EFFECT OF VARYING INTRALUMINAL PRESSURES IN DIFFERENT VISCERAS ON BLOOD PRESSURE AND RESPIRATION IN DOG

By

R.C. SHUKLA, G.S. TANDON AND S.S. SINGH

Department of Physiology, K.G. Medical College, Lucknow

The problem of abdominal distension in relation to pain, blood pressure and respiratory changes has been studied by Brodie and Russel (1). It was shown by Hurst (8) that a form of muscle sense existed in the various portions of the alimentary canal and at levels below the oesophagus, and the distension was an adequate stimulus for the sensation. Haden and Orr (6) found that the experimental obstruction on the cardiac end of the stomach in dogs resulted in rapid respiration and restlessness apart from other effects. Little information is available regarding the effect of varying intraluminal pressures in urinary bladder and oesophagus in relation to changes in blood pressure and respiration.

An attempt has been made to study the effect of varying intraluminal pressure in urinary bladder, stomach and oesophagus on blood pressure and respiration.

MATERIALS AND METHODS

The experiments were carried out on healthy mongrel dogs of both sexes, weighing between 12.5 to 14.0 kg. The animals were starved for a period of 24-28 hours prior to each experiment in order to keep the bowels empty. A bowel wash was done in each case. Operations were performed under chloralose anaesthesia (90 *mgm/kg.*/i.v.). In each case carotid blood pressure and respiration from the tracheal canulae was recorded under resting conditions and after raising intra luminal pressure by the baloon method in the urinary bladder, stomach and different parts of the oesophagus. The length of the oesophagus from the lower border of cricoid cartilage to T_1 (below xiphisternum) was measured and divided in three parts. A baloon was tied on the tip of a hard rubber tube and was introduced orally and its position was ascertained by suitably marking the distance on the tube. The size of the baloon was very big and its elasticity was made very low by keeping it inflated for a period of seven days before using it. The pressure within such a baloon was taken as the intraluminal pressure. The intragastric pressure was recorded by passing the tube further 5 cms beyond third mark, which ensured the position of the balloon in the stomach. The baloon was introduced through a cut in the fundus of the bladder.

RESULTS

The results of the analysis of the data on the study of the effect of intraluminal pressure in urinary bladder on blood pressure and respiration are given in Table I. The minimum and maximum intravesical pressures to elicit a response was found to be 20 mm and 120 mm.

Hg. respectively. It was observed that rise in blood pressure remained stationary till the release of pressure when it came to resting level.

TABLE I URINARY BLADDER

Showing mean (N) B.P. 104.3 *mm. Hg.* (7) *Mean (N) Resprate* 19.57*/mts.*(7)

Intra-vesical pressure in mm. Hg.	Mean B.P. rise mm. Hg.	% of rise in B.P. in (m.m. Hg.)	Mean recovery time in seconds	Mean rise in Resp rate per mts with range	Amplitude	Remarks
20	4.0±1.4(4)*	3.8	60.0	1.4 (0-4)	Increase in 4 dogs. Decrease in 3 dogs.	Sudden rise in B.P. in 5 dogs and gradual in 2 dogs.
40	9.7±1.1(7)	9.3	60.0	1.7 (0-6)		
60	**16.6±2.3**(7)	15.9	60.0..	**2.1 (0-8)**		
80	22.0±1.1 (7)	21.1	60.0	3.3 (0-8)		
100	30.9±2.5 (7)	29.6	60.0	3.9 (0-10)		
120	33.7±4.1 (7)	32.3	60.0	5.9 (0-12)		

N Normal ( ) Number of animals. ( ) Range. B.P. Blood pressure mm. Hg.
Resp/rate/min Respiratory rate per minute.

TABLE II STOMACH

Showing mean (N) B.P. and actual B.P. changes in mm. Hg. (Mean and S.E.)
Mean normal B.P. 166.6 (10) *mm. Hg. Mean normal Resp/rate/mt.* 19.0 (10).

Intra-gastric pressures in (mm. Hg.)	Mean fall (actual) changes in B.P. (mm. Hg.)		% fall in B.P. mm.Hg.	Mean rise in Resp/rate/mts( ) with its range( )	Amplitude	Remarks
80	20.6±3.9	(10)	12.4	5.2 (0-12)	Increase in all cases.	Transient apnoea in 3 dogs.
100	40.5±4.4	(10)	24.3	5.6 (0-12)		
120	42.6±5.5	(10)	25.6	7.8 (0-12)		
140	46.0	(10)	27.6	7.2 (0-12)		
160	49.6±8.2	(10)	29.8	8.0 (0-16)		
180	52.8±9.1	(10)	31.7	6.8 (0-16)		
200	43.4±9.8	(10)	33.3	8.6 (0-20)		
220	71.2±12.6	(10)	42.7	10.2 (0-24)		

N = Normal. ( ) *Number of animals. ( ) Range. B.P. Blood pressure mm. Hg.
Resp/rate/min = Respiratory rate per minute.

The increase in intragastric pressure up to 80 mm. Hg. did not show any change in blood pressure and respiration due to varying intragastric air pressure are shown in Table II.

