about two hours after the cardiac arrest that the pulmonary obstruction was bypassed. Post-mortem examination showed a tear in the left lobe of the liver and the haemoperitoneum, but no residual pulmonary emboli.

COMMENT

Massive pulmonary embolism often defies definitive clinical diagnosis. Cross and Mowlem (1967) reported a mortality of 100% in nine cases of erroneous diagnoses and attempted pulmonary embolectomies. Similar incidences were mentioned by Berger *et al.* (1968) and by Diacoff *et al.* (1968). The high mortality rate in pulmonary embolectomy has in part been related to errors in diagnosis, which can of course be prevented by the routine use of preoperative pulmonary angiography. Diacoff *et al.* (1968) reported on a few patients who underwent pulmonary angiography immediately after resuscitation from cardiac arrest; none died as a result of this procedure, and in some who subsequently died necropsy did not show any

evidence to suggest a deleterious effect from angiography in ill patients.

Pulmonary angiography is a safe and sure means of diagnosing a massive embolism. The above case, so far the first of its kind in the literature, shows that a diagnostic selective pulmonary angiogram of good quality can be obtained even when external cardiac compression is needed to support the circulation.

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Long-term Electrode Catheter Pacing from Coronary Sinus

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Electrode catheter pacing from the coronary sinus is usually characterized by a rapid rise in threshold and early pacing failure (Siddons and Sowton, 1967). We report the case of a patient who was inadvertently, but successfully, paced from the coronary sinus for 16 months.

CASE REPORT

A 75-year-old woman was referred to the Royal Melbourne Hospital in July 1966 with a two-month history of recurrent chest pain. She had been found to have complete heart block and was being treated with ephedrine, but on the day of admission she had three Stokes-Adams attacks. On her admission the heart rate was 52 a minute, and an electrocardiogram showed complete heart block with multifocal ventricular extrasystoles. Serum enzyme studies confirmed recent infarction. An Elema EMT588 unipolar pacemaker catheter was passed to what was considered to be the apex of the right ventricle from the long saphenous vein in the groin and was connected to a fixed-rate external pacemaker unit, the indifferent electrode having been implanted in the abdominal wall. The patient returned to sinus rhythm with only intermittent paced beats, but when pacing was discontinued three weeks later the rate fell to 54 a minute with a 2 to 1 atrioventricular block, and so a permanent pacemaker generator (Devices) was implanted in the upper abdomen. Postoperatively a wound infection necessitated repositioning of the pacemaker unit, but regular pacing continued and the electrocardiogram showed a right bundle-branch block type of pattern (Fig. 1). In September 1967 the patient was admitted to hospital with a cerebrovascular accident characterized by deterioration in conscious state over two days, and hemiplegia, following which she recovered enough to be able to lead a wheel-chair existence.

The pacemaker generator was tested every three months (Knuckey *et al.*, 1965) for a total of 16 months. The pacemaker readings remained unchanged until February 1968, when it was noted that the rate had risen from 74 to 79 beats a minute and the pulse width had decreased by 14%, from 0.91 to 0.78 millisecond. The unit, however, continued to pace well with a one-to-one response. In accordance with our previous experience with Devices pacemakers, it was decided to replace the unit electively, but the patient was

found dead in her bed at home before this could be carried out. Permission for only a limited necropsy was obtained.

The catheter in the groin, which ran subcutaneously to the abdominal unit, was in a satisfactory condition, as was the indifferent electrode. The heart weighed 480 g. and the left ventricular myocardium was 1.5 cm. in thickness. The coronary vessels showed moderate atherosclerosis, but there was no actual obstruction. There was patchy fibrosis in the myocardium of the posterior part of the left ventricle. The pacemaker catheter was traced up the inferior vena

FIG. 1.—Electrocardiogram showing paced beats with a right bundle-branch block type of pattern.

FIG. 2.—Inner aspect of right atrium with atrial septum in upper left field. The catheter loops back into right atrium and passes into coronary sinus.

FIG. 3.—Posteroanterior (A) and left lateral (B) chest x-ray films showing catheter tip (arrowed).

cava to the right atrium. It passed into the right ventricle, and, forming a loop, returned to the right atrium and passed into the coronary sinus (Fig. 2). The tip of the catheter lay impacted in a large tributary of the coronary sinus on the back of the left ventricle, and could be easily seen and felt on the external surface of the heart. There was a layer of fibrin over the intracardiac portion of the catheter, and the loop was firmly bound down to the apex of the posterior papillary muscle of the right ventricle and closely resembled the chordae tendineae. There was no thrombus in the right atrium, right ventricle, or coronary sinus, but the catheter had been covered with endothelium as it lay in the sinus. The lungs were clear macroscopically, but the brain was not obtained for examination.

A posteroanterior chest x-ray film had been taken after the initial positioning of the catheter (Fig. 3A) and the catheter tip appeared to be in an adequate position. Another posteroanterior film and also a lateral film were taken in November 1966 (Fig. 3B), but the lateral film was not reviewed until after the patient's death. From the x-ray picture it was clear that the pacemaker tip had been in the coronary sinus at least since November 1966, which was 16 months before the patient's death.

After removal from the body the pacemaker unit was tested electronically. The rate was still 79 a minute, pulse width was 0.8 millisecond, but the output voltage across 330-ohm resistance

was 3.8 volts, having been 5.4 volts before implantation. Recurrent erratic pacemaker discharges were also present, with energy levels of less than one microjoule compared with the normal output pulse energy of about 40 microjoules. Such an energy level would be unlikely to induce ventricular fibrillation.

COMMENT

Electrode stimulation in the coronary sinus usually leads to cessation of pacing in one to seven days (Siddons and Sowton, 1967). This may be because of instability of the catheter tip if it lies free in the coronary sinus and becomes covered with fibrin and blood clot. In our case the catheter tip was impacted into a tributary of the coronary sinus and thus no blood clot formed around it. Malposition of the catheter in the coronary sinus may be prevented by passing the catheter into the pulmonary artery and withdrawing it until the tip drops into the apex of the right ventricle, and this will usually provide a stable position. However, this must be carefully checked after a satisfactory threshold for pacing has been obtained. It is not possible to distinguish between a catheter in the apex of the right ventricle and a catheter in the coronary sinus by a posteroanterior chest x-ray film, and therefore the patient should always be screened in a lateral projection to confirm the anterior position of the catheter after its insertion.

Electrode pacing in the right ventricle usually causes a left bundle-branch block pattern on the electrocardiograph; while pacing from the left ventricular surface, owing to the catheter in the coronary sinus, results in a right bundle-branch block pattern (Siddons and Sowton, 1967). It is interesting to note that our patient showed this right bundle-branch block type of pattern. Reverse splitting of the second heart sound normally occurs with right endocardial ventricular pacing; however, no abnormality was noted on the auscultation in our patient, which may have suggested that pacing was not occurring from the right ventricle.

This case emphasizes the need for careful positioning of the pacemaker catheter and confirmation of its position by screening and an electrocardiogram. It also shows that long-term successful pacing from the coronary sinus may occur.

Mr. David Smith and Miss Michele Clifford performed the electronic testing of the generator unit.

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