

OBSTRUCTION OF INFERIOR VENA CAVA AS A FACTOR FOR REDUCED BLOOD PRESSURE ON DISTENSION OF STOMACH IN DOGS*

By

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AIMS AND OBJECTS

Abdominal as well as gastric distension is known to be associated with grave circulatory disturbances in clinical practice. Experimentally Mayer and Pribam (6), Brodie and Russel (1) and Irving, Mc. Swiney and Suffolk(5) demonstrated that distension of stomach caused changes in blood pressure of animals. More recently Shukla, Agarwal and Kapoor(7) and Shukla, Tandon and Singh (8) have demonstrated a significant fall of blood pressure on raising intragastric pressure in anaesthetised dogs. The blood pressure changes can be due to reflex (5,6) initiated by the stretch of the stomach wall. On the other hand, Shukla and his associates (7,8) have suggested that collapse of inferior vena cava, caused by increased abdominal pressure could possibly produce fall of blood pressure by way of diminished venous return.

It was, therefore, proposed to find out whether there was any obstruction of the inferior vena cava on distension of stomach. The obstruction, if any, will be shown by a rise of pressure in the femoral vein without any concomitant change in the pressure of brachial vein.

Subsequently experiments were carried on to find out whether such an obstruction, if it exists, contributes to the fall of blood pressure. In such case, restoration of blood pressure should occur with release of inferior vena caval obstruction even though stretch of the stomach wall is allowed to continue. This can be achieved by cutting open of the anterior abdominal wall while the stomach is still kept distended. Later the stomach can be deflated or re-inflated to cause alteration only in the stretch of the stomach wall.

MATERIAL AND METHOD

Experiments were carried on dogs, of both sexes under chloralose anaesthesia (100mg/Kg.). Blood pressure was recorded in *mm. Hg.* from carotid artery. Stomach was distended by inflation of a large rubber balloon introduced into it from mouth through oesophagus. Its position was ensured by manual palpation per abdomen and tested by appearance of a visible swelling in left hypochondrium and epigastrium on inflation. It was further confirmed postmortem. The pressure was raised to 20-40 *mm. Hg.* Venous pressure was recorded in centimeter of normal saline by water-manometer (with a float and flag) connected to the vessel concerned through polythene catheter of suitable size. Heparin was used as an anticoagulant. The positions of catheters were confirmed postmortem. Anterior abdominal wall was cut open

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with large scissors from symphysis pubis to xiphoid process in the midline. Carotid pressure and femoral venous pressure changes were studied in 22 dogs and the brachial venous pressure changes in 4 out of these. Effect of cutting open of abdomen was studied in another 4 of this group.

RESULTS AND OBSERVATIONS

A typical record of simultaneous changes of carotid blood pressure and femoral venous pressure on distension of stomach is presented in figure 1. Similarly the effect on brachial venous pressure is presented in figure 2.

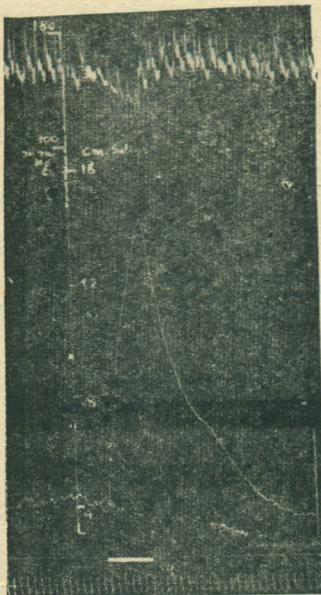


Fig. 1.

Simultaneous recording of carotid artery pressure (upper tracing) and femoral venous pressure (V.P.H.) showing a fall of blood pressure and a steep rise of femoral venous pressure on distension of stomach (indicated by signal).

Time : 10 Secs.

