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EDITORIAL COMMENT

When Good Goes Bad*

Interventricular Septal Hematoma Complicating Left Bundle Branch Area Pacing

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Left bundle branch area pacing (LBBAP) has emerged in the past few years as a safe and feasible strategy to achieve conduction system pacing.[1-4] Compared with the traditional right ventricular apical pacing, LBBAP has proved to preserve better electric and mechanical synchrony, and, in selected patients with heart failure, it demonstrated favorable results as a bailout approach or as an alternative to biventricular pacing.[4] Even though His bundle pacing (HBP) represents theoretically the most physiological pacing modality, LBBAP is characterized by some advantages in comparison with HBP because of the different anatomical characteristics of the 2 pacing sites. Whereas HBP targets a small cylindrical structure of approximately 1 to 2 mm in diameter encased in the central fibrous body (His bundle), LBBAP is achieved by positioning the pacing lead deep in the interventricular septum 1 to 4 centimeters from the distal His bundle region to capture a broader area extending from the main left bundle branch to its fascicles. This translates into higher R wave amplitudes, better pacing thresholds, reduced fluoroscopy and procedural times, and improved success rates in comparison with HBP.[5] Another advantage of LBBAP over HBP is the possibility to achieve a pacing site that is distal to the pathologic region in the conduction system (eg, infra-Hisian block), as first demonstrated by Huang et al.[1]

During LBBAP implantation, lead penetration in the interventricular septum is monitored under continuous fluoroscopy, assessing unipolar paced QRS morphology, unipolar pacing impedance, myocardial current of injury, evidence of left bundle branch/fascicular potential, and occasionally performing injection of contrast material via a delivery sheath to delineate the endocardial surface and determine the penetration depth of the lead.[6] The transseptal location of the LBBAP lead sets the basis for the occurrence of new procedural complications that are specific to this technique. In this issue of *JACC: Case Reports*, Trivedi et al[7] report a case of a giant interventricular septal hematoma complicating LBBAP implantation in a patient undergoing atrioventricular node ablation and pacemaker implantation for drug-refractory atrial fibrillation. Six hours after same-day discharge, the patient presented to the emergency department because of nausea, vomiting, and dyspnea. Blood tests revealed elevated cardiac enzymes, and an urgent echocardiogram disclosed a large septal hypoechoic mass (61 mm × 40 mm) determining partial obliteration of the right ventricle without pericardial effusion, which was compatible with an interventricular septal hematoma. The patient continued to be in hemodynamically stable condition and was given conservative medical therapy that ultimately resulted in complete resolution of the hematoma, confirmed with echocardiography after 6 weeks. Of note, the lead parameters remained stable throughout the clinical course, with constant confirmation of left bundle branch area capture. The authors suspected that the cause of the hematoma was an injury to the septal perforator arteries in the proximal anterior interventricular septum, aggravated by therapeutic oral anticoagulation and antiplatelet therapy.

The complication rate of LBBAP lead implantation ranges in the literature from 1.63% to 14.1%.[8,9]

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The results of the largest registry-based observational study on LBBAP, the MELOS (Multicentre European Left Bundle Branch Area Pacing Outcomes Study) (N = 2,533, mean age 73.9 years, female 57.6%, heart failure 27.5%), reported an overall rate of acute and late complications of 11.7%. The rate of complications specifically attributed to the transseptal position of the pacing lead was 8.3%. These included intraprocedural (3.67%) and delayed (0.08%) perforation into the left ventricular cavity, acute chest pain (0.98%), acute coronary syndrome (0.43%), coronary vein fistula (0.28%), coronary artery fistula (0.08%), LBBAP lead damage/trapping (0.43%), LBBAP lead dislodgement (1.5%), and threshold rise >1 V from baseline (0.71%).[2] Perforation of the interventricular septum represents the most common complication related to LBBAP septal placement, with rates ≤14.1% of cases.[9] If perioperative septal perforation is identified, it is important to reposition the lead to avoid any potential thromboembolic sequelae.

Septal hematomas after LBBAP implantation are rare. Another case has been described by Zheng et al,[10] who reported an interventricular septal hematoma measuring 8 × 8 mm, which was managed conservatively with complete resolution at 1 month.

The etiology of interventricular septal hematoma after LBBAP lead implantation is thought to be related to the injury to a small branch of a perforating septal artery during lead penetration in the interventricular septum. When clinically significant, it is typically characterized by chest pain or dyspnea, electrocardiographic abnormalities, and troponin increase above the levels normally achieved after routine LBBAP procedures.[11] To prevent septal hematoma formation during LBBAP lead septal placement, multiple factors should be considered. First, to avoid injury to the septal perforator branches, it is preferable not to place the lead too anteriorly because of the presence of large septal branches in the anterior septum. Second, the number of attempts in lead positioning within the septum should be reduced to a minimum, because multiple attempts, manipulation within the septum, and the injection of contrast material itself may cause local tissue damage and potential injury to the septal arteries. Third, careful management of periprocedural anticoagulation and antiplatelet therapy should be considered. If a septal hematoma is clinically suspected, urgent echocardiography should be performed. Septal hematomas typically present as hypoechoic masses within the interventricular septum, which may be associated with concomitant pericardial effusion. A diagnostic work-up can be completed with computed tomography angiography or coronary angiography to better determine the hematoma dimensions and the extent of the lesion to the septal branches.

The optimal management of septal hematomas complicating LBBAP largely depends on the specific clinical scenario and needs to be decided on a case-by-case basis. Although in case of hemodynamic stability, an initial conservative approach might appear reasonable, more severe forms may require invasive management. Chen et al[12] recently reported a case of interventricular septal hematoma after LBBAP complicated by pericardial effusion, which was successfully treated with urgent coronary angiography and coil embolization of a ruptured arterial branch.

Trivedi et al[7] should be congratulated for reporting an unusual complication potentially related to the deep septal location of the LBBAP lead that could have been overlooked. Although the reported interventricular septal hematomas were generally symptomatic, we may hypothesize that the real rate of septal hematomas may be underestimated owing to the possible occurrence of subclinical septal injuries that remain undetected because of the lack of routine echocardiographic screening after implantation. Moreover, considering the potentially aggressive clinical course of septal hematomas, with the increasing adoption of LBBAP it is of utmost importance to be aware of the possible occurrence of this complication for a timely diagnosis and appropriate management. The implementation of routine echocardiography after LBBAP implantation may be useful not only to confirm the correct position of the lead in the septum but also to exclude any procedural complications. However, the clinical advantage of routine periprocedural echocardiography needs to be demonstrated with further studies.

All cases described in the literature of interventricular septal hematomas complicating LBBAP are associated with the traditional lumenless pacing lead (Medtronic 3830).[7,10,12] Nowadays, stylet-driven leads (SDLs) are almost equally being used by implanting physicians, with results comparable with those of lumenless leads.[13] Compared with lumenless leads, SDLs are characterized by a larger lead diameter, which may increase the risk of collateral damage to septal vessels.[6] Although SDLs have not been associated with an increased risk of septal perforation,[13] future studies are needed to properly address specific differences in the rate of septal complications between the 2 lead types.

Finally, whether septal scars may develop after the resolution of interventricular septal hematomas, and whether they may play a role as a substrate for the occurrence of ventricular arrhythmias, needs to be elucidated by future longer-term studies.

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