Dissertation on reflex abdominal rigidity produced experimentally / by T. Watson Wadsworth.

Contributors

Wadsworth, T. Watson. University of Liverpool. Royal College of Surgeons of England

Publication/Creation

[Place of publication not identified]: [publisher not identified], [1912]

Persistent URL

https://wellcomecollection.org/works/epmmagmu

Provider

Royal College of Surgeons

License and attribution

This material has been provided by This material has been provided by The Royal College of Surgeons of England. The original may be consulted at The Royal College of Surgeons of England. Where the originals may be consulted. Conditions of use: it is possible this item is protected by copyright and/or related rights. You are free to use this item in any way that is permitted by the copyright and related rights legislation that applies to your use. For other uses you need to obtain permission from the rights-holder(s).



Minersite Raboratory of Physiology

C. 10 X ford
Please return when finished

C.S. Sherm Th

DISSERTATION

on

REFLEX ABDOMINAL RIGIDITY

Produced Experimentally.

Presented for the Degree of M.D. at the University of Liverpool, June 1912.

Ву

T. Watson Wadsworth, M.B., Ch.B.



Muserett Paper apart of Sonterolos

Produced Experimentally.

Presented for the Degree of M.D. at the University of Liverpool, June 1918.

T. Watson Wadsworth, M.B., Oh.B.



PREFACE.

The following experiments were performed in the Physiological Laboratories of the University of Liverpool, during the period extending from October 1911 to June 1912.

The subject I have chosen for this Thesis was suggested to me by Professor Sherrington. I would like to take this opportunity to thank him for his kind assistance and valuable advice given to me throughout the whole of this research.

10. Effect of stimulating

PREFACE.

The following experiments were performed in the Physical Laboratories of the University of Liverpool, during period extending from October 1911 to June 1912.

The subject I have chosen for this Thesis was suggested
me by Professor Sherrington. I would like to take this
opportunity to thank him for his kind assistance and valuable
advice given to me throughout the whole of this research.

ARRANGEMENT.

- 1. Introduction and plan of work.
- 2. Anatomy of the abdominal muscles and the sympathetic nerves.
- 3. Choice of an anaesthetic.
- 4. Effect of stimulating the central and of the superior mesenteric nerve.
- 5. Analysis of abdominal rigidity.
- 6. Afferent nerves involved in this reflex abdominal rigidity.
- 7. Effect on blood pressure and on the beat of the heart.
- 8. Afferent nerves involved in the above reflex.
- 9. Effect of stimulating the central end of the intercostal nerves.

Character. But 15 18 Act 50

- 10. Effect of stimulating the visceral and parietal pleurae compared.
- 11. Effect of stimulating the central end of the phrenic nerves.
- 12. Conclusion.

ARRANGEMENT.

- . Arow to nelq bas nortouboutal .I
- 2. Anatomy of the abdominal muscles and the sympathetic
 - .oldentseans ne to eciodo .c
- 4. Effect of stimulating the central and of the superior
 - 5. Analysis of abdominal rigidity.
 - 6. Afferent nerves involved in this reflex abdominal
- 7. Hifeot on blood pressure and on the best of the heart.
 - 8. Afferent nerves involved in the above reflex.
- 9. Effect of stimulating the central and of the intercosts
- 10. Effect of atimulating the visceral and particular pleurae compared.
 - ll. Effect of stimulating the central end of the phrenic
 - 12. Conclusion.

INTRODUCTION.

Abdominal rigidity is often associated with disease of the viscera, especially with appendicitis, gastric or duodenal ulcer and disease of the gall bladder. A similar reflex rigidity can be produced experimentally by stimulation of appropriate nerves.

Dr. Mackenzie has described the nature of abdominal pain and hyperaesthesia in his book on "Symptoms and their Interpretation". His suggestion is that the rigidity is also a reflex. Hence the following experiments to be described later were carried out.

The text books on medicine do not sufficiently emphasise the presence of rigidity in cases of gastric and duodenal ulcer. I can find no mention of rigidity as a sign in these diseases in most of the text books I have consulted.

It has been frequently demonstrated that ulcer of the stomach or duodenum has produced pain in the absence of any inflammation of the parietal peritoneum. But it is not so generally known that rigidity has been met with in cases where the parietal peritoneum was quite normal.

INTRODUCTION.

Abdominal rigidity is often essociated with disease of viscers, especially with appendicitis, gastric or duodenal ulcer and disease of the gall bladder. A similar reflex rigidity can be produced experimentally by stimulation of appropriate nerves.

