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## Splanchnic blood vessels

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SPLANCHNIC BLOOD VESSELS

BY

GORDON A. PRACHAR

## SPLANCHNIC BLOOD VESSELS

The original purpose in mind, in an attempt to present a discussion of the splanchnic blood vessels was to concert data as to how these vessels were affected, as to what the actual pathological and physiological changes were; and as to certain of the chemico-physical factors operating in determining as to what their status was in the more prevalent diseases common to man. After a search of available medical literature I found that it was necessary to focus my efforts mainly on generalizations as far as specific disease entities were concerned, and to present certain experimental data in an effort to show what available experimental agents and procedures are known to produce changes in the splanchnic blood vessels and their related abdominal viscera. With a realization of the available data on the anatomical aspect of the splanchnic blood vessels and their allied sympathetic innervations, an attempt will be made to present a concise account of the anatomy of this material. With this working basis the general clinical aspect of patients suffering with severe relaxation of the splanchnic blood vessels will be attempted in part, and an amalgamation of experimental data producing conditions simulating actual dilatation of the splanchnic blood vessels together with generalizations made upon the study of patients suffering with this condition; actual attempts made at therapeusis of conditions of relaxation of the splanchnic blood vessels will be presented.

The splanchnic circulation physiologically considered, is distinct from the somatic or peripheral circulation. It is well known that there is an inverse relation between the circulation of the somatic area and the splanchnic area. When the peripheral vessels dilate, the splanchnic vessels contract. This may be illustrated by placing a mustard plaster upon the surface. This produces a local hyperemia through the dilatation of the peripheral arterioles, with corresponding contraction of the deeper vessels. The splanchnic circulation, considered anatomically, includes the celiac axis (gastric, splenic and hepatic vessels), the superior and inferior mesenteric arteries and veins, the renal veins etc.; these supply the abdominal viscera. (1)

The arterial branches of the abdominal aorta are divided into visceral and parietal groups. The visceral vessels are roughly divided into renal, and spermatic or ovarian arteries; and a single group composed of the celiac axis, and superior and inferior mesenteric arteries. The paired visceral branches of the abdominal aorta beginning with the three pairs of suprarenal arteries- superior, middle and inferior. Of these, the middle only arise from the aorta directly; the superior spring from the inferior phrenic, and the inferior from the renal arteries. These vessels all form an anastomotic supply to the suprarenal glands. The renal arteries arise one on each side of the aorta below the origin of the superior mesenteric artery and opposite the second lumbar vertebra. Each artery enters the hilus of each kidney and divides into a number of branches. The in-

ternal spermatic arteries are present in both sexes; in the male they are called testical arteries and in the female, ovarian arteries. Each testicular artery runs downward and forward on the anterior surface of the psoas major to the abdominal inguinal ring, when it comes in relation with the ductus deferens. It accompanies the ductus deferens through the inguinal canal to the testis, to which it is distributed. The course and relations of each ovarian artery as far as the level of the brim of the pelvis minor, are the same as the relations of the corresponding testicular artery; but at the level of the upper end of the external iliac artery, each ovarian artery turns medially, crosses anterior to the upper end of the corresponding external iliac artery and vein and enters the upper part of the broad ligament of the uterus. In the broad ligament it runs medially, below the uterine tube, to the level of the ovary. There it turns backward and runs between the layers of the mesovarium, where it breaks up into terminal branches where it enters the hilum of the ovary. The unpaired visceral branches of the abdominal aorta beginning with the coeliac artery, arises from the front of the abdominal aorta immediately below the aortic orifice of the diaphragm and between its crura. It is a short but wide vessel which terminates by dividing into three branches- the left gastric, hepatic, and splenic. The left gastric artery approaches the lesser curvature of the stomach near the esophagus and runs down to the pylorus to anastomose with the gastric branch of the hepatic artery. The splenic artery is the largest branch of the coeliac axis and runs posterior to

the stomach in relation to the pancreas to supply the spleen. In its course it gives off tributary branches to the pancreas and stomach. The hepatic artery turns to the right, continuing as the main hepatic branch which supplies the liver and the gall bladder. It sends a short gastric branch to the lesser curvature of the stomach which anastomoses with the left gastric artery. Its largest branch is the left gastro-epiploic artery which passes posterior to the pylorus along the greater curvature of the stomach. The superior mesenteric artery springs from the front of the aorta just below the level of the coeliac axis in front of the first lumbar vertebra. It gives off numerous branches which supply the duodenum and the pancreas in part, the whole of the small intestine below the duodenum, and the large intestine nearly as far as the left colic flexure. The main branches are the intestinal to the small intestine, varying from ten to sixteen in number, which are separable into jejunal and ileal groups. An inferior pancreatico-duodenal artery supplies branches to the pancreas and duodenum. A middle colic branch supplies the transverse colon and a right colic branch supplies the ascending colon. An ileo-colic branch has much the same distribution.