Intraoesophageal pressure up to 60 mm. Hg. at three different regions of oesophagus did not produce any change in blood pressure or respiration. The mean blood pressure and respiratory changes at three different regions are shown in Table III.

TABLE III OESOPHAGUS

Showing mean B.P. and respiratory changes

Regions of Oesophagus	Intra oesophagal pressures mm. Hg.	Mean B.P. (mm. Hg.) decrease	Mean % fall in (mm.Hg.)	Mean recovery time/sec	Mean increase res/rate/min. (range)	Changes in amplitude	Remarks
Upper 1/3rd	80	10.4±1.6 (24)*	6.7	36.6	3.2 (0-14)	Increase in 23 dogs decrease in one dog.	Initial apuoea in 3 dogs.
	100	14.3±1.9 (24)	9.2	37.7	5.1 (0-16)		
	120	17.2±2.2 (24)	11.1	38.1	4.4 (0-20)		
	140	21.6±2.1 (24)	14.0	38.1	4.9 (0-20)		
	160	26.5±3.2 (24)	17.1	38.1	5.9 (0-20)		
	180	31.7±4.1 (24)	20.5	39.8	7.4 (0-22)		
	200	35.5±9.2 (24)	23.0	41.5	8.6 (0-42)		
	220	40.8±4.7 (24)	26.4	41.0	9.4 (0-42)		
Middle 1/3rd	80	13.5±2.3 (22)*	18.8	40.5	4.1 (1-12)	Increase in 21 dogs decrease in 1 dog.	do-
	100	16.3±2.3 (23)	10.8	42.2	4.2 (2-12)		
	120	20.8±2.6 (22)	13.7	43.8	6.3 (2-18)		
	140	23.9±2.8 (21)	13.8	43.3	6.7 (2-18)		
	160	29.6±2.9 (21)	19.6	45.2	6.9 (2-24)		
	180	33.5±3.3 (21)	22.1	45.2	6.4 (2-24)		
	200	36.3±3.4 (21)	24.0	43.4	7.7 (2-28)		
	220	39.8±4.1 (21)	26.3	45.5	8.4 (0-28)		
Lower 1/3rd	80	9.1±2.6 (21)*	6.0	43.3	3.9 (0-6)	Increase in 20 dogs decrease in 1 dog.	do-
	100	13.0±2.9 (21)	8.5	44.8	4.7 (2-14)		
	120	15.3±3.1 (21)	10.0	43.4	5.0 (1-14)		
	140	21.5±4.1 (20)	14.1	44.0	4.2 (0-20)		
	160	24.4±4.5 (20)	16.0	45.5	5.0 (0-25)		
	180	27.4±5.4 (20)	18.0	45.5	4.2 (0-29)		
	200	31.4±6.6 (21)	20.6	45.5	5.4 (0-35)		
	220	30.4±7.7 (20)	19.9	45.5	7.0 (0-35)		

Lower 1/3 region Mean (N) B.P. mm.Hg. 152.4 (21) Mean Resp/rate/min 16.0 min (21)

Middle 1/3 region Mean (N) B.P. 151 4 mm. Mean (N) Resp/rate/min 14.1 (22)

Upper 1/3 region Mean (N) B.P.(N)154.6 mm. Hg. (25) Mean (N) Resp/rate/min. 19.57 (25)

The Normal. *Number of animals. () Range. B.P. Blood pressure (mm. Hg.)
Resp/rate/min—Respiratory rate per minute.

DISCUSSION

Urinary Bladder

Perusal of Table 1, shows a significant rise in blood pressure after distension of the urinary bladder. The rise in blood pressure is particularly marked beyond 60 mm. Hg. pressure. When the bladder is distended with lower pressures (20-40 mm Hg.), the reflex rise in arterial blood pressure was small. As the bladder is further distended by raising the intravesical pressure, the arterial blood pressure response becomes more marked. Results of present study show a relationship between the height of intiavesical pressure and the extent of rise in arterial blood pressure. The present findings confirm similar observations of Watkins (14) and Mukherjee (11,12). However, an increase in the respiratory rate was observed in the present study which is contrary to those reported by Mukherjee (11,12). The fact that changes in respiration do not follow blood pressure changes in the present study, suggests the existence of reflex mechanisms at the inter-segmental level of the spinal-cord which is responsible for respiratory and blood pressure changes. The present contention is also supported by the observations of Guttman and Whitteridge (4) in paraplegic human patients and of Cunningham *et al.*,(2) in dogs. They suggested that splanchnic and renal vasoconstriction is a likely mechanism for the rise in blood pressure after distension of the urinary bladder.

