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Editorial

Importance and implications of the occurrence of AV block following radiofrequency ablation

Radiofrequency (RF) catheter ablation is now a widely used technique for treating cardiac arrhythmias—it is considered as routine first line treatment for most arrhythmias. Although its effectiveness is very high it has a low but definite risk of complications.[1 2] Complete atrioventricular (AV) block is one of the more common complications. Its importance is raised as many patients with this arrhythmia are young and, should they have AV block, they would need permanent cardiac pacing for a long expected lifetime. AV block may be caused by the delivery of RF energy in the septal region, close to the compact AV node or proximal His bundle in patients with mid or anteroseptal accessory pathways, or in patients with atrioventricular nodal reentrant tachycardia (AVNRT). Septal localisation of the accessory pathways is quite rare and the risk of AV block is balanced by the potential risk of life threatening arrhythmias that patients with Wolff-Parkinson-White syndrome may have. In contrast, it is a major risk for patients with AVNRT considering the benign nature and relatively high incidence of this arrhythmia in the general population.

Electrophysiology of AVNRT

Experimental and clinical studies have demonstrated that AVNRT is caused by a reentry circuit with two functionally and anatomically distinct pathways with different refractory periods and conduction properties. The fast pathway is located in the anterior part of the septum, near the His bundle recording site, while the slow pathway is in the posterior part of the septum near the coronary sinus os. There are three different types of AVNRT. In the typical form, affecting about 90% of patients, the reentrant circuit consists of the slow pathway in the anterograde direction and the fast pathway retrogradely (slow-fast). In the uncommon form, anterograde conduction occurs over the fast pathway and retrograde conduction over the slow pathway (fast-slow). In some cases, two distinct slow pathways may constitute the reentrant limbs of uncommon AVNRT (slow-slow). The first two types may be cured with ablation of either the fast or slow pathway, while in case of slow-slow AVNRT, ablation of the fast pathway is not effective.

Approaches for catheter ablation of AVNRT

At the end of the ’80s, the first attempts of catheter ablation were targeted to the fast pathway with a good success rate (about 90%) but with high incidence of complete AV block (mean 6.8%, range 2–23%). This is not surprising considering that the fast pathway is located very close to the compact AV node and proximal His bundle. This risk is too high considering the benign nature of the arrhythmia; therefore, at the beginning of the ’90s selective ablation of the slow pathway was proposed[3–5] as the slow pathway is more distant from the AV node.

Different approaches for slow pathway ablation were proposed: an anatomical approach[3] characterised by the delivery of serial RF applications with a stepwise movement of the catheter from the posterior zone of Koch’s triangle, near the coronary sinus os, to the midseptal and anteroseptal zone (close to the compact AV node) until the arrhythmia is no longer inducible.

Aiming to reduce the number of RF pulses and so the extent of the endocardial lesion, two other approaches were proposed. In both, endocardial potentials were used to guide application of RF energy: a “sharp” potential described by Jackman[4] and a “slow” potential described by Haissaguerre *et al* and us.[5]

The origin and significance of these two potentials have been widely debated in the recent past until McGuire and colleagues[6] demonstrated that the slow potential is caused by a band of nodal-type cells close to the coronary sinus os and the tricuspid annulus, but it is not part of the compact AV node and may be the substrate of the slow AV nodal pathway. On the other hand, the sharp potential may be caused by asynchronous activation of muscle bundles above and below the coronary sinus os.

Using the slow potential as a marker for slow pathway ablation gives a high success rate (about 99%) with a selective lesion of the slow pathway, delivers few RF pulses, and has a very low risk of complete AV block. In our experience, among 383 patients who underwent slow pathway ablation only one (0.26%) had complete AV block. The multicentre European radiofrequency survey (MERFS) registry[1] and the North American Society for Pacing and Electrophysiology (NASPE) survey,[2] reported a higher incidence of AV block (up to 2.1%) but most of the procedures collected in these studies were performed at the beginning of the experience (mainly between 1990 and 1992), before publication of the electrogram guided technique.

However, because of the benign nature of this arrhythmia it is very important to reduce the risk of AV block as much as possible both during RF delivery and during follow up.

AV block related to slow pathway ablation

AV block generally occurs during RF delivery or in the first 24 hours; however, rare cases of late AV block have been reported.[7 8] Few parameters have been proposed as predictors of this complication: the anatomic site of the ablation; occurrence of junctional rhythm either rapid or with ventriculoatrial block during RF delivery; worsening of AV anterograde conduction; and the extent of tissue damage.

The anatomic site is fundamental as it is important not to deliver RF energy close to the compact AV node or His bundle to avoid damaging them. This is generally checked, both before and during RF delivery, using fluoroscopic projection with catheters in the coronary sinus and in His bundle region as landmarks for the septal area. It has been suggested[9] that the measurement of the interval between the atrial component of the His bundle electrogram and the atrial signal of the distal mapping catheter is an expression of the distance from the compact AV node, and thus is a marker of risk for AV block.

The occurrence of junctional ectopy during RF ablation of the slow pathway is common. It has been suggested to be a response to thermal injury of the compact AV node and/or the perinodal tissue forming the input of fast and slow pathways. Its presence is a highly sensitive finding occurring in about 90% of effective sites.[7] However, the presence of faster junctional tachycardia and/or ventriculoatrial block during junctional ectopy are generally reported as markers predictive of complete permanent AV block[10 11] but they do not seem to be predictive for transient AV block.[9] This parameter seems to be relevant in predicting possible late AV block as reported by Elhag *et al*.[8]

The importance of monitoring the anterograde AV conduction (PR and/or AH interval) during RF delivery is obvious, as a progressive or abrupt lengthening of these intervals may be a sign of a more extensive endocardial damage involving the AV node or proximal His bundle.

It is very important to limit the extent of tissue damage by minimising the number of RF applications as in some cases they could progress beyond the border of the lesion causing acute and late complications. To explain the possible rare late AV block two hypotheses have been proposed. A relevant extension of fibrosis in the peripheral zone of RF lesion and/or tissue retraction during scar formation might explain the delayed AV conduction disturbances.[12] An alternative explanation is suggested by the demonstration that RF energy[13] results in a severe reduction in blood flow beyond the borders of the site of coagulation necrosis because of microvascular injury; in some cases, especially with multiple lesions, this damage may be progressive. It is remarkable, however, that late AV block is generally progressive with a good escape rhythm, and no sudden deaths have been reported.[7 8]

Clinical implications

Catheter ablation of AVNRT may be performed with either fast or slow pathway ablation; however, the latter must be preferred because of the lower risk of complete AV block, and the electrogram guided technique should be used to reduce the number of RF pulses. Careful monitoring of both anterograde and retrograde conduction during junctional rhythm may be a reliable criterion for safety; if no impairment of the conduction is present during RF delivery, generally no immediate or late permanent AV block occurs. In contrast, if even a transient impairment of AV or VA conduction occurs, careful follow up should be performed because of the risk, although rare, of late AV block.

A prospective multicentre registry is advisable to improve understanding of the criteria that can further increase the safety of the procedure both in the short and long term.

F GAITA
R RICCARDI
L CALO

*Division of Cardiology Hospital of Asti,
Via Botallo, 4 14100 Asti, Italy
email: cardclin@provincia.asti.it*

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