Dr. Mackenzie has described the nature of abdominal pat and hypersesthesia in his book on "Symptoms and their Interpretation". His suggestion is that the rigidity is also a flex. Hence the following experiments to be described late were carried out.

The text books on medicine do not sufficiently emphasis
the presence of rigidity in cases of gastric and duodenal
ulcer. I can find no mention of rigidity as a sign in thes
diseases in most of the text books I have consulted.

It has been frequently demonstrated that ulcer of the stomach or duodenum has produced pain in the absence of any flammation of the parietal peritoneum. But it is not so generally known that rigidity has been met with in cases when the parietal peritoneum was quite normal.

The fact that rigidity can be produced by stimulation of the central end of a sympathetic nerve is in accord with the above clinical manifestations.

The rigidity met with clinically in ulcer of the stomach or duodenum is confined to the epigastrium and involves the recti chiefly. If the ulcer perforates then the rigidity becomes much more marked but in the early stages confined to the epigastrium, and during anaesthesia this part is the last to relax.

The rigidity associated with diseases of the gall bladder is most marked in the rectus of the same side, but may involve all the muscles on the right side.

It was found that rigidity of the recti and the other abdominal muscles could be produced by stimulating the central end of the sympathetic nerves which supply the stomach, duodenum, pancreas, and gall bladder.

The contractions following this stimulation were tetanic and lasted as long as the stimulus.

The recti were divided into segments between their motor nerves. The upper segments became more contracted than the lower. This contraction was obtained even after both vagi were divided in the neck. Hence the vagus does not contain the afferent nerves in this reflex.

The fact that rigidity can be produced by stimulation the central end of a sympathetic nerve is in accord with the above clinical manifestations.

The rigidity met with olinically in wheer of the stoman or duodenum is confined to the epigastrium and involves the recti chiefly. If the wheer perforates then the rigidity comes much more marked but in the early stages confined to epigastrium, and during anaesthesia this part is the last to relax.

The rigidity associated with diseases of the gall blade is most marked in the rectus of the same side, but may involation the muscles on the right side.

It was found that rigidity of the recti and the other abdominal muscles could be produced by stimulating the centred and of the sympathetic nerves which supply the stomach, duod num, pancreas, and gall bladder.

The contractions following this stimulation were tetent and lasted as long as the stimulus.

The recti were divided into segments between their moto nerves. The upper segments because more contracted than the lower. This contraction was obtained even after both vagi were divided in the neck. Hence the vague does not contain the afferent nerves in this reflex.

The rigidity met with in diseases of the vermiform appendix is also probably a reflex, because stimulation of the nerves which supply this portion of the alimentary canal is followed by a contraction of the abdominal muscles.

Rigidity of the abdomen has been present during the life of a patient suffering from an ulcer of the stomach, whose parietal peritoneum was found to be quite normal at the autopsy. Similarly in the case of inflamed appendix or one which was not inflamed, but contained a calculus, rigidity has been exhibited although at the operation no involvement of the parietal peritoneum was found.

Therefore, from the results of necropsies, from the evidence of operations, and from the fact that a similar rigidity can be produced by stimulation of nerves which do not supply the parietal peritoneum, it is clear that involvement of this portion of the peritoneum is not an essential factor in abdominal rigidity.

Rigidity following disease of the pleura is less common than that due to disease of the abdominal viscera but not less important.

Cases of pneumonia have presented a rigidity of the abdomen which simulated that associated with general peritonitis to

The rigidity met with in diseases of the vermiform apport also probably a reflex, because atimulation of the nerve which supply this portion of the alimentary canal is follow by a contraction of the abdominal muscles.

Rigidity of the abdomen has been present during the list a patient suffering from an ulcer of the stomach, whose par peritoneum was found to be quite normal at the autopsy. A slarly in the case of inflamed appendix or one which was not flamed, but contained a calculus, rigidity has been exhibite although at the operation no involvement of the parietal ner toneum was found.

Therefore, from the results of necropsies, from the evidence of operations, and from the fact that a similar rigid; can be produced by stimulation of nerves which do not supply the parietal peritoneum, it is clear that involvement of this portion of the peritoneum is not an essential factor in abdominal rigidity.

Rigidity following disease of the pleura is less common that due to disease of the abdominal viscers but not le

Cases of pneumonia have presented a rigidity of the abd of simulated that associated with general peritonitis to

such a degree, that a laparotomy has been needlessly performed.

Apparently the only way this could result is by a reflex contraction of the muscles due to stimulation of the afferent nerves of the pleura.

Experiment supports this view. It was found that when the central end of an intercostal nerve was stimulated there resulted a contraction of the abdominal muscles.

