Fuchsinophilic degeneration of myocardium in patients with intracranial lesions*

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Fuchsinophilic myocardial degeneration is described in 12 per cent of 169 patients dying of strokes, head injuries, brain tumours, and intracranial infection. This may have resulted from excessive secretion of catecholamines, after sympathetic stimulation, and three possible methods of preventing such damage are suggested. There is no evidence from a study of the incidence of subendocardial haemorrhage, peptic lesions, and pulmonary oedema that increased activity of the autonomic nervous system caused the heart damage. The significance of this lesion, and of focal myocytolysis, to the recipient of a heart transplant is discussed.

In a previous paper (Connor, 1968), focal myocytolysis was described in the hearts of patients dying of various intracranial lesions. In the present report a less severe form of myocardial damage is described in patients dying of the same types of brain damage.

Materials and Methods

From July 1964 until October 1965, 169 necropsies were performed in the West of Scotland Neurosurgical Unit. The four main causes of death were intracranial haemorrhage (35%), intracranial tumours (25%), head injuries (20%), and intracranial infection (15%). The hearts of these patients were examined for myocardial damage.

Blocks of ventricular myocardium were fixed in neutral formal saline (10%) and double-embedded by the method of Russell (1956).

Sections were stained with haemalum and eosin and with cresyl violet and acid fuchsin (Bajusz, 1963). From the 21 cases included in this series 138 blocks of myocardium were examined.

Results

Of the 169 hearts examined, 21 (12%) showed fuchsinophilic degeneration (Fig. 1 and 2), but hearts which showed only the earliest sign of damage, i.e. red staining of the transverse striations, are not included in the present series. Only those hearts showing more extensive change have been graded as positive. The criterion for including cases was the presence of alterations in staining characteristics as severe as those in rapid death from myocardial

ischaemia (Fig. 3). The sections stained with haemalum and eosin showed only eosinophilia.

The main features of each case are seen in the Table. Of the 21 patients, 13 died of intracranial haemorrhage or infarction, 3 of tumour, 2 of head injury, 1 of encephalitis, 1 of pulmonary embolism following a thalamotomy, and the other of obstructive hydrocephalus.

FIG. 1 Case 2. Section of heart muscle from a woman of 48 years who died with a ruptured cerebral aneurysm. Note the transverse bands of coagulated sarcoplasm and the denser areas of fuchsinophilia. (Cresyl violet-acid fuchsin. $\times 250$. Green filter.)

Received 7 July 1969.

* This forms part of the work submitted for a M.D. thesis of the University of London.

Seven of the cases were in the second or third decade; 14 were aged 40 years or over. There were 10 men and 11 women, and only 3 had evidence of coronary stenosis.

Of the 19 patients aged 16 years or over, 14 had pulmonary oedema with combined lung weights of more than 900 g. Six patients had subendocardial haemorrhages and 12 had acute peptic lesions of the oesophagus, stomach, or duodenum.

The average length of survival (2.8 days) after the terminal ictus was shorter than in patients showing focal myocytolysis (6 days). This interval could only be calculated for 19 patients. Only 2 patients had no evidence of raised intracranial pressure or a shift of the midline structures at necropsy. One of these had a lesion made in the thalamus and this may have stimulated the hypothalamus. The other had an intracerebral haemorrhage and the intracranial pressure must have been raised earlier.

Ten of the adults had hearts which weighed more than 350 g. and 9 hearts weighed less than 350 g.

Discussion

Thirteen of these patients died of intracranial haemorrhage or infarction. Since such patients

FIG. 2 Case 20. This section is from the heart of a woman of 45 years who also died with a ruptured cerebral aneurysm. The damaged, fuchsinophilic fibres are clearly seen. (Cresyl violet-acid fuchsin. $\times 400$. Green filter.)

TABLE Details of cases

Case No.	Sex	Age (yr.)	Length of survival after terminal ictus (dy.)	Coronary stenosis	Combined lung weight (g.)	Raised intracranial pressure	Subendocardial haemorrhage	Erosion or ulceration of oesophagus, stomach, or duodenum	Heart weight (g.)	Cause of death
1	M	60	3	—	900	+	+	+	390	Ruptured cerebral aneurysm
2	F	48	2	+	840	+	—	+	500	Ruptured cerebral aneurysm
3	M	57	10	—	1000	+	—	—	350	Cerebral tumour
4	F	23	$\frac{1}{2}$	—	950	+	—	+	220	Ruptured cerebral aneurysm
5	F	69	?	—	1230	—	—	—	330	Intracerebral haemorrhage
6	M	45	2	+	1350	+	—	+	420	Cerebral infarction
7	M	49	1	—	990	+	+	+	420	Intracerebral haemorrhage
8	M	54	19	—	1380	+	—	—	360	Secondary carcinoma
9	M	57	2	—	1300	+	+	+	440	Schwannoma
10	M	14	$\frac{1}{2}$	—	oed.	+	—	?	?	AV malformation
11	F	57	6	—	1680	+	—	+	340	Ruptured cerebral aneurysm
12	F	52	4	—	1310	+	—	—	380	Ruptured cerebral aneurysm
13	M	19	2	—	1050	+	—	—	290	Head injury
14	F	22	?	—	1210	+	—	+	280	Encephalitis
15	F	44	$\frac{1}{2}$	—	810	+	+	+	320	Ruptured cerebral aneurysm
16	F	75	1	—	950	+	+	—	330	Head injury
17	M	27	4	—	750	+	+	+	320	Brain-stem haemorrhage
18	F	15	5	—	460	+	—	—	180	Obstructive hydrocephalus
19	M	21	3	—	2250	+	—	—	400	Intracerebral haemorrhage
20	F	45	1	—	680	+	—	+	370	Ruptured cerebral aneurysm
21	F	66	6	+	740	—	—	+	270	Pulmonary embolus after thalamotomy

