A CASE OF CARDIAC ARREST VAGAL INHIBITION RELIEVED BY PROCAINE

BY

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Cardiac arrest occurs about twice a year in a busy surgical unit (Hamilton Bailey, 1941; Lahey and Ruzicka, 1950); it may arise quite unexpectedly in any operation or with any form of anaesthetic, and when it occurs very rapid measures must be taken if the patient is to survive. Anoxia lasting for more than $3\frac{1}{2}$ minutes may lead to irreparable cerebral damage, and survival is unlikely if the circulation has been arrested for more than $8\frac{1}{2}$ minutes (Weinberger, Gibbon, and Gibbon, 1940).

No apology is therefore necessary in reporting a single case, and that ultimately unsuccessful, if the experience thereby obtained will contribute to success in the future.

Case Report

A man aged 48 was admitted on June 12, 1950, on account of a retrosternal goitre causing dysphagia, voice changes, and thyrotoxicosis of eight weeks' duration. He was a nervous patient with exophthalmos and a tachycardia of 140 a minute. His blood pressure was 170/70 mm. Hg; B.M.R. +37%; serum cholesterol 220 mg. per 100 ml. An electrocardiogram showed sinus tachycardia only. There was no evidence of cardiac failure.

After two weeks' rest and sedation a course of Lugol's iodine was given in preparation for operation. On July 20 his pulse rate had steadied to 96 a minute and he was considered fit for operation.

Next day potassium bromide and chloral, 30 gr. (2 g.) each, and hyoscine, 1/150 gr. (0.43 mg.), were given at 7 a.m., followed by Lugol's iodine, 30 min. (1.8 ml.) by mouth. At 8.30 a.m. induction was begun smoothly, using gas and oxygen, supplemented by isopropyl chloride, and an endotracheal tube was passed without difficulty. At 8.40 a.m. he was brought into the theatre and lifted on to the operating table: he immediately gave a slight cough and raised his arms, and was then seen to change colour to a grey lividity. His pulse could not be detected.

His head was lowered, and controlled respiration with pure oxygen was begun. An intracardiac injection of 0.5 ml. of 1/1,000 adrenaline was given without effect, and an upper midline abdominal incision was made and infradiaphragmatic cardiac massage started by 8.48 a.m. Control of the heart was unsatisfactory and an antero-posterior incision was made through the diaphragm and three fingers were passed into the pericardial cavity.

The left ventricle was felt to be dilated, flaccid, and inert; on the other hand, rhythmic rippling movements of the left auricle could be felt at about 160 a minute. Rhythmic compression of the ventricles at 60 to 80 beats a minute, allowing refilling between strokes, was maintained against the sternum without effect. Meanwhile occasional shallow jerky respirations continued; the pupils remained moderately dilated. Controlled respiration with pure oxygen continued.

At 9.10 a.m. another 1 ml. of adrenaline was injected into the cavity of the right ventricle; within two minutes the ventricle was felt to pass into a state of systole and a few rippling twitches followed. At 9.20 a.m. 3 ml. of 2% procaine was injected into the cavity of the ventricle: after a delay of about five minutes strong rhythmic contractions quite suddenly returned at about 100 a minute; these began to weaken after a few minutes, but improved with further massage; intermittent irregularity and weakening occurred. At 10 a.m. a further injection of 6 ml. of 2% procaine was given. By 10.10 a.m. normal rhythm was restored (see accompanying electrocardiogram). The abdomen was later closed. Respirations returned,

but were of a rapid, gasping type, and the lividity persisted. Despite treatment in an oxygen tent, the pulse weakened gradually, and he died at 2.10 p.m. without regaining consciousness.

Necropsy showed gross congestion of the upper part of the body, including the brain. The thyroid gland was much enlarged, weighing 4 oz. (113 g.), and completely encircled the trachea and oesophagus. The heart was enlarged, the muscle fibrous and not of good quality; the only evidence of trauma was a small nick in the postero-inferior surface which had injured the descending branch of the right coronary vessel. About a pint (570 ml.) of blood had escaped into the left pleural sac, which had been opened.