The inferior mesenteric artery springs from the anterior aspect of the aorta, supplying the large intestine, and is continued as the superior hemorrhoidal. The first branch, the left colic artery, supplies the colon in most of its extent. The sigmoid branches supply the sigmoid and together with the left colic branch, anastomose freely with the internal branches of the superior mesenteric. The superior hemorrhoidal

artery anastomoses with branches of the middle hemorrhoidal artery together with which they supply the rectum in its full extent.

In a consideration of the venous drainage of the viscera, the vein of paramount importance is the inferior vena cava and its tributaries, which receives the whole of the blood from the lower extremities, and the greater part of the blood from the walls and contents of the abdomen and pelvis. It commences opposite the right side of the body of the fifth lumbar vertebra, behind and to the right of the right common iliac artery. It ascends through the abdomen, anterior and to the right of the vertebral column, continuing on through the diaphragm, middle mediastinum, and up to the right side of the heart.

The hepatic veins convey the blood which has passed through the liver from the portal veins and hepatic artery, and they open into the portion of the inferior vena cava just below the diaphragm. The inferior phrenic veins convey venous blood from the substance of the diaphragm. The right inferior phrenic vein terminates in the upper part of the inferior vena cava, and the left inferior phrenic vein terminates in the left suprarenal vein. The suprarenal veins issue from the substance of the suprarenal vein. The right vein terminates in the inferior vena cava, and the left suprarenal vein opens into the left renal vein. The renal veins begin by the union of five to six tributaries issuing from the hilum of the kidney which terminate in the inferior

vena cava.

The testicular veins, one on each side, issue from the testis and epidymus and form a plexus, the pampiniform plexus. The plexus forms a constituent of the spermatic cord, passing upward through the scrotum and inguinal canal. The terminal testicular vein on the right side opens into the inferior vena cava and that on the left side into the left renal vein. The ovarian veins have a much similar distribution and termination.

The portal system is comprised of the portal, superior and inferior mesenteric together with the splenic veins and their tributaries. This system conveys blood to the liver from almost the whole of the abdominal and pelvic parts of the alimentary canal, from the pancreas, and from the spleen. The tributaries of origin correspond closely with the terminal branches of the splenic, and the superior and inferior mesenteric arteries, after which they are named and which they accompany for a considerable distance. The larger, or terminal veins, however, leave their associated arteries; the inferior mesenteric vein joins the splenic vein, and the latter unites with the superior mesenteric vein to form the portal vein which passes to the liver. (2)

When considering the supply of the abdominal viscera by these vessels, we find that they are of necessity, extremely sensitive to all stimuli. This is explained by their dependence for activity upon the stimulation supplied by food, water, and other substances coming in contact with the gastrointestinal mucosa. Besides this office of the splanchnic circulation in supplying the abdominal viscera, especially during their functional activity, we must regard it as a vast



reservoir and regulating apparatus for the entire circulation. We know that when passing from a cool into a warm atmosphere, the peripheral vessels naturally dilate; when passing from a heated atmosphere into an intensely cold atmosphere the peripheral vessels vigorously contract, and the blood which was before distributed over the surface, passes not into the brain or pulmonary vessels, but into the splanchnic area, and these vessels must necessarily dilate to accommodate the influx of blood. The mechanism must be extremely sensitive to admit of such rapid changes. The response to local stimuli is still more prompt. When stimulation is applied to the mucosa of the gastro-intestinal tract, immediate hyperemia results. The vascular activity is entirely dependent upon the integrity and sensitiveness of the vaso-motor apparatus. Prolonged stimulation results in congestion of pathologic hyperemia. We must regard all stimulation as reflex, even psychic impulses originating in the higher centers, such impulses being transmitted to the vaso-motor apparatus that controls the splanchnic circulation.

We find, therefore, that the characteristics of the splanchnic circulation are; its sensitiveness to all stimuli, promptness of action, and a marked difference between the effects of weak and strong stimulation and the effect of brief as compared with prolonged stimulation.

While the physiologic laws of this third characteristic as applied to other parts of the body, is more or less universally understood, there is a marked distinction observed when it is applied to the splanchnic circulation. Locally, the main stimulation of the circulation of the gastro-intestinal tract,

is obtained from the entrance of food and its passage through the stomach and intestines. Normally, there results: hyperemia, secretion, motivity of stomach and intestines, and absorption. It will thus be understood that physiologic hyperemia is essential, before muscular activity and absorption can occur.

The forms of stimulation may be summarised as follows: Chemic, mechanic, psychic-varying degrees of heat, cold, etc.

Chemic stimulation may be demonstrated by the use of mustard emulsions applied to the mucous membrane of the stomach; mechanic stimulation may be produced by the use of bran and coarse substances, distention of the stomach with air and water, or the mechanical applications of any instrument. The result of psychic influence is observed in the increased secretion by means of odors of food, sight of food, etc., increased digestive activity from pleasurable emotions as compared to the retarded digestion incident to fright, sorrow, or mental depression from any cause.