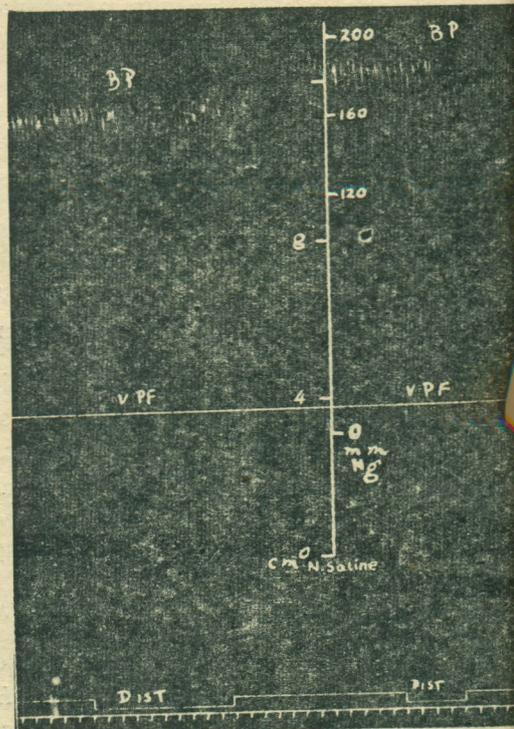


Fig. 2.

Simultaneous recording of carotid artery pressure (upper tracing) and brachial venous pressure (V.P.F.) showing that the brachial venous pressure remained unaltered on distension of stomach (indicated by signal).

Time : 10 Secs.

The result of experiments are presented in Table I.

TABLE I

Effect of gastric distension on carotid arterial pressure, femoral and brachial venous pressure.

	DISTENSION					RELEASE OF DISTENSION	
	No. of	Direction of Change	OBSERVATION		S.D.	No. of	OBSERVATION
	Dogs		RANGE	MEAN		Dogs	
B.P.	22	*Fall	10-34 mm. Hg.	19.30	± 5.70	22	**Rises back to normal
V.P.H.	22	Rise	3.5-17.5 cm. Saline	10.75	± 5.87	22	Falls back to normal
V.P.F.	4	No Change	4	No Change

*Transient initial rise of 15 mm. followed by fall of carotid pressure was observed in 2 dogs.

**In two dogs carotid pressure overshoot by 20 mm. Hg above predistension level (as in Fig. 2).

B.P.—Carotid blood pressure.

V.P.H.—Venous pressure of hind limb vein (Femoral vein)

V.P.F.—Venous pressure of fore limb vein (Brachial vein)

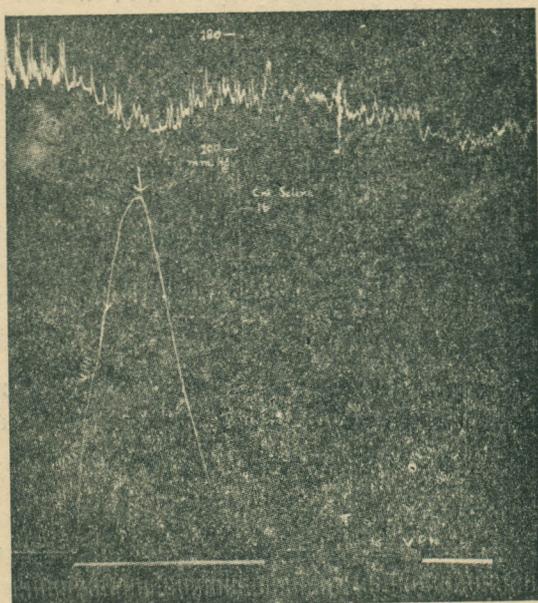
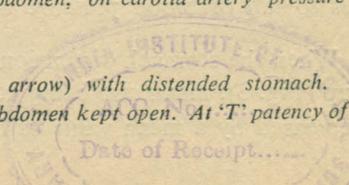


Fig. 3

Effect of distension of stomach and subsequent cutting open of abdomen, on carotid artery pressure (upper tracing) and femoral venous pressure (V.P.H.)

Signal indicates distension. Time : 10 Seconds.

In the first part of experiment abdomen was cut open (indicated by arrow) with distended stomach. In the second part, the stomach was distended (indicated by signal) with abdomen kept open. At 'T' patency of venous pressure instrument was tested.



Effect of cutting open of anterior abdominal wall with stomach still distended is depicted in Fig. 3 together with effect of redistension of stomach with abdomen kept open. Results of cutting open of the abdomen and subsequent inflation and deflation of stomach are given in Table II.