The contraction varied with the particular nerve stimulated. The rigidity from the lower intercostals was more general than that from the upper.

The uppermost intercostals when stimulated caused a reflex contraction of the upper segments of the rectus on the same side, and a slight contraction of the external and internal oblique muscles on this side. There was practically no contraction of the muscles on the opposite side.

There was a gradual transition from the limited contraction produced by stimulation of the uppermost intercostal to the general contraction resulting when the lowermost intercostals were stimulated, so that the extent to which the rectus was contracted could be used as an indication to the intercostal nerve excited.

anch a degree, that a laparotomy has been needlessly perform apparently the only way this could result is by a reflex contraction of the muscles due to stimulation of the afferent nerves of the pleura.

Experiment supports this view. It was found that when central end of an intercostal nerve was stimulated there resed a contraction of the abdominal muscles.

The contraction varied with the particular nerve stimuled. De contraction the lower intercostals was more generated that from the upper.

The uppermost intercostals when stimulated caused a reflection of the upper segments of the rectus on the same side, and a slight contraction of the external and internal collique muscles on this side. There was practically no contraction of the muscles on the opposite side.

There was a gradual transition from the limited contract produced by stimulation of the uppermost intercostal to the general contraction resulting when the lowermost intercostal were stimulated, so that the extent to which the rectus was tracted could be used as an indication to the intercostal need to

I think that remembering the relation between the extent of the contraction and the intercostal nerve involved may be of value in locating the site of the lesion from the rigidity when present in disease of the lungs.

These experiments demonstrate the reflex nature of abdominal rigidity met with in some cases of pneumonia. This condition is so well recognised that in all cases of abdominal rigidity a very careful examination of the lungs should be made before submitting the patient to an operation.

I have noticed rigidity of the rectus in pleurisy, the rigidity was confined to the same side.

As an instance of this rigidity I may quote the case of a patient suffering from phthisis.

She was under the care of Dr. Bradshaw in the Royal Infirmary, there was well marked rigidity of the upper portion of the rectus on the same side as the cavity. The patient was suffering from a severe haemoptysis, under these circumstances the danger of making a thorough examination, and the difficulty of localising the haemorrhage is well known. But the examination of the abdomen in this case revealed the site of the bleeding without any of the above disadvantages.

I suggest that the examination of the abdomen in similar cases may be of assistance in determining the region to which

I think that remembering the relation between the exter of the contraction and the intercostal nerve involved may be of value in locating the site of the lesion from the rigidit when present in disease of the lungs.

These experiments demonstrate the reflex nature of abdoright the with in some cases of pneumonia. This condition so well recognised that in all cases of abdominal rigidit very careful examination of the lungs should be made before submitting the patient to an operation.

I have noticed rigidity of the rectus in pleurisy, the rigidity was confined to the same side.

As an instance of this rigidity I may quote the case of patient suffering from phthisis.

She was under the care of Dr. Bradehaw in the Royal Infary, there was well marked rigidity of the upper portion of rectus on the same side as the cavity. The patient was sufting from a severe haemoptymis, under these circumstances the danger of making a thorough examination, and the difficulty closalising the haemorrhage is well known. But the examination of the abdomen in this case revealed the site of the bleedin without any of the above disadvantages.

I suggest that the examination of the abdomen in similar

counter-irritation should be applied or where a pneumothorax should be made to prevent the bleeding.

When the visceral pleura was stimulated no contraction of the abdominal muscles was elicited, but when the parietal pleura was similarly stimulated there followed a reflex contraction of these muscles varying with the portion stimulated and corresponding to that produced by the excitation of the neighbouring intercostal nerve.

Blood pressure tracings were taken when the central end of the superior mesenteric nerve was stimulated. Each stimulation was associated with a rise in blood pressure.

A rise in blood pressure is taken by most authorities as indicating pain, so a record of it may be taken as a graphic representation of pain.

The rise in blood pressure followed almost immediately on the stimulation of the central end of the above nerve. This is in accord with the view of Dr. Mackenzie that the pain experienced in disease of the abdominal organs is a viscerosensory reflex.

On one occasion a very interesting alteration in the rhythm of the heart beat was recorded, the beats became much larger and

counter-irritation should be applied or where a pneumothora

when the visceral pleurs was stimulated no contraction the abdominal muscles was elicited, but when the parietal please abdominal muscles was elicited there followed a reflex contraction these muscles varying with the portion stimulated and correcting to that produced by the excitation of the neighbouring intercostal nerve.