Heat modifies the splanchnic circulation more promptly and effectually than is observed in other areas of the body.

Chemic Stimulation.- This may be demonstrated by douching the mucous membrane of a dog's stomach with a 1 to 500 mustard emulsion. The method is to first make a gastric fistula by the <sup>(PK)</sup>author's valve operation, (4) which permits the introduction of an electric light speculum for the observation of the mucosa. On withdrawal of the instrument from the stomach, the valve closes and prevents the escape of any of the gastric contents.

In douching the stomach with the mustard emulsion, it is best to use the author's needle douche.(5)

Experiment 1. Dog, with gastric fistula, (valve operation under chloroform) Introduced the electric light speculum through the gastric fistula and noted the appearances of the mucosa. The needle was then introduced through the mouth into the stomach, and a mustard emulsion 1 to 500, at body temperature douched over the mucosa. In five minutes a local hyperemia of the mucous membranes became markedly reddened. No evidences of changes in the peripheral circulation or indication of splanchnic congestion could be observed. In twenty minutes the mucosa was deeply congested.

Experiment 2. Dog without anesthesia, placed in operating trough and tied in position. Prolonged examination not so practical. Examined the mucosa with speculum, as in Experiment 1. Introduced mustard solution 2 to 500, through the fistula. Again examined the mucosa and observed within five minutes a local hyperemia, as in the first experiment.

Experiment 3. Dog under anesthetic. Introduced douche with water at temperature 40 degrees C. raised to 45 degrees C. in place of mustard emulsion. The heat produced a slight pinkish shade at the end of three minutes. When the water was increased to 45 degrees C., and the pressure of the projected steam was increased, a marked hyperemia of the mucosa was observed.

Experiment 4. Used douch of cold water at 15 degrees C. No marked change in the circulation was observed at first. In five minutes the mucous membrane showed a hyperemia; this was especially noticeable when the pressure of the projected stream.

was increased, with a corresponding increase in the percussion force of the spray.

Experiment 5. Mechanical stimulation of the mucous membrane by the use of the revolving sound(gyromele). After revolving the sound within the stomach for three minutes, the stomach was examined and presented a markedly reddened and hyperemic appearance of the gastric mucosa.

Similar experiments to the above were performed on dogs and rabbits, with the abdomen exposed so as to observe the changes of the splanchnic circulation. It was found that moderate stimulation by chemic or mechanic means, or by heat or cold do not produce marked changes in the splanchnic circulation, but the effect, so far as could be observed, is chiefly local. When the chemic or mechanic irritation is increased or prolonged and where the temperature of the water reaches 50 degrees C. within the stomach, there is a prompt and marked change in the splanchnic circulation. There is undoubtedly increased activity in other organs, produced by the local stimulation of the gastric mucosa, but which cannot always be shown experimentally. The control experiments were made to compare with the changes observed.

From the above experiments, we may conclude that moderate stimulation of the gastric mucosa produces local hyperemia and reflexly affects the circulation of the other organs.

The effects of disturbances of the splanchnic circulation upon the stomach and intestines are largely as follows:

Contraction of the splanchnic area, with dilatation of somatic area, i.e., the peripheral circulation, is a condition in which the blood is distributed to the periphery with

simultaneous contraction of the splanchnic vessels. We have, as examples of this condition, the results of exercise just before or after a meal, which increases the peripheral circulation and interferes materially with the physiologic hyperemia necessary to gastric digestion. Putting the feet in hot water immediately after a meal, will inhibit, or perhaps check completely, the motor and secretory functions of the stomach, this being the result of the disturbed circulatory balance. Colonic lavage, or injections of large quantities of hot water into the colon, interferes at once with the motor activities of the stomach, causing more or less nausea and even vomiting, if performed after a meal; this has an effect similar to placing the feet in hot water immediately after eating, inasmuch as the use of hot water 55 degrees C. in the colon produces contraction of the splanchnic vessels with dilatation of the peripheral arterioles. (6)

Pronounced dilatation of the splanchnic area, or pathologic hyperemia (both arterial and venous congestion). Clinically the general symptoms of splanchnic congestion are noted by inspection of surface, character of the pulse, the use of the sphygmograph before and again after hot baths, colonic lavage and blood count.

