Br Heart J 1985; **53**: 240–2

Intracardiac contrast echoes during transvenous His bundle ablation

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SUMMARY Two patients undergoing endocavitary ablation for resistant supraventricular tachycardia had cross sectional echocardiography performed during the ablative procedure. In both cases immediate opacification of the right heart cavities occurred at the time of the current discharge. The contrast effect was similar to that resulting from a peripheral venous injection of dextrose or saline during echocardiography for the diagnosis of intracardiac shunts. In one patient contrast echoes were also seen in the left ventricle. This contrast effect may be produced by gaseous release or blood element destruction. The risk of embolisation in patients undergoing endocavitary ablation, particularly on the left side of the heart, should be further evaluated.

Endocavitary ablation has recently been used in the control of resistant supraventricular arrhythmias.[1] DC discharge with energies of up to 500 J are delivered to the right side of the ventricular septum via a transvenous pacing electrode. Complete heart block is thereby induced by destruction of the atrioventricular node-His bundle or tissue in the region of this structure.[1 2] This procedure has also been advocated for the ablation of local regions of left or right ventricular myocardium, identified electrophysiologically to be responsible for ventricular tachycardia.[3]

The energies produced by this current discharge result in a transient rise in temperature and pressure[4] with presumably additional electrolytic effects. One or more of these effects may be responsible for the local destruction of myocardial or conducting system tissue. The changes that these transient physical alterations induce in blood within the ventricular cavities may include gaseous release or blood element destruction. If produced by current discharge, small particles may therefore represent a potential risk for embolism to the small vessels of the pulmonary or systemic circulation.

Cross sectional echocardiography has been previously used to detect contrast echoes when small particles—in this case gas bubbles produced by systemic venous injection—follow abnormal intracardiac blood flow patterns in conditions such as atrial septal defect.[5] We report the use of cross sectional echocardiography to characterise the effect of endocavitary current discharge on the intracardiac blood pool in two patients undergoing His bundle ablation.

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Accepted for publication 31 October 1984

Patients and methods

Two patients, aged 38 years (case 1) and 43 years (case 2), underwent His bundle ablation because of symptomatic paroxysmal atrial fibrillation which had proved unresponsive to medical treatment. Neither patient had identifiable structural heart disease, and at the time of study the foramen ovale was considered closed. Under general anaesthesia and with muscle relaxation a standard temporary transvenous electrode (USCI 6F Tripolar) was introduced into the right ventricle via the femoral vein. The electrode was positioned adjacent to the His bundle so that a stable unipolar His bundle electrogram of at least 0·25 mV was recorded. A total of six DC discharges (five for case 1, one for case 2) were delivered between the intracavitary electrode and a back plate, used as the cathode. The discharge was timed to the R wave of the electrocardiogram; thus it occurred when the tricuspid valve was open. One DC discharge (case 1) was of 20 J and the remainder (for both patients) were of 320 J. In both patients permanent complete heart block was produced and the cardiac rhythm