Electrocardiogram taken at 11.10 a.m., showing return to normal rhythm with marked variations in voltage.

Comment

The cardiac arrest was at the time attributed to failure of a thyrotoxic heart under the added strain of an anaesthetic, but the subsequent sudden restoration of normal rhythm following on the injection of procaine, when prolonged massage and two injections of adrenaline had completely failed, suggests that the immediate cause of the arrest was intense vagal inhibition. According to Fulton (1949), vagal stimulation weakens the force of the heart beat and depresses conduction within the heart, chiefly within the auricles and the A-V node, where it may produce all grades of A-V delay and dissociation. Vagal reflexes may be initiated from nerve endings in the aortic arch and carotid sinus, and also from any part of the respiratory tract from the nose to the trachea. Reid and Brace (1940) have demonstrated electrocardiographically that the insertion of an endotracheal tube under light anaesthesia may produce cardiac irregularities such as extrasystoles, delayed conduction time, and bradycardia, and that this vagal reflex can largely be abolished by atropine.

This case is in many respects similar to that reported by Adams and Hand (1942) in which a patient undergoing lobectomy for bronchiectasis gave three sharp coughs when endotracheal suction was applied: cardiac arrest occurred, and the circulation was kept going manually for 20 minutes. Adrenaline failed to produce any effect, but procaine was given intramuscularly at 15 minutes, and the heart restarted five minutes later, with complete recovery. Success in this case was probably due to the fact that as the thorax was open immediate compression of the heart was carried out and actual arrest of the circulation did not occur. Howkins *et al.* (1946), however, report a case in which the circulation was not established for 11 minutes and extensive cerebral changes were found after death on the twenty-sixth day. Recovery following 25 minutes' arrest relieved by intravenous procaine also occurred in a case quoted by Burstein (1949).

Although it has been customary to give adrenaline on these occasions, its value in complete arrest is doubtful, as there is no evidence that it restarts the heart and it may produce ventricular fibrillation. Lahey and Ruzicka (1950) recommend that a stock dose containing 9.5 ml. of 1% procaine with 0.5 ml. of 1/1,000 adrenaline should be kept

ready in the operating theatre. The present case has shown, however, that, despite its dramatic effect, procaine may have no action for about five minutes, during which time severe damage to the brain will occur. Time should therefore not be wasted in awaiting the result of the procaine injection, and cardiac massage should be started at once. Our experience with the above case showed the difficulty of compressing the heart satisfactorily from below the diaphragm, as mentioned by Nicholson (1942), and that the trans-diaphragmatic incision carries a risk of injury to the heart. Unless the abdomen be already open, Lahey and Ruzicka recommend a direct transthoracic approach through the fourth interspace, dividing the fourth and fifth costal cartilages. Lahey and Eversole (1950) suggest that a disconnected needle be passed through the fourth interspace into the ventricle as soon as the pulse becomes imperceptible; if no movement be observable, or begins after the needle prick, the case is one of true cardiac arrest and not momentary inhibition as may occur following accidental pressure on the carotid sinus; the procaine-adrenaline mixture is then injected in two instalments of 5 ml. each, and if there is no response within 30 seconds cardiac massage should be started at once. Lahey and Ruzicka report 46% of complete recoveries in 15 cases; Hamilton Bailey had only four survivors of 40 cases, though the heart restarted in 13; and Barber and Madden (1945) reported 48 recoveries in 143 cases

Summary

A case of cardiac arrest is reported in which complete asystole persisted for 45 minutes despite cardiac massage and adrenaline, but normal rhythm was restored after two intracardiac injections of procaine, though the patient survived for only four hours. The immediate use of procaine, injected into the heart in preference to or with adrenaline, is suggested, but in view of its delayed action cardiac massage should be performed at once so that there is no interruption of the cerebral circulation.

