1932

Splanchnic blood vessels

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Recommended Citation

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BY

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1973

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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 cir-
culation of the somatic area and the splanchnic area. When
the peripheral vessels dilate, the splanchnic vessels con-
tract. 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 correspond-
ing contraction of the deeper vessels. The splanchnic circu-
lation, considered anatomically, includes the celiac axis
(gastric, splenic and hepatic vessels), the superior and in-
ferior mesenteric arteries and veins, the renal veins etc.;
these supply the abdominal viscera. (1)

The arterial branches of the abdominal aorta are di-
vided into visceral and parietal groups. The visceral ves-
sels 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 vis-
ceral branches of the abdominal aorta beginning with the
three pairs of suprarenal arteries- superior, middle and in-
ferior. Of these, the middle only arise from the aorta di-
rectly; 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 ab-
dominal ingainal ring, when it comes in relation with the
ductus deferens. It accompanies the ductus deferens through
the inguinal canal to the testic, to which it is distributed.
The course and relations of each orarian artery as far as the
level of the brim of the pelvis minor, are the same as the re-
lations 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 e-
sophagus 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, continu-
ing as the main hepatic branch which supplies the liver and
the gall bladder. It sends a short gastric branch to the les-
ser 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 seperable 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 mesentericartery springs from the anterior
aspect of the aorta, supplying the large intestine, and is con-
tinued 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 hemorroidal
ar tery together with which they supply the rectum in its
full extent.

In a consideration of the venous drainage of the vis-
cera, 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, continu-
ing on through the diaphragm, middle midiastinum, 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 con-
vey 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 opins into the left renal vein. The renal
veins begin by the uhion 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 t 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 gastro-intestinal 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 peri-
pheral vessels vigourously 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 accomodate 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 vas-
cular activity is entirely dependent upon the integrity and
sensitiveness of the vaso-motor apparatus. Prolonged stimula-
tion results in congestion of pathologic hyperemia. We must
regard all stimulation as reflex, even psychic impulses or-
iginating in the higer centers, such impulses being transmitted
to the vaso-motor apparatus that controls the splanchnic circu-
lation.

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 ef-
fects 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 univers-
ally 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 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, particulary 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 meloncholia. A
congested prostate or inflamed uterus may add a nervous syn-
drome. Trophic disturbances are present, as evidenced by de-
ficient secretions, dry hair, a dry discolored skin, and brit-
tle nails. Respiration is sometimes disturbed, owing to pres-
sure or downward traction. Dyspnea may occur on slight exer-
tion, probably owing to diminution of oxygen and increase of
carbon dioxide in the blood, causing quicker and deeper res-
piration until respiration becomes labored. The oxygen content
of the blood is lowered, so affecting nutrition. Bilious at-
tacks may occur, due to disordered circulation and engorgement
of the liver. Gastro-intestinal symptoms often predominate
with fermentation, eructations, nausea, vomiting, or even at-
tacks simulating ptomaine poisoning or the symptoms of extreme
gastroduodenal dilatation, the proximal (10) end of the duoden-
um 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 excep-
tional results from treatment, as mechanical vibratory applica-
tions, 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, conges-
tion, and stasis of the pelvic organs. The liver suffers like-
wise 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 di-
lated, enteroptosis with a large quantity of gas is usually pre-
sent, and the liver is engorged. When displaced, (16) the liver
may even change the relationship of the portal vein, and the in-
ferior 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 embalance, 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 noticealbe during a rest period, but eliminated by exertion. It is these cases which are particularly amenable to treatment with mechanical vibrations over the correspinding 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 hyperresonant, 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 teh 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 tome 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 vas-
cular relaxation of the splanchnic area are "peripheral or
vasomotor constriction" and cardiac tonicity. Causes af-
fecting 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 approx-
imately four millimetres higher when sitting than lying, in
cases of splanchnic dilatation it may be the same, or some-
times 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 exophthal-
mic goitre.

Sys.lying 192 Dia. lying 126 P.P. 66 Pulse 116 V-7988
  " sitting179   " sitting110 P.P. 69   "   118 V-8142

After a five minute' vibratory treatment with the ball vibratode
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 in-
crease 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 gen-
eral 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 Pulse72 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:

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Sys. lying 120 Dia.  lying 80  P.P. 40  Pulse 60
  "  sitting124  "  sitting 82  P.P. 42    "   54
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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 splanchnoptosis. Her record was:

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Sys. lying  Dia.  lying 78  P.P. 26  Pulse 68
  "  sitting    "  sitting70  P.P. 30    "   70
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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 inervertebral 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, havits, 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 biscera. The sympathetic nervous sys-
tem 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 import-
ant 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 gang-
liated 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 op-
posite 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 lumber 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 celiac 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 cotinuous 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 ganlion 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 subsidary 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 inseperable 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 with-
in 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 investiga-
tion these patients were found to have their splanchnic blood
vessels extremely dilated and congested.

The only definite therapeutic measure that has been in-
stituted along these lines is the use of a vibratory appara-
tus (node) placed between the vertebral bodies which corres-
pond 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.

BIBLIOGRAPHY

(1) Fenton B. Turck, M.D., Chicago.
(2) Cunningham's Anatomy
(3) Fenton B. Turck, M.D., Chicago   The American Therapeutist.
                                                    Vol. 9.
(4) Glandular Gastritis   Medical News, Apr.4,'96.
(5) "A New Operation for Gastrostomy." Brit. Med. Journal,
                                            Nov. 19, 1898
      Journal of the American Medical Association, June 22, 1895.
(6)"Treatment of the Abdominal Viscera Through the Colon".
      Journal of the Am. Med. Association, October 7, 1899 and
                                            May 5, 1900
(7) "Surgical Shock" Journal of the Am. Med. Association
                  June 19, 1897-
      "The Care of Patients During Surgical Operations".
            Medical Record, August 11, 1900.
(8) Physical Therapeutics   Vol. 44. By Mary L. H. Arnold Snow,M.D.
(9) Robinson, Byron: The Abdominal and Pelvic Brain, p.546.
(10)Robinson, Byron: The Abdominal and Pelvic Brain, p.622-623.
(11)Robinson, Byron: The Abdominal and Pelvic Brain, p.633
(12)Weaver's Chart. Philadelphia, Pa.
(13)Landois: Text Book of Human Physiology.
(14)Landois and Stirling: Text Book of Human Physiology, p.861.
(15)Robinson, Byron: The Abdominal and Pelvic Brain, p.627.
(16)Robinson, Byron: The Abdominal and Pelvic Brain, p.627.
(17)Robinson, Byron: The Abdominal and Pelvic Brain, p.628.
(18) Robinson,Byron: The Abdominal and Pelvic Brain, p.548.
(19)Vaquez, Laidlow, Thayer: Diseases of the Heart, P.642-643.
(21) Howell,Wm. A., Ph.D., M.D., LL.D.:"Text Book of Physiology,
                                            p.501, 1909.
(22)Howell, Wm.A., Ph.D.,M.D., LL.D.:"Text Book of Physiology,
                                            p.589, 1909.
(23)Erlanger and Hooker: Johns Hopkins Hospital Reports, Vol.12,
                                            1904,377.
(24)Erlanger and Hooker:Johns Hopkins Hospital Reports, Vol.12,
                                            1904, p.161.
(25)Robinson,Byron: The Abdominal and Pelvic Brain, p.639.
(26)Kingscote, Movement in Organic Disease.
(27)Robinson,Byron: The Abdominal and Pelvic Brain, p.629.
(28) Cunningham's Anatomy.