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Blood Pressure Changes Correlated with Time, Length and Type of Intestinal Strangulation in Dogs.*

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Introduction. A significant fall in blood pressure was observed following release of the constricting ligature in cases of strangulation obstruction reported from this laboratory several years ago.[1] Just prior to that, Foster and Hausler,[2] writing on the same subject, pointed out a direct relationship between the drop in pressure and the length of gut strangulated. Believing that the type of strangulation may vary greatly, depending on the degree of arterial or venous occlusion present, and knowing that the time factor is of great importance, we decided to control these variables in an effort to determine whether or not there was any correlation between the blood pressure on the one hand and the time, length and type of strangulation produced on the other.

Methods. The carotid artery was cannulated in 30 dogs and a tracing made of the blood pressure during the course of various types of vascular occlusions. In each experiment the time as well as the length and site of bowel strangulated were noted. In order to control the degree of arterial and venous occlusion, the experiments were divided into 4 groups, as in the preceding paper on "Length of life following various types of strangulation obstruction." The methods employed were identical.

Results. In group I (encirclement obstruction), the bowel strangulated varied between 1 and 11½ feet. The time factor between 3 and 7 hours. The blood pressure prior to strangulation was recorded in 5 of these experiments, while the resulting pressure after from 3 to 7 hours is known in every case. The lowest pressure recorded after this interval was 70 mm. of Hg. pressure and the highest 140 mm. In the 7 dogs in which the length of gut was less than 3 feet, the blood pressure had not fallen in any case below 100 mm. In the 9 remaining dogs in which the segment strangulated was more than 3 feet in length, the pressure at time of release was less than 100 mm. in 6 cases. The time at which the release

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[1] Wangensteen, O. H., and Loucks, Milo, *Arch. Surg.*, 1928, **16**, 1089.

[2] Foster, W. C., and Hausler, R. W., *Arch. Int. Med.*, 1924, **34**, 697.

was effected varied in each instance, but the time interval was approximately the same in both divisions of this group with but one exception.

In group II, in which the arteries and veins were ligated the pressure was found to be within normal limits after from 4 to 6 hours.

In group III, in which the arteries were ligated, the pressure was also found to be within normal limits after from 4 to 6 hours. Tracings were then taken after 18½ hours on 2 which appeared moribund. The one showed a mean pressure of 20 mm. and the other 70 mm. The first died ½ hour later and the second 1½ hours later.

In group IV, in which the veins were ligated in 10 dogs, the pressure was below 70 mm. in every instance after from 1 to 5 hours. Three of the 10 animals were dead. One animal in which the superior mesenteric vein was ligated died within one hour. Two of 3 dogs in which the veins to a 5½ foot segment were ligated, died within 4 hours with consistent decline in blood pressure during

TABLE I.
Encirclement Strangulation. (Ligation of bowel and mesentery.)

Exp. No.	Dog Wt.	Gut Length	Strang. Time	Initial Press.	Resulting Press.
	kilos	ft.	hours	mm.	mm.
5	20	1	4		140
14	5	1	5		140
1	11.3	1	3		100
2	16	1	4½		130
3	9	1	5		100
8	11	3	4¼		130
7	20	3	4		110
47	8	4	5	110	90
9	19	5	4½	130	100
11	10	5	3¾		94
12	8	4	4½		110
32		4	5	100	90
13	10	5	4		90
10	5.5	5	4½		80
31		7	7	140	120
36	25.5	11½	4½	110	70

TABLE II.
Ligation of Arteries and Veins.

Exp. No.	Dog Wt.	Gut Length	Strang. Time	Resulting Press.
	kilos	ft.	hours	mm.
17	20	4½	4¾	120
16	14	5	4	145
16	14	5	6	135

the course of the experiments. One animal in which the veins to a 5-foot segment were occluded, was still alive at the end of 4 hours, but had a blood pressure of only 54 mm. The remaining 6 dogs in which the segment was less than 3 feet were all alive after an interval varying from 3 to 5½ hours.

