PREVENTION OF ACUTE FAILURE OF CIRCULATION FOLLOWING INJURIES TO LARGE ARTERIES

EXPERIMENTS WITH GLASS CANNULAE KEPT
PATENT BY ADMINISTRATION OF HEPARIN

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The results of vascular surgery have been improved by the clinical use of heparin (Murray, 1940). As many war wounds involve large blood vessels it is probable that vascular surgery will play a more important part in the treatment of such injuries in the future. In the last war many limbs and lives were lost because of extensive infection and gangrene. It seemed attractive, therefore, to investigate the possibility of a simple method that might prevent the acute failure of circulation following injuries to large arteries. If by such simple

FIG. 1.—Approximately actual size.

method adequate circulation could be maintained up to twenty-four hours, until the patient could be transported to a hospital with better operating facilities, permanent repair of the injured vessel or the bridging of a gap by a venous graft might be carried out, or collateral circulation might become established. Tuffier's (1915) tubes

were employed for this purpose, but failure of circulation usually occurred from rapid plugging of the tube and the adjacent segments of the vessel. It was hoped, therefore, that by using heparin better results might be obtained.

Experiments were carried out to test the effectiveness of heparin in preventing plugging of such tubes and blood vessels over varying lengths of time. The dosage of heparin necessary to obtain this result was also investigated. In these experiments glass cannulae with a bore 1.5 to 2 mm. and a length of 3.5 cm. were inserted between the cut ends of the common carotid artery of dogs. The ends of the cannulae were slightly flared. The cut ends of the artery were drawn over the flanges and secured by means of linen ligatures. Fig. 1 illustrates this procedure. Without the use of heparin these tubes became plugged within twenty minutes, on the average, following the re-establishment of circulation through these cannulae.

Results

The table, summarizing the results of fifteen experiments on fourteen dogs, shows the different amounts of heparin and saline given. An average of 56 units per kg./hr. was used, but this was considerably more than was necessary in many of the animals. This high figure is partly accounted for by the large initial dose of heparin given before the continuous intravenous injection was started, and another large dose administered immediately before the specimen was recovered. When a satisfactory continuous intravenous injection of heparin was given, 55 units per kg./hr. was enough to raise the clotting time of an animal from the normal of two minutes to thirteen minutes or more. This sufficed to keep the cannulae patent in all experiments. The method of estimating the clotting time both experimentally and clinically is illustrated in Fig. 2.

With excessive dosage of heparin there was fairly extensive oozing from the operative field in some of these experiments, but when the clotting time was kept at a level of thirteen minutes there was little if any oozing. If the experiments on thrombin (Warner *et al.*, 1939) continue to show that this substance will prevent oozing from operative fields it might be used to advantage by surface application on surgical wounds in patients who are receiving heparin.

Table giving Results of Experiments

Exp. No.	Dog No.	Weight (Kg.)	Heparin (Units)	Saline (c.cm.)	Aver. No. Units of Heparin per c.cm.	No. of Hours	Result	Units per Kilogramme	Remarks
1	78	10	21,800	1,800	12	71	Cannula not patent	30	
2	79	9	20,150	1,650	12	72	" "	31	
3	82	11	10,000	500	20	24	" "	38	
4	46	—	34,250	1,350	25	76	Cannula patent	—	Unfortunately this dog's weight was not obtained. It was a large animal
5	23	6	17,000	600	28	24	" "	118	
6	65	10	14,100	900	16	44	" "	32	
7	85	12.5	26,500	1,000	26.5	24	" "	85	Observed at necropsy
8	83	8	12,600	430	29	24	" "	65	
9	83	8	8,100	300	27	24	" "	42	
10	(Other common carotid) 84	12	18,500	800	23	14	" "	110	Died as result of massive oozing from operative site
11	87	6	—	—	26?	12	" "	—	Died from same cause as above; too much heparin
12	90	12	12,000	500	24	20	" "	42	
13	92	9	8,500	300	28	24	" "	39	
14	D	10	7,000	200	35	23 h. 10 m.	" "	30	Dog had also been heparinized the day previously
15	97	10	12,000	400	30	24	" "	50	
								Av. 56	

The heparinized saline was administered according to the continuous intravenous technique of Jacobs (1931).

