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Editorial

Endocavitary ablation of atrioventricular conduction

Endocavitary electrical ablation of atrioventricular conduction can be used to treat the symptoms of supraventricular tachycardia by creating complete heart block and allowing the ventricular rate to be controlled by an implanted pacemaker. Since it was first described in 1982[1] the technique has become an established alternative to surgical ablation in patients with supraventricular tachycardia that is refractory to medical treatment.[2]

Conventional method of ablation

For conventional ablation 200–300 J shocks are delivered via an endocardial wire that is positioned to record an optimal His bundle deflection. Patients selected for ablation usually have atrial flutter or fibrillation,[3] but atrioventricular nodal re-entry tachycardia and atrioventricular re-entry tachycardia through an accessory atrioventricular connection may also be treated.

The technique is largely successful, creating complete heart block in 60–80% of patients,[3] and beneficially modifying conduction in a further 10–30%. Complete failure is reported in around 10%. There are several disadvantages to conventional ablation that deserve attention: a general anaesthetic is required; a degree of uncontrolled myocardial damage is produced by the explosive discharge, as shown by the subsequent rise in cardiac enzymes[4]; there are acute and chronic complications, some of which may be severe[3 5]; a permanent pacemaker must be implanted after a successful procedure[3]; pacemaker function may be disrupted if a repeat ablation session is necessary[5]; and there is evidence of diffuse damage to left ventricular function in long term studies of exercise tolerance after ablation.[6 7]

Other ablation sites

When the same conventional technique was applied to other myocardial sites it was generally less successful and potentially more hazardous.[3 5 8 9] The success rate for the ablation of accessory pathways[10 11] was much lower than that reported for ablation of atrioventricular conduction, with the exception of Warin's group in Bordeaux whose innovative catheterisation techniques allowed them to overcome many of the deficiencies of the conventional technique.[12] Nevertheless, ablation of accessory pathways must be regarded as experimental.[13]

Ablation of ventricular tachycardia was often accompanied by complications[3 14–17] and procedure-related mortality was high. The World Registry reported that the cure rate was 18% without drugs, with a further 41% of patients responding to drugs that had been ineffective before ablation; the procedure-related mortality was 8%.[3] Some groups have claimed greater success rates,[15 18] but because of the high risk the technique must be regarded as experimental.

Direct ablation for atrial arrhythmias[19 20] has also been attempted with conventional techniques. If successful, these direct ablations would provide a complete cure without the creation of a complete heart block.

In general, the conventional method is not sufficiently safe for widespread use to be recommended for other than ablation of atrioventricular conduction. Many regard conventional ablation as a relatively safe technique in this setting, and newly developed methods of ablation are always applied initially to the atrioventricular junction because it is the safest site. So ablation of atrioventricular conduction is a clinical procedure and also a testing ground for new methods that may later be more applicable to ventricular tachycardia or accessory pathways.

Aims of ablation

Creation of complete heart block, and subsequent pacemaker dependence, is a drastic solution to supraventricular tachycardia with a rapid ventricular response. A medical treatment that created a complete block would not be used, and it is not surprising that attempts have been made recently[21–23] to modify rather than destroy atrioventricular conduction so that the ventricular rate could be controlled without the need for a pacemaker. But how long do the immediate effects of ablation last? If ablation initially increases the PR interval from 0·1 to 0·3 seconds, what will be its long term value, and indeed will there be any measurable long term effect on atrioventricular conduction? This highlights the difficulties in predicting the relation between the shock intensity and the extent of the acute lesion produced, and in predicting the eventual size of the lesion. The basic mechanisms by which lesions are created during ablation procedures, despite extensive investigation,[24 25] remain controversial. There is, however, no doubt that conventional ablation with high energy DC shocks has greater effects in the short term than in the long term.[26] The central area of damage is surrounded by considerable oedema and if the target structure is within this oedematous region, an apparently successful ablation may prove to be a failure hours or days later when the oedema resolves. In addition, other, more complex phenomena that are little understood can result in the late appearance[27] or disappearance of heart block. In our own series, one patient mysteriously resumed atrioventricular conduction after nine months in complete heart block.[28]

Problems and pitfalls

The major drawback of using high energy shocks and conventional electrodes is the highly explosive nature of the discharge.[29] A vapour globe that can be up to 4 cm in diameter is formed and can rupture the coronary sinus or damage the underlying myocardium.

To improve the safety of the procedure, several modifications have been proposed. Active fixation of

permanent pacing electrodes[30] reduced the energy required for ablation to four shocks of 50 J. More recently the energy requirements have been further reduced by use of non-arcing DC ablation, which uses a modified power source[31] and electrode[32]; the energy required for ablation with this system is around 20 J. This method was effective for ablation of the atrioventricular node[28] and also for treatment of ventricular tachycardia[33 34] and ablation of accessory pathways. Although the safety margin is improved by use of lower energy shocks, the patient still needed general anaesthetic. A multicentre international trial is underway to assess the technique for ablation of atrioventricular conduction.

The use of radiofrequency energy through standard or suction electrode catheters has also achieved much attention.[35] This variation allows most ablations to be performed without general anaesthesia, but more importantly a graduated effect may be achieved through short applications of radiofrequency energy and observation of the prolongation of the PR interval. Radiofrequency ablation has the disadvantage of being extremely focal: a thermal lesion is more localised than an electrical lesion and therefore positioning of the electrode catheter must be precise. Furthermore, if the electrode at the tip of the wire exceeds 100°C it will char the tissue and produce a thermal barrier that prevents further effective ablation. Research into the better control of tip temperature[36 37] may improve the results of radiofrequency ablation or modification, which are currently only moderately successful. However, because a general anaesthetic is not needed the technique can be repeated with less harm to the patient than other methods of ablation. In addition, doubts remain about the applicability of the technique to ablation of ventricular tachycardia because the size of the lesion that radiofrequency can produce is limited. Presentations[38–41] at the 1990 Scientific Sessions of the American College of Cardiology seemed to indicate a better success rate with the low energy DC technique than with radiofrequency ablation when the object was to produce a complete atrioventricular block.

Other techniques of interest are transcatheter lasers[42] (problems of perforation have prevented clinical application so far), thermal loop ablation (again entirely experimental), and transcoronary alcohol ablation; this latter technique uses selective coronary catheterisation and infusion of ethanol to create a limited myocardial lesion. It has previously been used as the last resort in cases of untreatable ventricular tachycardia,[43] but very recent work in the United Kingdom suggests that better control of lesion size may make the technique feasible for ablation of atrioventricular conduction.[44]

Conclusions

The mechanism responsible for the damage created during ablation procedures—whether with high energy DC, low energy DC, or radiofrequency electrical current—is not sufficiently well understood to permit the design of an optimal system. Also our understanding of the mechanics of conduction through the atrioventricular node is still sufficiently vague to hinder our attempts at its modification by endocavitary methods.

What is apparent is the need for further research into safer and more reliable methods of ablation if the technique is to make the major leap forward that coronary angioplasty has made—to be used as an alternative to drug treatment rather than as a last resort. If this goal is to be reached, we must be able to reliably modify chronic atrioventricular conduction with negligible risk to the patient and without the need to implant a permanent pacemaker and we must also be able to treat the patient with ventricular tachycardia or an accessory pathway with at least moderate success, but, above all, without risk.

The physical specifications of the lesions required for ablation or modification of different arrhythmias will vary; and so too will the optimal technique. Once this is taken into account, and the desire to prove that one system is better than all the others *in all situations* is suppressed, ablation research can begin to focus on providing clinicians with a set of tools with which they may reliably tackle a wide range of clinical tachycardias.

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