We are familiar with changes of the splanchnic circulation in cardiac disease, especially the disordered circulation following large ingestion of food and water, and also the circulatory disturbance in hepatic obstruction with the resulting inactivity of the gastro-intestinal tract caused by the venous congestion. Chronic gastro-intestinal diseases:

ofte produce marked disturbance of the splanchnic circulation, interferes with the motility and the secretory function of the gastro-intestinal tract. This is especially true of acute pathologic lesions of the intestines, such as various forms of inflammation, acute enteritis, intussusception, impaction, appendicitis, all of which are known to result in marked splanchnic congestion which interferes with both the motor and secretory functions of the stomach and intestines. In shock, after an operation, the chief pathologic condition observed is splanchnic congestion. Clinical evidence has proved the inactivity of the digestive function, both of motivity and secretion in shock. This, I have repeatedly shown in my experiments on animals in shock. (7) (14)

Splanchnic congestion may be artificially produced in animals. My earlier experiments were by the direct method of observation of the changes in the circulation according to the following order: By opening the abdomen and observing color changes of the abdominal viscera, by changes in the calibre of vessels observed with a small lens and in the mesentery of the frog and guinea pig; microscopic examinations of the capillary circulation. Observations by this method show the rapidity of the current, dilatations of the vessels, stases, etc.

A second method is indirect. It consists of observing the color changes in the peripheral circulation and the blood pressure (taken with the manometer and kymograph tracings, etc.)

Vascular relaxation or dilatation of the splanchnic area is a symptom complex with associated nervous and physical phenomena.

In our practice the condition is found most frequently in women, but it is not of uncommon occurrence in men.

The causes are congenital or acquired. Environment and correct habits may offset a congenital tendency. In general the causes are those affecting peripheral resistance or heart energy. There is intraabdominal congestion preceded by splanchnic vasomotor insufficiency. These conditions arise from various functional or organic derangements, such as toxemias, particularly autotoxemias, constitutional diseases, frequent pregnancies, tumors, and endocrinal imbalance, as in case of adrenal insufficiency and thyroid excess, all associated with a derangement of the autonomic-sympathetic nervous system. Splanchnic dilatation is often found in splanchnoptosis(9), including abnormal distalward movement of viscera, "abdominal relaxation, which may sometimes be preceded by thoracic relaxation, elongation of mesenteries, and compression of the duodenum! Constipation with its inducing factors, particularly ptosis, is often an associated cause. Many of these patients are heavy flesh consumers with a resultant purin excess, favoring decomposition with its toxic wastes. Others suffer from nonobservance of a balanced diet, associated with a capricious appetite and other violations of the laws of health.

In appearance the patient often presents a picture of lowered tonicity- thin, flat chested, with impaired respiratory movement, and poorly postured, with flaccid abdomen and flabby muscles representative of lowered resistance. The less frequent type is inclined to obesity and has a heavy abdomen.

The symptoms most frequently mentioned are those of fatigue. These patients are always tired on rising, and have a general let down feeling with lost initiative and resiliency. The slightest exertion causes exhaustion, and the sufferers are disposed to be cross and irritable. The ordinary duties of life, even dressing are onerous. The vision of life is disturbed and depressed, often verging on melancholia. A congested prostate or inflamed uterus may add a nervous syndrome. Trophic disturbances are present, as evidenced by deficient secretions, dry hair, a dry discolored skin, and brittle nails. Respiration is sometimes disturbed, owing to pressure or downward traction. Dyspnea may occur on slight exertion, probably owing to diminution of oxygen and increase of carbon dioxide in the blood, causing quicker and deeper respiration until respiration becomes labored. The oxygen content of the blood is lowered, so affecting nutrition. Bilious attacks may occur, due to disordered circulation and engorgement of the liver. Gastro-intestinal symptoms often predominate with fermentation, eructations, nausea, vomiting, or even attacks simulating ptomaine poisoning or the symptoms of extreme gastroduodenal dilatation, the proximal (10) end of the duodenum being dilated with the stomach, the duodenum being fixed, while the organs move distalward in splanchnoptosis. In such cases pain (11) is felt and is mainly referred to the lateral and dorsal region." Symptoms of endocrinal disturbance may be present. When the cardia is involved, syncope may occur.



The splanchnic area, the largest vasomotor area, is controlled by the splanchnic nerves connected with the semilunar ganglia and solar plexus, which supply all of the abdominal viscera and the diaphragm. The sympathetic nerves regulate the lumen of the bloodvessels. Disturbance, mechanical or pathological, in this region or in association with a disturbed thoracic area affects the solar plexus with the associated nerves and the blood vessels regulated by them, as well as the organs whose functions and activities are controlled by the nerves and bloodvessels.

According to some authorities, the splanchnics are from fibres coming from the fifth to the twelfth dorsal nerves, which may arise (12) from the second to and including the eighth dorsal vertebrae, or even including the ninth. The splanchnic nerve has the largest vascular control of the body; in the liver alone it controls one fourth of the total amount of blood in the body. The lesser splanchnic has its origin from the tenth and eleventh dorsal ganglia. Irritation of the communicating branches between the eleventh dorsal and second lumbar nerves causes marked dilatation after primary contraction.

Landois (13) notes that "irritation of this nerve (the splanchnic) is, therefore, followed by marked increase in the blood pressure. Paralysis of the splanchnic, as it innervates the large branches of all arteries of the abdomen, is attended with such marked stagnation of blood in the dilated abdominal vessels that all remaining portions of the body become anemic and death may even result in a measure in consequence of intravascular hemorrhage."