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A conference was held on July 14 at Salford, Lancashire, under the auspices of the public health department, to consider the better co-ordination of home and hospital services in the sphere of mental health. The conference was attended by local medical and nursing staff, social workers, and local government councillors. The Mayor of Salford, Alderman Frank Cowin, was in the chair. Dr. J. Bierer (Institute of Social Psychiatry, London) described his experience of day hospitals and therapeutic social clubs in the home management of psychotic patients. He had found day hospitals valuable for those who had spent many years in mental hospitals but were now at home, for patients who had undergone prefrontal leucotomy, for those discharged from hospital for after-treatment or unimproved, and at times to help delinquents in their return to society. A number of other speakers contributed to the conference.

Medical Memoranda

Acute Myocardial Infarction following Tetraethylammonium Chloride Therapy

Since Acheson and Moe (1945) drew attention to the autonomic ganglion blocking effect of the tetraethylammonium ion, preparations of this drug have been increasingly used in the investigation and treatment of hypertension and peripheral vascular disease. Lyons *et al.* (1947) confirm the usefulness of the drug in this respect and also record two cases in which intravenous administration dramatically relieved the pain of acute myocardial infarction. Lindgren and Frisk (1948) treated three cases of angina pectoris with tetraethylammonium bromide: this was followed by severe anginal attacks in two cases and by acute myocardial infarction in one. They conclude that the drug should be used with caution in angina pectoris and hypertension with marked arteriosclerosis. Below are reported three cases of occlusive arteriosclerosis of the lower limbs in which tetraethylammonium therapy was followed by acute myocardial infarction.

CASE REPORTS

Case 1.—A man aged 41 was admitted to hospital on October 24, 1948, with a complaint of pain in both calves which came on after walking 50–100 yards (46–92 metres) and which disappeared on rest. He had also suffered from coldness of the feet for some years. No dyspnoea was present, nor did he complain of chest pain. His pulse was 70 a minute and regular, and the vessel wall was not palpable. The heart sounds were good, with no murmurs and a normal x-ray shadow. His blood pressure was 125/85 mm. Hg. Urinary investigation was negative. Both feet were cold and slightly congested, and ankle pulses were absent. His right great toe became increasingly discoloured. Right lumbar ganglionectomy was carried out on March 1, 1949, but no improvement followed. On March 30 the right lower limb was amputated because of spreading gangrene. Tetraethylammonium chloride, 6 ml. (7.5 mg. per kg.) twice daily by intramuscular injection, was started on July 14 and continued for five days. On July 30 6 ml. daily was given. On August 2 he had a sudden attack of pain in the neck and shoulders spreading to the chest, with dyspnoea. An electrocardiogram showed changes compatible with posterior myocardial infarction. X-ray examination revealed consolidation of the bases of both lungs. His blood pressure was 120/70 mm. Hg.

Case 2.—A man aged 71 complained in June, 1949, of pain in his calves after walking 60–70 yards (55–64 metres), with occasional slight breathlessness on exertion and mild precordial pain. These symptoms occurred only on exercise and were relieved by rest. His pulse was 80 a minute and regular; the vessel wall was just palpable. The heart sounds were poor, without murmurs, and his blood pressure was 170/110 mm. Hg. Tetraethylammonium chloride, 2 ml. (3 mg. per kg.), was administered intravenously followed by 5 ml. (7.5 mg. per kg.) by the same route seven days later. Five days after the latter dose the patient suffered a severe attack of dyspnoea, precordial pain radiating to the finger-tips, and he was very restless. During the following two days signs of pericarditis developed and he died on the sixth day from congestive cardiac failure. (As this patient was treated at home no electrocardiographic confirmation exists, but the clinical picture was typical.)

Case 3.—A man aged 49 was admitted to hospital on June 14, 1949, with a complaint of pain in the calves after walking 50 yards (46 metres). This pain disappeared with rest. His feet were cold and congested, and the ankle pulses were absent.