FIG. 3 This section is from the heart of a man of 50 years who died of myocardial ischaemia. Transverse bands of coagulated sarcoplasm are seen. (Cresyl violet-acid fuchsin. $\times 200$. Green filter.)

tend to have hearts which are overweight (Brewer, Fawcett, and Horsfield, 1968), they are probably more liable than others to suffer heart damage. But only 7 of the present series who died of a cerebrovascular accident had hearts weighing more than 350 g. Furthermore, only 3 had a significant degree of coronary stenosis, and 7 of the patients were less than 30 years old. It is unlikely that coronary artery disease or hypertension play a major part in the causation of this type of heart damage. The sudden increase in intracranial tension caused by the vascular accident possibly results in stimulation of the autonomic nervous system with a rise in the level of circulating catecholamines. Such an increase could cause myocardial damage in some subjects (Szakács and Cannon, 1958). It is known that the sudden injection of small quantities of air into the lateral cerebral ventricles of rabbits will cause heart lesions (Shkhvatsabaia, 1961).

The presence of pulmonary oedema in 14 of the 19 adults (73%) is of no significance, as in a control series of 100 neurosurgical necropsies, 81 per cent had lung weights of over 900 g. While there is no evidence that the oedema is due to left ventricular failure, it is possible that more cases have heart damage than are included in this series. Certainly, many cases with fuchsinophilia have been excluded because the changes were not considered to be significant, though they were more conspicuous than is seen in hearts from patients with no suspicion of myocardial damage.

Six patients (28%) had subendocardial haemorrhages.

These are evidence of excessive autonomic activity, either vagal (Manning, Hall, and Banting, 1937), or sympathetic (Klouda and Brynjolfsson, 1969). Again the figure is not significant, because 26 per cent of a control series of neurosurgical necropsies also showed this lesion. Similarly, 12 (57%) patients had erosion or ulceration of the oesophagus, stomach, or duodenum, which has to be compared with 49 per cent of the control series. There is no evidence of a greater increase of autonomic activity in the patients with heart damage than in the control series.

The length of survival after the terminal ictus is shorter than in the series showing myocytolysis (Connor, 1968). This period of time has been calculated from a study of the clinical notes. If a patient died without regaining consciousness after a cerebrovascular accident, the time was measured from the onset; if, however, he regained consciousness and had a second haemorrhage, or had an aneurysm clipped, and died without regaining consciousness, the second event was taken as the terminal one. The average survival period for this series was 2.8 days compared with 6 days in the cases with myocytolysis. This suggests that the changes of focal myocytolysis need time to develop, as do the changes of myocardial infarction (Mallory, White, and Salcedo-Salgar, 1939). The damage to the hearts included in this series is of such a degree that it is probably not reversible, though there is no reason to suppose that it need have been fatal.

The prevention of such damage is a matter of clinical trial. There is a possibility that reserpine will be successful in man, as it has been in animals (Eichbaum and Bissetti, 1966). This drug certainly causes a lowering of the blood pressure in patients who have had strokes (Leonberg, Green, and Elliott, 1964). These patients appear to be more sensitive to the drug than ordinary hypertensive patients, suggesting that the hypertension in some may be due to an excess of catecholamines. Dibenamine is another drug which has prevented cardiac lesions due to catecholamines in animals (Méhes, Papp, and Rajkovits, 1967), and may succeed in man. 'Chemical denervation' of the heart with atropine and propranolol (Valero, 1968) is another possible means of preventing such damage.

It is important to prevent this heart damage occurring as it may cause the sudden unexpected death of the patient, as in Case 9. It may also cause circulatory failure and cerebral hypoxia and lead to worsening of the existing brain damage.

The heart lesions which are secondary to

brain damage may also be of importance in heart transplants. Focal myocytolysis (Connor, 1968) and the lesions shown in Fig. 1 and 2 are obviously not reversible, but should heal with fine fibrous tissue replacement if not too extensive.

Lesser degrees of damage will probably revert to normal when the noxious agent is removed.

Two patients in the present series and one in the previous series (Connor, 1968) died of head injuries, but 18 altogether died with ruptured aneurysms or a vascular malformation. It is suggested, therefore, that donor hearts should come preferably from patients dying of head injuries until such time as a means is found of preventing this myocardial damage.

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