Moderate stimulation causes constriction, whereas too prolonged or heavy stimulation causes dilatation. The exceptional results from treatment, as mechanical vibratory applications, may be due to the personal equation, an ordinary stimulus acting possibly as an inhibitor in those of lowered vitality, or a depressor effect may predominate. Landois (14) states that the capacity of the vascular system, depending in part on the condition of the vasomotor nerves, influences body weight.

Constriction and stasis with dilatation may be present. The veins, owing to their anatomical construction, are more easily affected by stasis than the arteries. In advanced cases of splanchnoptosis, according to Byron Robinson (15), "The pelvic veins are widely and irregularly dilated, containing enormous quantities of blood. This causes hyperemia, congestion, and stasis of the pelvic organs. The liver suffers likewise from congestion, hyperemia, and blood stasis and, by its dislocated position, compromises the blood current, especially in the portal and hepatic veins. Stagnation, stasis, congestion and hyperemia are the characteristics in the splanchnoptotic."

In all cases of splanchnic dilatation the stomach is dilated, enteroptosis with a large quantity of gas is usually present, and the liver is engorged. When displaced, (16) the liver may even change the relationship of the portal vein, and the inferior vena cava and the veins of the liver may be displaced or compromised. The dislocated viscera naturally cause irritability. In splanchnoptotics (17) "the visceral circulation is impeded by flexion, dilatation, constriction, decalibration, elongation of vessels" and the nerve sheath is wounded. Autopsy findings

according to Byron Robinson, have shown a lengthening of several inches in a splanchnoptotic subject. He further states that "the visceral arteries elongate, decrease in diameter, diminish spirally, experience parietal atrophy," and their accompanying nerves suffer, "damaging vascular function (especially rhythm) so that excessive, deficient, or disproportionate circulation arises."

The organs, - stomach, liver, spleen, kidneys, as well as the intestines, but especially the liver, affected suffer from pathological changes due to congestion. There is, as a result, a lowered functional activity and form, the latter due to increased tension and interference with normal function, as well as extraneous pressure. Owing to the stasis, invasion of infection is easy.

Defective circulation results in "cardioptosis, (18) Flexion, stenosis, elongation, dilatation," nerve imbalance, and venous congestion. Venous congestion alters the body distribution of the blood, resulting under certain conditions in myocardial insufficiency, which may often be demonstrated by taking the pulse of the individual in the lying and sitting posture, and noting the presence of a higher rate or the same pulse record when lying as when sitting. Dizziness, headache, disturbed vision, and cardiac irregularities may be a common syndrome with these patients. Loss of tonicity of the heart vessels results in muscular relaxation, accompanied by murmurs noticeable during a rest period, but eliminated by exertion. It is these cases which are particularly amenable to treatment with mechanical vibrations over the corresponding spinal centers.

In cardiac cases the liver may become enlarged. Vaquez (19) states that, " at necropsy on subjects dead of heart failure, the liver is increased in size, the average weight being from sixty-six to ninety-three ounces. The gaping hepatic veins outside of the liver may be so distended that they admit the thumbs. The trunk and branches of the portal vein also are distended and sclerous. This pylephlebitis may extend to a distance, explaining the customary congestion of the abdominal viscera and the ascites."

In cardiac disease the typical, fully developed cardiac kidney, says Chauffard (20), " is the end result of an intense, persistent venous stasis, which has become chronic. This formula sums up very accurately the evolution of the lesions of the kidneys in cardiac patients, and it indicates that the congestive element plays the preponderant part." It is a cyanotic kidney.

Examination should be made of the pulse and blood pressure, both in the erect posture and the prone position, with the patient stripped from the waist up. Also, observe the limited respiratory excursions. It will be noted that most of these cases are abdominal breathers. X-ray examinations are of importance in completing the diagnosis. A pathognomonic sign of splanchnic dilatation is found when the lower part of the sternum contiguous to the heart is percussed before and after interrupted vibration applied over the stomach. The percussion note before treatment is resonant or hyper-resonant, whereas after treatment it is dull or flat.

In vascular dilatation of the splanchnic area this area of dullness is greater than in the normal individual. There is also an exaggerated abdominal dullness.

Another finding of great importance is the disparity existing in the blood pressure of patients suffering from vascular dilatation of the splanchnic area, or vasomotor tonal deficiency. It is our observation that these cases, when of long standing, often terminate in sudden death as a rule ascribed to apoplexy or acute indigestion. Howell (21) states "In determinations of blood pressure in the brachial artery of man care must be taken to keep the arm in the same position in a series of observations, in order to equalize the hydrostatic factor. The importance of this gravity is most evident in the case of the abdominal (splanchnic) circulation."

