THE BLOOD PRESSURE DURING CARDIAC MASSAGE IN MAN

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Cardiac massage, by which is meant rhythmic manual compression of the heart, is an accepted part of the treatment of cardiac arrest and ventricular fibrillation occurring during anaesthesia or surgical operations. This measure has been justified by the reports of resumption of the heart beat, and less frequently survival, following its use, when the dysrhythmia has been prolonged. The explanation usually given of its beneficial effect is that the heart may respond to the local mechanical stimulus and also that the procedure is a means of maintaining the circulation.

In experiments on dogs cardiac compression between the fingers and thumb has maintained a cardiac output of approximately half that resulting from spontaneous activity under the conditions of the experiment (Johnson and Kirby, 1950). McMillan *et al.* (1952) have observed in dogs during cardiac massage a blood pressure of 40 mm. Hg. However, there are no reports of direct measurements on the circulation in man during cardiac massage, and there is consequent uncertainty of its effectiveness. The observations recorded here offer some information on this point.

We have been recording the intra-arterial blood pressure during certain surgical operations by means of an electrical condenser manometer and a thin plastic catheter introduced into a suitable peripheral artery (Peterson *et al.*, 1949). On two occasions while we have thus been recording the systemic blood pressure cardiac arrest has occurred and we have been able to record the effect of manual cardiac compression on the peripheral circulation. Both patients had severe heart disease (rheumatic aortic incompetence) with gross cardiac enlargement, and both were undergoing thoracotomy.

Case Reports

Case 1.—A man aged 50 had a blood pressure before operation of 220/110. It fell sharply during the induction of anaesthesia, and by the time the skin incision for a right thoracotomy was completed the systolic pressure was 100 mm. Hg. As the muscles of the chest wall were being incised the heart stopped. The chest was rapidly opened through the third intercostal space with division of the third costal cartilage, and 10 ml. of 1/10,000 solution of adrenaline was injected into the heart. Cardiac massage was begun with the pericardium intact. During this procedure the pulsations shown in Fig. 1, A and B, were recorded from the brachial artery. This pulsation coincided with the compression of the heart and ceased when it was interrupted. During one such interruption the record shown in Fig. 1, C, was obtained. The heart at this time was thought to exhibit ventricular fibrillation. The records are admittedly over-damped, but they show a sustained pulse wave of 55/20 mm. Hg at a rate of approximately 50 a minute.

Case 2.—A man aged 48 had a blood pressure of 140/35, measured by sphygmomanometer, before operation. The intra-arterial pressure just before the skin was incised was 120/40 (Fig. 2, A). During a long and difficult operation the pressure fell gradually to 75/25 (Fig. 2, B). Then in the course of a few minutes the blood pressure fell steadily to an insignificant level and the heart action became very weak. Cardiac massage with two hands encircling the very large heart was begun immediately, and produced a palpable pulse in the temporal arteries. Fig. 2, C, shows the brachial artery pulsations just before and at the beginning of cardiac massage. Fig. 2, D, is a tracing made at the same paper speed as Fig. 2, A and B, and shows the shape of the pulsation produced by cardiac massage. The peripheral blood pressure resulting from cardiac massage was about 70/30, with a maximum of 75/30, at a rate of approximately 50 beats a minute.

FIG. 1.—Case 1. Intra-arterial pressure records obtained during a period of cardiac arrest. (A) The record obtained when cardiac massage was started; (B) during cardiac massage. (C) Record obtained when cardiac massage was temporarily interrupted and there was thought to be ventricular fibrillation.

FIG. 2.—Case 2. (A) Intra-arterial pressure record obtained just before starting the operation. (B) Record obtained during course of operation before onset of cardiac arrest. (C) Record obtained during period of cardiac arrest just before and during beginning of cardiac massage. (Note slower paper speed.) (D) Record during cardiac massage showing slow-rising plateau form of pulse wave.

Discussion

Maintenance of the circulation during cardiac arrest (together with adequate administration of oxygen) is important for two reasons. A heart which is anoxic is unlikely to resume its normal rhythm and the dysrhythmia itself is often the result of anoxia. Anoxia from cessation of the circulation of more than three minutes' duration may be followed by irreversible damage to the central nervous system. Thus the question whether cardiac massage has a beneficial effect because it provides a local mechanical stimulus to the heart or because it is a means of maintaining the circulation is not an academic one. If it can be shown that it serves the latter purpose then its importance in this respect far outweighs the former, and the operator must not be content with merely gaining a limited access by which to apply some mechanical stimulus to the heart. His exposure must enable him to achieve as efficient a pumping action as possible.

