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Changes in the peripheral circulation following intestinal trauma.

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This investigation had for its purpose the demonstration of the actual changes in the condition of the peripheral circulation following severe manipulations of and trauma to the intestines.

The term peripheral is employed to include the musculature of the extremities and trunk.

Many statements have been made by various investigators as to the actual condition of the peripheral vessels after shock has been brought about by intestinal trauma, but, with few exceptions, such changes have not been clearly demonstrated. Some have apparently concluded that the vessels in the periphery following long-continued intestinal trauma are dilated,[1] while fully as many[2] maintain that this is not true.

RELATION OF TIME, VOLUME AND BLOOD PRESSURE.

Length of Experiment, Minutes.	Fall in Volume at End of Experiment in c.c.	Blood Pressure.	
		Beginning.	End.
52	3	87	70
45	2	110	115
165	5	133	131
120	10	106	105
50	0	91	65
51	9	115	135
92	5 in 31 min., 10, at death	107	118 in 31 minutes

Dogs were used, the anesthetic in each case being ether administered by intratracheal insufflation preceded by physiological doses of morphine and curare. The blood pressure was taken from the carotid artery. A specially made plethysmograph was placed around the leg to above the knee, and was connected with a water manometer which was calibrated. Readings gave changes in volume of the leg.

[1] Mummery, *The Lancet*, 1905, 696; Meltzer, *Arch. int. Med.*, 1908, I, 571.

[2] Malcolm, *The Lancet*, 1905, 573; Seelig and Lyon, *Jour. A. M. A.*, 1909, 52, 45.

The abdomen was then carefully opened along the linea alba and the intestines pulled out. This organ was then handled until a condition of shock was brought about in the animal.

In every experiment except two the water manometer registered a change in leg volume immediately or within a few minutes after the handling of the intestines had begun. In most instances the manipulations of the gut resulted immediately in a slight fall of volume with a fall in blood pressure which was followed in some cases, in a few minutes, by partial or complete recovery of the leg volume to normal. There seemed to be at the beginning of the experiment a period of unstableness of the vaso-motor mechanism in the leg, the arteries being alternately contracted and dilated, without much disturbance in blood pressure.

These variations in leg volume in most cases passed away in a few minutes and the volume tracing from then on showed a gradual fall to the end of the experiment. In one experiment (January 31), the handling of the intestines immediately brought about a slight fall in the volume of the leg with at first a *fall* then a *rise* in blood pressure.

When the handling ceased for two minutes, the leg volume went up, the blood pressure remaining about normal. When the manipulation was taken up again, there was a fall of volume. These transitory changes in leg volume and blood pressure went on through the whole experiment (52 minutes), the general trend of the volume being downward so that at the end of the experiment there was a permanent fall of 3 c.c.

In all cases but one there was a fall of leg volume of from 2 c.c. to 10 c.c.

In all cases but two the blood pressure was maintained throughout the experiment, or at the end was higher than at the beginning.

In the experiment of January 13 where, up to the end, there had been no change in the vaso-motor condition of the leg arteries, as shown by the leg plethysmograph, the blood pressure was 91 mm. Hg at the beginning and had dropped to 65 mm. Hg at the end.

In the experiment of January 31, when the vaso-constriction

in the leg resulted in a 3 c.c. fall, the blood pressure was 17 mm. Hg lower at the end than at the beginning.

In the experiment of December 4, where a 2 c.c. fall in leg volume was noted, the blood pressure rose from 110 mm. Hg at the beginning to 115 mm. Hg at the end of the experiment.

In the two experiments of November 21 and December 13, the fall of volume was 5 c.c. and 10 c.c., respectively, and the blood pressure was exactly maintained throughout the experiments. The time of intestinal handling in the latter experiment was *two hours*, with forty minutes elapsing before any change in volume was noted.

In the experiment of March 18, there was a fall in leg volume of 9 c.c. and a gain in blood pressure of 20 mm. Hg.

In the experiment of January 9, which lasted one hour and thirty-two minutes, the leg volume at the expiration of thirty-one minutes had decreased 5 c.c. and the blood pressure had risen from 107 mm. to 118 mm. Hg. There was a gradual loss of vaso-motor tone in the leg vessels from then on, the leg increasing in volume, the blood pressure showing a steady fall. Within a few minutes of death there was a rapid fall of leg volume, the decrease at death being 10 c.c.

CONCLUSIONS.

Trauma to the exposed intestines brings about a certain vaso-motor response in the blood vessels of the periphery, and this response is a vaso-constriction. This change begins almost immediately that the intestines are disturbed and continues as long as the stimulation is applied.

This reflex vaso-constriction in the peripheral vessels is an important factor in maintaining the blood pressure in cases of gradually developing shock from intestinal trauma, overcoming the blood pressure lowering effect of the splanchnic dilatation. It is shown that whenever the intestinal irritation is not accompanied by vaso-constriction of the peripheral vessels, the blood pressure tends to fall. Whenever the vaso-constriction is present but slightly, the blood pressure shows itself to be better maintained. When the vaso-motor centers can bring about a marked vaso-constriction, the tendency towards the maintenance of the general blood pres-

sure is greater, and in some cases there is actual raising of blood pressure.

Since there is no reason to suppose that the vaso-constrictor center is the variable factor in the difference of vaso-constrictor effect which was obtained, it is reasonable to assume that the results are to be explained by the variation of the normal degree of vaso-constriction present in the periphery at the inception of the experiment. If the vessels were dilated, then reflex constriction could occur to a great extent and aid in the retention of normal blood pressure. If, on the other hand, the peripheral vessels were well constricted, further constriction from trauma would be impossible and the compensatory effect being absent, the blood pressure would fall.

In other words, the effect of intestinal trauma upon blood pressure is determined by the relative degree of constriction or dilatation which exists in the periphery at the inception of the procedure.

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Reflex cardio-inhibition in conditions of lowered blood pressure and " shock."

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The experiments reported here represent a continuation and amplification of those presented previously by Ewing and the present author.[1]

In the first series, the accelerator fibers were cut in the dog in order to remove accelerator effects as possible causes for the rise in threshold value of the cardio-inhibitory reflex, observed in conditions of low pressure (hemorrhage, etc.) where the rate of the heart is increased. This factor can be excluded as the same results were obtained as previously published.[1] The second series consisted in an attempt to alter the blood supply of the medulla

[1] Ewing and Jackson, *Amer. Jour. Physiol.*, 1914.