DISCUSSION

A mean fall of 19.30 *mm.Hg.* in carotid pressure (Table I) has been observed in 22 dogs on distension of stomach. This confirms what has previously been observed by Brodie and Russel(1), Shukla, Agarwal and Kapoor (7) and Shukla, Tandon and Singh(8). There was initial rise of blood pressure in 2 dogs out of 22, which might be caused reflexly. It may as well be attributed to emptying of the venous bed of the stomach into general circulation due to compression.

Fall of blood pressure on gastric distension has been believed to be caused reflexly by stretch of stomach wall (5,6). However, the fact that increased intra-abdominal pressure causes collapse of the vein of the abdomen has also been pointed out in the past. Charles *et. al.* (2) found that when intra-gastric pressure was raised, pressure in inferior vena cava rose promptly. Guyton and Adkins (4) inferred from their experiments that inferior vena cava collapses on increasing intra-abdominal pressure by injection of saline into the peritoneal cavity. According to Gupta (3) the fall of blood pressure was both due to fall in cardiac output and peripheral resistance though these were not recorded during his experiments. Shukla *et. al.* (7,8) suggested that the fall of blood pressure on gastric distension might be caused by reduced venous return due to collapse of inferior vena cava. Steep rise and fall of pressure in the femoral vein (Fig. 1) with inflation and deflation of balloon in the stomach, without any change in the brachial venous pressure (Fig. 2) under the same circumstances, have been demonstrated in the present series of experiments. This leads to the conclusion that the gastric distension of 20-40 *mm of Hg.* is potent enough to cause obstruction of the inferior vena cava. The stationary brachial venous pressure excludes other probable circulatory factors as cause of elevated inferior vena cava pressure.

The carotid pressure overshoot in 2 dogs on deflation of stomach may possibly be due to sudden large increase in venous return by blood released from the distended inferior vena cava and its tributaries before the circulatory adjustment could be effective.

When the abdomen was cut open with stomach still distended, the femoral venous pressure fell down steeply (Fig. 3). The obstruction of inferior vena cava had been relieved without relieving stretch of stomach wall. There was concomitant rise of blood pressure obviously due to restoration of deficient venous return. The inference is that the gastric distension causes obstruction of the inferior vena cava (*vide supra*) and this obstruction, in turn, contributes to fall of blood pressure irrespective of the reflex mechanism.

When the stomach distension was relieved with abdomen kept open, the carotid pressure went up (Fig. 3), mean rise being 15 *mm.Hg.* (Table II). On redistension the carotid pressure was decreased by a mean value of 8.75 *mm.* (Table II) to rise back again when the stomach

TABLE II
Effect of Gastric Distension on blood pressure and Femoral Venous Pressure on cutting open of abdomen in 4 Dogs.

Abdomen	Cut Open		OPEN	
	Closed	Distension continues	Inflated	Deflated
Stomach	Inflated	Distension continues	Inflated	Deflated
		Direc- Range Mean S.D. Direc- Range Mean S.D. Direc- Range Mean S.D. tion of of of change change change of of of change change change		
B.P.	Falls	Rises 10-30 20 \pm 8.16 Rises 10-25 15 \pm 7.09 falls 5-15 8.75 \pm 4.78 Rise 5-10 6.25 \pm 2.50 mmHg mmHg mmHg mmHg mmHg		
V.P.H.	Rises	falls back to normal.	No Change	No Change

*In one dog the rise was transient as in Fig. 7.

was deflated (Fig. 3). The femoral venous pressure recorded no change with all these manoeuvres. This indicates that the reflex mechanism, initiated by tension changes of the stomach wall also contributes to blood pressure changes quite independent of the mechanism of venous obstruction, although the extent of changes are, on the whole, lower than those caused by venous obstruction.

SUMMARY

1. The effect of gastric distension (20-40mm.Hg.) on carotid blood pressure and pressure in femoral and brachial veins have been studied in dogs.
2. On the basis of these observations as well as on the basis of observed changes in femoral venous pressure consequent to opening of abdomen, it has been concluded that the fall of blood pressure during gastric distension was largely due to obstruction of inferior vena cava.
3. It was observed that stretch of stomach wall could also cause reflex lowering of blood pressure.

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