Normally from lying to sitting the systolic and diastolic pressures are in the ascending scale. The pulse pressure is in a descending scale, and the pulse rate ascending, as with the blood pressure. In vascular dilatation of the splanchnic area the systolic pressure is uniformly higher when lying than sitting. Howell states (22) "that, under normal conditions, the peripheral resistance in this great area (splanchnic) plays a predominating part in the maintenance of normal arterial pressure, and, by the same reasoning, variations in tone in the arteries of this region must play a very large part in the regulation of arterial pressure". Erlanger and Hooker(23) acknowledge that "the changes of the circulatory conditions, when the erect posture is assumed, are induced mainly by the action of gravity, and are probably elicited by 'bleeding' into the lower extremities. The effect is compensated by peripheral

constriction and by an increase in the energy of the heart". The two factors requiring regulation in the treatment of vascular relaxation of the splanchnic area are "peripheral or vasomotor constriction" and cardiac tonicity. Causes affecting a disturbance of the normal relations must be removed if possible, and the possible consequences be so obviated.

Whereas normally the systolic blood pressure is approximately four millimetres higher when sitting than lying, in cases of splanchnic dilatation it may be the same, or sometimes reversed, often as much as twenty to thirty millimetres. This we find is pathognomonic. It may be associated with either high or low blood pressure. (24)

#### CASE ONE.

Mrs. B. A case of high blood pressure associated with exophthalmic goitre.

Sys. lying	192	Dia. lying	126	P.P.	66	Pulse	116	V-7988
" sitting	179	" sitting	110	P.P.	69	"	118	V-8142

After a five minute vibratory treatment with the ball vibrator in the intervertebral spaces alternately from side to side from the second to the sixth dorsal vertebra from above downward, using moderate pressure, her record was:

Sys. lying	178	Dia. lying	126	P.P.	58	Pulse	106	V-6148
" sitting	184	" sitting	110	P.P.	74	"	110	V-8140

The pulse pressure was lowered lying and the velocity of the blood diminished lying and sitting, meaning an increase in peripheral resistance. This patient's treatment also consisted of the use of the fractional dose of X-ray over the goitre, a static wave current with a metal electrode over the goitre

for twenty minutes, and a static wave current with a metal electrode over the liver, the electrode being connected to the positive side of the machine, the negative being grounded.

CASE TWO.

Mrs. G.H.G. A case of vascular dilatation of splanchnic area associated with uterine fibroid. Complained of fatigue

12/2/24

Sys. lying 196 Dia. lying 100. P.P. 96 Pulse 68 V-6528  
" sitting 180 " sitting 110 P.P. 70 " 70 V-4900

She received X-ray treatment for her fibroid, the static wave current over the liver for twenty minutes to deplete and increase its functional activity, and mechanical vibration in the intervertebral spaces from the second to the sixth dorsal vertebra to contract the splanchnic vessels by stimulating the nerves supplying that area, and autocondensation for its general soothing effect. In general, mechanical vibration is the most effective means for lowering the blood pressure.

The next day (12/3/24) the reading was:

Sys. lying 180 Dia. lying 110 P.P. 70 Pulse 72 V-4940  
" sitting 174 " sitting 100 P.P. 74 " 66 V-4884

The lowered pulse pressure and lowered velocity of the blood flow lying increased peripheral resistance. This patient showed a myocardial insufficiency, but was not vibrated for it while her pressure was high.

A week later (12/10/24) her record was:

Sys. lying 150 Dia. lying 100 P.P. 50 Pulse 58  
" sitting 150 " sitting 110 P.P. 40 " 64

A little over five weeks later (1/19/25) her record stood:

Sys. lying 112 Dia. lying 80 P.P. 32 Pulse 54  
" sitting 116 " sitting 80 P.P. 36 " 58

Later readings showed even systolic pressure and later correct relationship and a restoration to normal diastolic relationship. Almost two weeks later her systolic pressure dropped below one hundred, probably due to reaction from the X-ray, and a week following there was a reversed postural relationship of the systolic and diastolic pressures, but on February 22 her record was:

Sys.	lying	120	Dia.	lying	80	P.P.	40	Pulse	60
"	sitting	124	"	sitting	82	P.P.	42	"	54

The pulse showed a myocardial insufficiency, calling for a two minute vibratory treatment in the intervertebral spaces between the seventh cervical and first dorsal vertebrae, which corrects such disparity by toning up the nervous mechanism of the heart.

### CASE THREE

Mrs. R. A case of uterine hemorrhage from fibroid and of splachnoptosis. Her record was:

Sys.	lying	Dia.	lying	78	P.P.	26	Pulse	68
"	sitting	"	sitting	70	P.P.	30	"	70

Her treatment consisted of the use of the X-ray for the hemorrhage and fibroid, static breeze as a tonic, and mechanical vibration, five minutes from the second to the sixth dorsal vertebra with the ball vibratode. It was applied in the intervertebral spaces alternately from side to side and from above downward. After the hemorrhage ceased ultraviolet rays were used as a tonic, and vibratory treatment was given between the seventh cervical and first dorsal vertebrae, as there was myocardial insufficiency.