Our tracings offer evidence that cardiac massage in man is an effective means of maintaining some peripheral circulation. In one case the peripheral blood pressure during this manoeuvre was 75/30 and in the other it was 55/20 even with the pericardium closed. The blood pressure depends not only on the cardiac output but also on the peripheral resistance, so that the recording of such pressures does not provide an exact indication of the amount of the circulation. It is possible that over a short period of time intense peripheral vasoconstriction could result in such pressures being achieved with only a small cardiac output. But this consideration does not detract from the possible value of the procedure, for it is generally believed that such vasoconstriction does not involve the cerebral and coronary circulation, and is in fact a means of achieving a favourable distribution of blood to these organs. Thus it is reasonable to suppose that the recording of such pressures offers evidence that the flow of blood to the brain and heart achieved by cardiac massage is of considerable value. Reports of recovery without serious cerebral damage, following cardiac massage for several minutes (for example, Coyne, 1952; Touroff and Adelman, 1949), also support this supposition.

The shape and amplitude of the peripheral pulse depend on the volume, rapidity, and duration of cardiac ejection and the elasticity and state of contraction of the peripheral vessels. In both cases we recorded a slow rising and sustained pulse; this characteristic may be connected with the difficulty reported by others in detecting the pulse by palpation or auscultation and measuring the blood pressure by means of a sphygmomanometer (McMillan and Cockett, 1952).

Summary and Conclusions

In two cases a record of the peripheral pulse has been obtained by means of an intra-arterial catheter and an electronic manometer during the performance of cardiac massage. The records obtained offer evidence that cardiac massage is capable of maintaining some circulation. It follows that for cardiac massage to be properly performed the surgical approach must enable the heart to be firmly grasped.

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DRUG RESISTANCE IN MALARIA

BY

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The resistance of many cases of malaria to drug treatment has long been a matter of concern to those who have to treat this disease, and so far no satisfactory solution has been found. The evidence submitted here suggests that infestation with hookworm, which is endemic in all malarious areas, or with other blood-sucking or blood-infesting worms, is a cause of malaria being resistant to drug treatment.

A chance observation in a very resistant case of malaria (*Plasmodium falciparum*) in which the parasites persisted in the blood in spite of repeated courses of treatment with proguanil, mepacrine (by intramuscular injection), and quinine, used either singly or in combination, showed that the patient was excreting hookworm in the faeces. It was observed that by the day following treatment of the patient for hookworm the malaria parasites, fever, and general symptoms had disappeared. During the next 8-9 months 12 similarly resistant cases were studied. All were shown to have hookworm infestation, and all failed to respond to anti-malarial treatment until hookworm treatment was given, when they immediately responded.

In January, 1949, a large-scale study was begun. All cases of malaria were thenceforward treated for hookworm and observations made to see whether, compared with previous years, the relapse rate fell and continued at a low level. The standard of "relapse" adopted was that any case returning with malaria within six months of the original treatment was to be regarded as a relapse and not as a new infection, unless the parasite found was of a different variety from the previous one. The drugs and methods of treatment used were the same in all the years mentioned in Tables I and II, except that in 1948 hookworm treatment was not given.

TABLE I

	1948		1949		1950		1951	
	New Cases	Re-lapses	New Cases	Re-lapses	New Cases	Re-lapses	New Cases	Re-lapses
<i>Plasmodium</i> :								
Vivax ..	8	26	3	1	5	2	4	1
Ma'ariae ..	94	217	94	24	14	6	65	7
Falciparum ..	219	712	127	37	70	9	307	44
Total ..	321	955	224	62	89	17	376	52
% relapses to new cases ..	297.5		27.7		19.1		13.86	

Results

Table I refers to proved cases of malaria in which parasites had been demonstrated. In Table II are presented the number of cases suspected of malaria clinically in which no parasites were found but other evidence—for example, malaria debris, monocytosis, etc.—was usually present. The results given in both tables show a great reduction in the malaria relapse rate and have a similar trend, though the relapse figures for 1950 in Table II are slightly higher than might be expected; this may be due to a period of four and a half months' leave, during which the diagnosis was in the hands of a locumtenent with rather less experience of malaria.

The figures for 1947 were in general similar to those for 1948.