TABLE III.
Ligation of Arteries.

Exp. No.	Dog Wt.	Gut Length	Strang. Time	Resulting Press.
	kilos	ft.	hours	mm.
115	18	2½	18½	20
115	18	2½	19	0
116	22	2	18½	70
116	22	2	20	0

TABLE IV.
Ligation of Veins.

Exp. No.	Dog Wt.	Gut Length	Strang. Time	Initial Press.	Resulting Press.
	kilos	ft.	hours	mm.	mm.
101	13.5	2	2	120	56
100	20	2½	4	150	60
93	9	2½	4½	120	60
99	19	2½	5½	140	70
91	21	2½	5	140	70
92	12	3	3	110	38
55	20	5	4	140	0
56	16.2	5	4	150	56
51	13	5½	2½	120	0
114	10	S. Mes. V.	1	140	0

Comment. The marked early fall in blood pressure which is seen in the group in which the veins are ligated points strongly to death resulting from a loss of blood from the general circulation. Blalock,[3] working on the etiology of traumatic shock has come to a similar conclusion, namely, that a loss of blood into the traumatized tissues occurs in sufficient amounts to account for the observed fall in blood pressure.

Conclusions. There appears to be a direct correlation between the fall in blood pressure and the time, length, and type of vascular occlusions. In general, the longer the time and the longer the loop, the greater the fall in blood pressure. The type of obstruction, however, is of even greater importance than the time and length of the occlusion. In those instances in which the veins were ligated and in the encirclement strangulations (Group I), in which the ar-

[3] Blalock, Alfred, *Arch. Surg.*, 1930, **20**, 959.

teries were not entirely occluded, the fall in pressure was much more rapid than in those instances (Group III), in which the arteries were absolutely occluded regardless of the condition of the veins.

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Liver Autolysis in the Peritoneal Cavity of the Dog.

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Mann observed in his experiments with hepatectomy in dogs that when small pieces of liver tissue were left behind in the peritoneal cavity, the dogs invariably died of a severe peritonitis in less than 24 hours. Mason[1] and coworkers confirmed Mann's observations, studied the blood chemistry in such dogs, and found that saline extracts of autolized dog's liver injected intravenously proved very toxic. If the liver was *not* autolized, no toxic reactions were observed. They described the typical picture of dogs dying following deposition of pieces of dog's liver into the peritoneal cavity. One to 300 cc. of a serosanguinous fluid was usually present and the peritoneal surfaces were reddened. After 24 hours, liver placed into the cavity could hardly be identified except as a friable mushy mass which contained gas. Wangensteen[2] showed the relative non-toxicity of rat's liver and adult dog's kidney compared to adult dog's liver. He also showed the existence of a quantitative tolerance of dog's liver introduced into the rat's peritoneal cavity, the rats usually not dying till 15 gm. of dog's liver per kilo body weight of rat had been exceeded. Ellis and Dragstedt[3] indicated that an anaerobic gas forming bacillus commonly found in the dog's liver was responsible for death in liver autolysis *in vivo*. They identified this organism closely with the Welch bacillus. Later Rewbridge[5] showed that introduction of sterile bile salts into the peritoneal cavity of dogs caused a peritonitis death similar to that of liver autolysis. Still

[1] Mason, E. C., Davidson, C. C., *et al.*, *J. Lab. and Clin. Med.*, 1924, **10**, 622, 906, 977.

[2] Wangensteen, O. H., *Endokrinol.*, 1928, **2**, 170.

[3] Ellis, J. C., and Dragstedt, L. R., *Arch. Surg.*, 1930, **20**, 8.

[4] Andrews, A., and Hrdina, L. S., PROC. SOC. EXP. BIOL. AND MED., 1930, **27**, 987.

[5] Rewbridge, A. G., *Surg. Gynec. and Obstet.*, 1931, **52**, 205.