The erratic pulse is usually corrected and murmurs sometimes lessened or eliminated by a two minute vibratory treatment with the ball vibratode interruptedly in the intervertebral spaces between the seventh cervical and first dorsal vertebrae, and the tachycardia by a five minute vibratory application with the ball vibratode in the intervertebral spaces alternately from side to side from the second to the sixth dorsal vertebra from above downward.

For the engorged organs, the heart reflex of contraction affecting the heart and liver is induced by a two or three minute vibratory treatment or percussion between the seventh cervical and first dorsal vertebrae in the intervertebral spaces from side to side, which also induces a reflex contraction of the liver and stomach. For the liver, spleen, stomach, and intestinal reflex of contraction, a ten minute vibratory treatment in the intervertebral spaces is given between the first and second and second and third lumbar vertebrae. The kidney reflex of contraction may be elicited over the twelfth dorsal spine. The above outlined treatment is symptomatic. The cause or causes must be considered. If splanchnoptosis is present, replacement and mechanical means should be used to keep the viscera in their normal position. Supports with elastic are condemned. A linen mesh support, properly bound, or a rigid support is preferred.

The splanchnoptotic should lie on the abdomen or side or assume the lateral horizontal position(30) "to increase the superior mesenteric vertebral angle, to avoid venous congestion,

and to prevent the viscera from passing distalward, producing stenosis and flexion of the lumen of the vessels, ducts, and viscera." Lying on the back and standing increase the compression. Gymnastic exercises for respiration, such as Kingscote's (31), are recommended to help overcome respiratory deficiency, and special exercises should be used to tone up the weak muscles and affect the ptosis of the abdomen.

Vascular dilatation of the splanchnic area is a most neglected subject for consideration in diagnosis. Many deaths are caused by the patient bleeding into his own arteries. Byron Robinson reported (32) that "in autopsies on some advanced splanchnoptotics the numerous vastly distended blue veins presenting among the abdominal viscera suggest the idea that the patient had bled to death in his own abdominal veins. The veins of the viscera and ganglia are engorged, flooded with stagnant, venous blood surcharged with carbonic acid-while the arterial blood invigorated with Life's messenger, oxygen, is excluded."

Habits of life, a nontoxic and nonacid producing diet and the removal of toxic syndromes are indicated. Medically, the promotion of elimination and assimilation is necessary. Visceral drainage and toxic elimination are best treated by high colonic flushings, radiant light and heat, or carbon arc light baths, hydrotherapy, and the static wave or sinusoidal current. Restoration or promotion of functional activity is obtained by the use of ultraviolet rays, the static wave current, and diathermy, as indicated; the lessening of reflex muscle tension by the static sparks or mechanical vi-

bration, and by regulation of daily life as regards baths, diet, habits, and environment.

(28) Since the greater amount of variation in the splanchnic circulation is directly or indirectly due to some involvement of the vasomotor system, it might be well to consider some of the grosser aspects of the nerve supply to the splanchnic blood vessels and the viscera. The sympathetic nervous system is divided into cervical, thoracic, and abdominal portions. The cervical portion does not concern us, but the lower part of the thoracic system does, in that it gives rise to the splanchnic nerves which pass into the abdomen to make important neural connections.

The splanchnic nerves are three in number, and they arise from the inferior portion of the gangliated trunk, partly from the ganglia themselves, and partly from the connecting cord between the ganglia. Actually they consist in greater part of fibers of the white rami which merely transverse the gangliated trunks on their way to their distribution. Passing downward over the bodies of the thoracic vertebrae, they pierce the diaphragm to end in the abdomen.

The greater splanchnic nerve arises from the gangliated trunk between the fifth and ninth or tenth ganglia. By the union of several irregular strands, a nerve of considerable size is formed, which descends in the posterior mediastinum, and piercing the crus of the diaphragm, joins at once the anterior end of the coeliac ganglion. In its course in the thorax, the splanchnic ganglion is formed upon the nerve opposite the eleventh or twelfth thoracic vertebrae.

From both, nerve and ganglion branches arise in the thorax for the supply of the esophagus and descending thoracic aorta.

The lesser splanchnic nerve arises from the gangliated trunk opposite to the ninth and tenth ganglia. It passes over the bodies of the lower thoracic vertebrae, pierces the diaphragm near, or along with the greater splanchnic nerve, and ends in the coeliac plexus. The lowest splanchnic nerve arises from the last thoracic ganglion of the sympathetic, or it may be a branch of the lesser splanchnic nerve. It pierces the diaphragm and ends on the renal plexus.