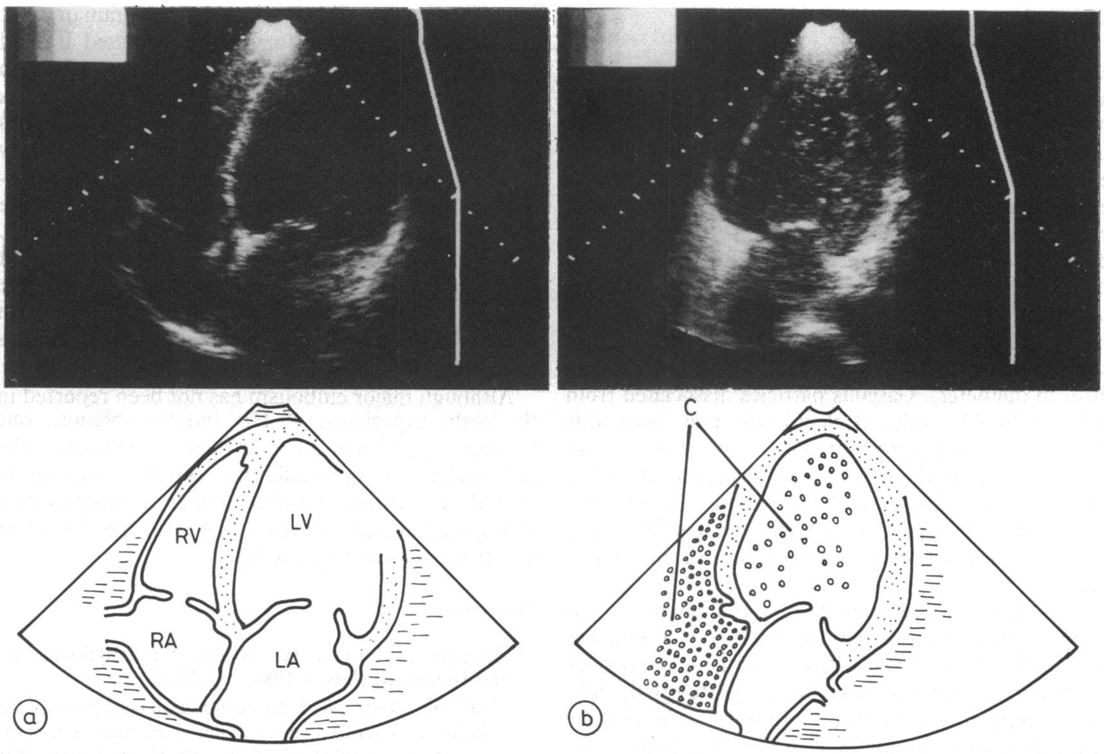

Figure *Cross sectional echocardiograms of the heart in the apical four chamber view (case 2), (a) immediately before current discharge and (b) after current discharge showing dense opacification of the right heart and to a lesser extent the left ventricle. RA, right atrium; RV, right ventricle; LA, left atrium; LV, left ventricle; C, contrast.*

immediately supported by temporary ventricular pacing and later by the insertion of a permanent pacemaker.

Cross sectional echocardiograms of the left and right heart chambers were recorded from an apical four chamber view throughout the procedure. Both the operator and system were electrically isolated from the current discharge. The presence and intensity of contrast echoes produced by DC discharge and the time course for their resolution were noted.

Results

Immediately after each DC discharge, profound opacification of the right ventricular and atrial cavities was seen (Figure). This contrast effect cleared only after several heart beats and occurred whether or not complete heart block resulted from the discharge. The intensity of this echo effect was subjectively judged as less for the one DC discharge which used 20 J.

In the patient in case 2, the DC discharge produced an additional, although less intense, contrast effect within the left ventricle. The passage of contrast echoes through a patent foramen ovale cannot be excluded on the basis of one observation; nevertheless, this appeared unlikely as the echoes appeared at the same time within the left and right ventricles during temporary atrial and ventricular asystole and were not seen within the left atrium. For the same reasons, the left ventricular echoes did not appear to have traversed the pulmonary circulation and thus presumably arose from transfer of the physical effect of the discharge across the ventricular septum adjacent to the ablated region.

During the asystolic period after the DC discharge in the patient in case 2, additional but qualitatively different contrast echoes appeared within the left ventricle. These were similar to echoes generated with current high resolution echocardiographic systems when intracardiac stasis occurs such as in the left atrium in severe mitral stenosis. A clinical evaluation of each patient after the procedure showed no evidence of pulmonary or systemic embolism.

Discussion

We noted contrast echoes within the cardiac chambers after DC discharge via a right ventricular electrode when His bundle ablation was attempted. The density of echoes produced, particularly at higher current energies, obliterated the right heart chambers for several seconds after current discharge before being cleared to the pulmonary circulation. Although echo density was greatly enhanced, the echoes appeared to be qualitatively similar to those used when performing diagnostic contrast echocardiographic studies. It is, therefore, likely that they originated from similar sized ultrasonic target particles (approximately 15–30 μ in diameter). Gaseous particles dissociated from solution by DC induced electrolysis may cause this effect, a view supported by our observations of small bubble clouds in the region of an electrode when discharged in a saline bath. Nevertheless, current discharge may also produce small solid particles as a result of destruction and aggregation of blood elements.

Although the exact nature of this phenomenon is unclear, the pronounced contrast echo effect indicates a potential risk of embolisation. No major pulmonary embolic complications have been reported with right sided ablation procedures despite considerable experience with the method. While this is no doubt due to the small size and possible gaseous nature of the particles produced, the effect and risk of embolism in small pulmonary vessels from these particles need to be determined.

Contrast echoes, whatever their nature or origin, produced in the left ventricle represent a more serious risk in that systemic embolism may occur. The long term sequelae of small particle emboli after cardiopulmonary bypass are being increasingly considered.[6] Gaseous particles produced after endocavitary ablation, and particularly in quantity if large current energies need to be used, might constitute a similar risk to the small vessel circulation of the brain or other organs. This risk may further be increased if solid aggregates contribute to the contrast effect. Although experience with left sided intracavitary ablation is less than with right sided procedures, major embolism has not been reported. Small vessel effects, however, may not be obvious on clinical grounds, and more sensitive investigations may be necessary to determine whether small vessel organ damage has occurred. Specific studies concerning the nature of contrast effect, its relation to current energies used, and the embolic potential of left sided current discharge in an animal model may answer some of the questions raised by our observations.

Although major embolism has not been reported in the early experience of His bundle ablation, our findings suggest that the risks of adverse effect on the pulmonary and especially the systemic circulation should be considered before similar techniques gain widespread acceptance, particularly in the treatment of left ventricular tachycardia.

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