterior portion of the left atrial septum is anatomically contiguous with the septal mitral isthmus. This area is located in close proximity to the triangle of Koch (on the contralateral side of septum), which harbors critical structures such as AV node and His bundle (Figure 4). During RF ablation with sufficient power, these structures can become inadvertently damaged via heat conduction through septal myocardial tissue. The left atrial septum has been shown to be an important target of ablation in patients with not only persistent AF but also paroxysmal AF secondary to non-PV triggers. Interestingly, in our case, the development of AV block was delayed until the following day. As mentioned, this is likely explained by progressive lesion expansion and maturation within the septal tissue over the following several hours post ablation. Of note, the PR interval immediately post ablation was only 169 ms, which did not raise any concern about the possibility of impending AV block. Given the widespread acceptance of left atrial substrate ablation, we wonder whether this type of complication is more prevalent than is reported in the literature. This case clearly demonstrates the vulnerability of the AV node even from the left atrial septal side.

Figure 3: The very last recording of sinus rhythm before the patient was taken off the table. Note that the PR interval was normal at 156 ms. Bidirectional conduction block across the isthmus was difficult to confirm because of the lack of local capture even with high output pacing.
and emphasizes the care that has to be taken when RF energy is being applied to this location. It is also worthy to note that there are two potential complications associated with RF ablation within the intravascular coronary sinus. First, catheter-induced trauma could result in pericardial effusion leading to cardiac tamponade. Second, the distal left circumflex artery, which is in close proximity to the ablation site, can be subject to inadvertent heat injury resulting in acute myocardial ischemia. A thorough understanding of regional anatomy and meticulous catheter manipulation are critical in avoiding such types of complication.

In the same paper, Zoppo et al. describe electroanatomical mapping around various places around the mitral annulus with the intent of identifying the location that is anatomically closest to the AV node and thus the most likely to be injured during the ablation. While conceptually attractive, such a method may have its own limitations, including the inability to pace during atrial arrhythmia, potential difficulties in reliably identifying His signals from the left atrial septum, and the additional time burden required in performing this diagnostic maneuver. In our opinion, much in parallel to the manner that we attempt to avoid atrioesophageal fistula during the posterior left atrial wall ablation, a solid understanding of regional anatomy and exercising clinical prudence will suffice in most cases to avoid such a type of complication. Based upon our experience, we recommend that the power delivered to this area be limited to no more than 30 watts for a duration of 20–25 s per lesion. In conclusion, this case demonstrates not only the potential for complete AV block while ablating the mitral septal isthmus region, but also the temporal unpredictability of such an event, which can happen many hours after an apparently routine and successful RF ablation.

References