The abdominal, or lumbar part of the sympathetic trunk is placed upon the bodies of the lumbar vertebrae, medial to the origins of the muscle, and in front of the lumbar vessels. It is connected with the thoracic portion of the trunk by an attenuated cord which either pierces or passes behind the diaphragm. It is joined by medullated fibers (white rami communicantes) from the first two or three lumbar spinal nerves, and it contains, as well, medullated fibers continued down from the lower part of the thoracic sympathetic trunk, and derived from the visceral branches (white rami communicantes) of the lower thoracic nerves. This part of the trunk is characterized by great irregularity in the number of the ganglia. They are usually four in number, but there are frequently more (up to eight); and in extreme cases union may occur to such an extent that the separation of individual ganglia becomes impossible. Only the first two to three lumbar spinal nerves send white rami communicantes to the sympathetic trunk.

The coeliac or solar plexus, the largest of the pre-vertebral plexuses, lies on the posterior abdominal wall in relation to the abdominal aorta and behind the stomach. It is composed of these three elements; the coeliac plexus surrounding the origin of the coeliac artery, between the crura of the diaphragm, and two coeliac ganglia, each lying on the corresponding crus of the diaphragm, and overlapped by the suprarenal gland, and on the right side by the inferior vena cava. The plexus is continuous with subordinate plexuses, diaphragmatic, suprarenal, renal, and superior mesenteric. It is continued downward into the aortic plexus, which by means of the hypergastric nerves, is connected with the hypogastric plexus, which again forms the chief origin of the pelvic plexuses.

At the upper end, the coeliac ganglion receives the greater splanchnic nerve. The aortico-renal ganglion at its lower end receives the lesser splanchnic nerve. The coeliac plexus investing the coeliac artery, forms several subsidiary plexuses. The left gastric plexus supplies branches to the stomach and esophagus; the hepatic plexus supplies branches to the liver and gall-bladder, stomach, duodenum, and pancreas; and the splenic plexus sends off sets to the spleen, pancreas, and stomach.

The phrenic plexus consists of fibers arising from the coeliac ganglion, and accompanies the phrenic artery. It supplies the diaphragm and connects on each side with the phrenic nerve. The suprarenal plexus situated on the suprarenal arteries receives branches from the coeliac plexus,

communicating above with the phrenic plexus and below with the renal plexus. The renal plexus situated in relation to the kidneys is connected with the coeliac, aortic, and suprarenal plexuses.

The superior mesenteric plexus is inseparable from the coeliac plexus. It accompanies the superior mesenteric artery and sends branches to the small intestine, cecum, vermiform appendix, and ascending and transverse colon.

The aortic plexus is a continuation of the coeliac plexus, surrounding the abdominal aorta and being connected below by means of the hypo-gastric nerves to the hypo-gastric plexuses which are located on either side of the rectum. It is connected with the suprarenal and renal plexuses, and gives rise to the spermatic, or ovarian, and the inferior mesenteric plexus. The spermatic plexus accompanies the spermatic artery and supplies the spermatic cord and testis. The ovarian plexus accompanies the ovarian artery and supplies the ovary, broad ligament and uterine tube. The inferior mesenteric plexus is continued along the inferior mesenteric artery. It sends branches to the descending colon, iliac, colon, pelvic colon, and upper part of the rectum.

#### SUMMARY

After considering the context of this article the most striking aspect is the fact that the subject of the splanchnic blood vessels, while yet in its incipiency, has afforded much interesting, as well as valuable information up to the present time and will continue to yield much more valuable data within the near future.

We find that most work performed up to the present time has had to do with the physiological aspects of the splanchnic blood vessels, largely as gleaned through experiments on animals. One also notes that there is a definite appreciable disturbance of the splanchnic blood vessels in various diseased conditions and in conditions which produce actual physical distortion of the splanchnic blood vessels as in splanchnoptosis, etc. The resultant condition has, however, been directly or indirectly concerned with the vasomotor tone as regulated by the splanchnic nerves which results in a symptom complex associated with certain nervous and mental phenomena.

Several important generalizations were made as to the definite clinical aspect of patients suffering with relaxation of the splanchnic blood vessels, brought about by some definitely demonstrable organic or functional bodily pathology and disfunctionnot necessarily connected with the immediate physiology of the splanchnic blood vessels. The exact relationship in all cases is not known and no satisfactory attempt has been made to explain with a plausible relationship on an understandable and workable basis. Whether the influence is brought to play upon the splanchnic nerves directly or through the transmission of some substance through the blood stream, or as a result of a combination of these factors is not definitely known.

The fact that severe relaxation of the splanchnic blood vessels actually exists as a clinical and pathological entity has been verified, in that patients supposedly having been

afflicted with a condition of relaxed splanchnic blood vessels have been found to die in a state simulating apoplexy or acute indigestion. Upon confirmatory necropsy investigation these patients were found to have their splanchnic blood vessels extremely dilated and congested.

The only definite therapeutic measure that has been instituted along these lines is the use of a vibratory apparatus (node) placed between the vertebral bodies which correspond to the origin of the splanchnic nerves. These vibratory treatments usually result in a definite improvement in the tone of the contiguously innervated splanchnic blood vessels.