As this procedure has not been carried out in clinical patients, and as the dose required to heparinize a dog differs from that required to heparinize a patient, it is difficult to predict the dosage accurately. From our experience we would suggest that between 15 and 20 units per kg./hr. should be adequate. Since continuous intravenous administration is impracticable in patients outside hospitals, the intermittent intravenous injection of the heparin in doses of 1,500 units q.h. for the patient of average weight should suffice.

Consideration of this experimental evidence suggests that it might be possible to insert glass cannulae in torn

FIG. 2.—Approximately half actual size.

arteries soon after the accident. With suitable doses of heparin the cannulae might be kept patent until the patient could be removed to a hospital where repair of the vessels could be undertaken. This might be carried out with the simplest technique in advanced dressing stations behind the fighting line. In this way some of the disastrous effects of acute failure of circulation in extremities and neck might be prevented.

Summary

With a view to using glass cannulae to bridge defects in the arterial system of human beings as a temporary measure a series of experiments have been carried out on dogs. The results have been tabulated. With adequate heparinization, using a pump to provide continuous intravenous administration, glass cannulae of 1.5 to 2 mm. bore and 3.5 cm. length may be kept free from clot for varying periods of time up to seventy-six hours. The danger of oozing from the operative field in overdosage with heparin must be borne in mind.

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LEPROSY CASES IN THE BRITISH ISLES

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At the request of the Medical Committee of the British Empire Leprosy Relief Association a subcommittee consisting of the three of us have carried out an inquiry into the number of leprosy cases seen during the last thirty years by dermatologists in all parts of the country. The following is an analysis of replies received to a circular letter which enclosed forms to cover the required information. These were received from fifty specialists, only fourteen of whom had seen any cases of the disease. The great majority were reported by Dr. J. M. H. MacLeod (to whom we are particularly indebted for his reports of cases) from the St. Giles Homes in Essex and private cases, and by two of us (Sir Leonard Rogers and Dr. E. Muir). All but six cases had been seen in London, doubtless due to so many patients from over-seas visiting London for medical advice. The provinces therefore show very few cases, although no doubt there are some regarding which no information has been received. Concealment is likely to be less common than it was two decades ago now that it is generally known that treatment of value is available to those seeking it in good time.

Countries of Origin.—It will be seen from the data in Table I that no fewer than thirty-five of the seventy-

TABLE I.—Countries in which the Disease was Apparently Acquired (87 Cases)

Europe :	British Isles 4, Malta 1, Norway 1, Russia 1	7
Asia :	India and Burma 35, Malaya 9, East Indies 2, China 3	49
Africa :	S. Africa 5, S. Rhodesia 1, Zanzibar 1, Nigeria 2, Egypt 1	10
Western Hemisphere :	West Indies 5, British Guiana 4, Colombia 1, Brazil 2	12
Doubtful :	"Abroad" 6, unrecorded 3	9

eight cases regarding which information is available came from India, including Burma—doubtless owing to the large number of Europeans and to the high incidence of leprosy in that densely populated country. Malaya was next, with nine cases.

Cases Apparently Contracted in the British Isles.—These number only four in thirty years, all of which were seen from eleven to twenty years ago, and were reported by Dr. J. M. H. MacLeod. In each of these there was prolonged close contact with a highly infective lepromatous case; one was a conjugal infection, and the other three patients were first seen when respectively 12, 15, and 18 years old, indicating infection at the early susceptible age. On account of lower susceptibility in adults conjugal leprosy infections are far less common, and we know of several highly infectious patients who have been faithfully nursed by devoted wives for a number of years in this country without transmitting the disease. No case is known to us of infection in the British Isles from a neural or a tuberculoid case, in which leprosy bacilli are very few and are difficult to find.

Classification of the Cases

In Table II the eighty-seven cases (after excluding duplicates returned by more than one specialist) are classified into different types and arranged to bring out the number still alive and resident in this country. These are subdivided into the little-infective neural and tuberculoid and