Stomach

An increase in the intra-gastric pressure brings about a significant fall in blood pressure and a rise in respiratory rate (Table II). The fall in blood pressure is akin to a fall after heavy meals. The latter part can be explained on the basis of increase in the splanchnic vascular bed diminishing the venous return. The distension of the stomach results in an increase in intra-abdominal pressure, which obstructs the venous return in the inferior vena cava below the liver thus resulting in fall of blood pressure. The return of blood pressure to resting level after registering a sudden and consistent fall on the release of intragastric pressure could be due to the participation of afferent vagal fibres (10). Further it has been shown by Dowman and McSwiney (3) that visceral stimulation (by pinching of intestine and stomach) resulted in an increased blood pressure in spinal animal preparation. Paintal (13) reported that certain afferent fibres in the cervical vagus of cats yield a discharge of impulses when the stomach is distended with baloon. He conjectured that these afferents must inevitably play an important role in the various reflexes concerned with the stomach. He suggested that the normal function of the stretch receptors in the walls of the stomach is to signal the state of distension of the stomach and that they are not likely to be situated in or near the blood vessels as superimposed cardiac rhythm was not observed.

An increase in the rate of respiration was observed in the present study (Table II). Mukherjee (11,12) and Heymans *et.al* (7) reported an increase in respiratory rate on distension of the rectum. They attributed it to mechanical and unspecified stimulation of pain receptors. Paintal (13) reported the possibility of existence of two different types of stretch receptors having pressure or depressure effects respectively or the receptors of the two responses being common but having different central connections.

Oesophagus

The effect of the intraoesophageal pressures (80-220 mm Hg.) on blood pressure and respiratory rate has been studied at three different regions of the oesophagus. Blood pressure decreased in direct proportion to the intensity of intraoesophageal pressure (Table III). The intensities of intra-oesophageal air pressures did not act uniformly for different regions of the oesophagus so far as decrease in blood pressure was concerned. Mean increase in respiratory rate and amplitude is shown in Table III. There was a universal increase in the amplitude of respiration with an exception in one dog at lower third of the oesophagus. Transient apnoea was observed in three dogs only .The fact that the blood pressure decreased due to distension of any region of the oesophagus and this was associated occasionally with apnoea, is suggestive of a reflex mechanism operating from the oesophagus itself. The reutrn of blood pressure to its normal level could be due to the compensatory mechanism mediated via the buffer nerves from the receptors of the Carotid sinus. Iggo (9) suggested that pressure sensitive receptors are present in the muscularis externa and serosa of oesophagus, stomach and intestines which are stimulated by distension and their rate of discharge was higher when the distension was rapid.

SUMMARY

The experiments were conducted on healthy mongrel dogs of both sexes. Intraluminal pressure was increased by inflating a rubber baloon in the urinary bllader, stomach and oesophagus. The response to increased intravesical pressure was an increase in blood pressure and slight increase in the rate of respiration. Increased intra-gastric pressure resulted in hypotension and an increase in the rate of respiration. Similar results were obtained in the case of oesophagus at its different regions. Statistically, no significant difference between regions of the oesophagus was found so far as decrease in blood pressure was concerned. It has been suggested that a reflex mechanism exists in the oesophagus itself which may have different central connections or there exists separate inhibitory and excitatory receptors in the oesophagus.

REFERENCES

1. Brodie, T.G. and A.E. Russel. On reflex cardiac inhibitions. *J. Physiol.* **26**:92. 1900.
2. Cunningham, D.J.C., L. Guttamann. Cardiovascular responses to bladder distension in paraplegic patients : *J. Physiol.* **121**:581, 1953.
3. Dowman, C.B.B. and B.A. Mc-Swiney. Reflexes elicited by visceral stimulation in the acute spinal animal. *J. Physiol.* **105**:80, 1947.
4. Guttmann, L. and D. Whitteridge. Effect of Bladder distension on autonomic mechanism after spinal cord injury *Brain.* **70**:361, 1947.
5. Guyton, A.C. and L.H. Adkins, Quantitative aspects of the collapse factor in relation to venous return *A. J. Physiol.* **177**:523, 1954.

6. Haden, R.L. and T.G. Orr. Chemical changes in the blood of the dog after obstruction of the oesophagus and of the cardiac end of the stomach. *J.Exper. Med.* **38**:477, 1923.

7. Heymans, C.A.F., Deschaep Dryver, and G.R. De Vleeschhouwer. Abdominal baro and chemo sensibility in dogs . *Cir Res.* **8**:347, 1960.

8. Hurst, A.F. Sensibility of Alimentary canal. Oxford. p. 593, 1911.

9. Iggo, A. Tension receptors in the stomach and urinary bladder. *Quart. J. Exper. Physiol.* **42**:130, 1957.

10. Irwing, J.T., B.A. McSwinery, and S.F. Suffolk. Afferent fibres in the stomach and small intestines. *J. Physiol* **89**:407, 1937.

11. Mukherjee, S.R. Effect of bladder distension on arterial blood pressure and renal circulation in acute spinal cats : *J. Physiol.* **138**:300, 1957.

12. Mukherjee, S.R. Effect of bladder distension on arterial blood pressure and renal circulation: Role of splanchnic and buffer nerves *J. Physiol.* **138**:307, 1957.

13. Paintal, A.S. Gastric stretch receptors. J. *Physiol.* **126**:255, 1954.

14. Watkins, A.L. Reflex responses on the nictiatating membrane and blood pressure to distension of bladder and rectum. *J. Physiol.* **132**:39, 1938.