Blood pressure tracings were taken when the central end of the superior mesenteric nerve was stimulated. Rach stim lation was associated with a rise in blood pressure.

A rise in blood pressure is taken by most authorities a indicating pain, so a record of it may be taken as a graphic representation of pain.

The rise in blood pressure followed almost immediately the stimulation of the central and of the above nerve. This the scoop of the view of Dr. Machenzie theth the pain expertance in disease of the abdominal organs is a visceroseensory reflex.

On one occasion a very interesting alteration in the ring of the heart beat was recorded, the beats became much larger

the frequency became halved. The pulse was diminished from 240 to 120 per minute. This resembled heart block, both vagi were divided in the neck and the phenomenon disappeared.

I am unable to offer any explanation except that there was vagal inhibition. I am not aware that a similar condition has been met with clinically in disease of the alimentary canal.

To obtain reflex abdominal rigidity by stimulating various

To analyse and compare the contractions obtained reflexly

To note the effect on blood pressure and the heart.

. To determine the afferent path in the above rigidity.

the frequency became halved. The pulse was diminished from 240 to 120 per minute. This resembled heart block, both ve

bersequesib nonemoned end bne most of the belivib erew eight that the parameter any explanation except that the I am unable that a start erews for me I amountain legat to essent in vilsoluilo dilw tem meed

PLAN OF WORK.

- 1. To obtain reflex abdominal rigidity by stimulating various nerves.
- 2. To analyse and compare the contractions obtained reflexly.
- 3. To note the effect on blood pressure and the heart.
- 4. To determine the afferent path in the above rigidity.

PLAN OF WORK

- 1. To obtain reflex abdominal rigidity by stimulating vari
- 2. To analyse and compare the contractions obtained reflex
 - .treed edt bne erwaserg boold no toelle edt eton of .&
 - .vd ibigin evode edt ni dieg inerelle edt enimueteb of ...

ANATOMY. (Cat).

The Abdominal Muscles.

External oblique: arising from the lower eight ribs and the aponeurosis of the lumbar fascia the fibres are directed downwards and inwards.

It is inserted into the brim of the pelvis and the linea alba.

The muscle is superficial to the rectus abdominis, but the fascia is closely adherent to that muscle.

Internal oblique: arising from the ventral aspect of the margin of the ilium and the lumbar fascia external to the erector spinae muscle, the fibres are directed downwards, forwards and inwards.

It is inserted into the cartilages of the ribs. The fascia of this muscle passes ventral to the rectus muscle in its posterior half, but dorsal to it in its anterior half.

Transversalis muscle: it arises from the cartilages of the ribs behind the diaphragm, the ventral margin of the ilium, and from the fascia which invests the ventral aspect of the erector spinae muscle.

. (cat). YMOTAMA. (cat).

External oblique: arising from the lower eight ribs and the aponeurosis of the lumbar fascia the fibres are directe downwards and inwards.

and bue sivied end to mind end oful befream si di .edis semil

the fasoia is closely adherent to that muscle.

Internal oblique: artaing from the ventral aspect of the ma of the illum and the lumbar feachs external to the orec spinse muscle, the fibres are directed downwards, forwa and inwards.

restrict this muscle passes ventral to the rectus muscle not the state of this muscle passes ventral to the rectus muscle in its posterior half, but dorsal to it in its anterior half.

Transversalis muscle: it erises from the certileges of the
ent to nigram lerine ventral margin of the
latium, and from the fascia which invests the ventral
aspect of the erector spinge muscle.

It is separated at its origin from the internal oblique by the erector spinae muscle and some fat. The nerves are found between this muscle and the internal oblique. The fibres are directed vertically downwards and are inserted into a fascia which lies dorsal to the rectus abdominis muscle throughout its whole extent.

Rectus abdominis: the origin is from the symphysis pubis. The fibres run forward in contact with their fellows of the opposite side to be inserted into the third rib and thence onwards by an aponeurosis into the second and first ribs.

The rectus sheath is formed ventrally by the external oblique fascia in the whole of its extent, and in the posterior half by the internal oblique as well. Dorsally it is formed from the transversalis fascia in the whole of its extent, and in its anterior half by the internal oblique also.

The linea alba separates the recti. There are faintly marked tendinous transverse intersections dividing the recti into segments.

It is separated at its origin from the internal oblique by the erector spinae muscle and some fat. The round between this muscle and the internal oblique. The fibres are directed vertically downward are inserted into a fascia which lies dorsal to the reabdominis muscle throughout its whole extent.

Rectus abdominis: the origin is from the symphysis pubia.

fibres run forward in contact with their fellows of the opposite side to be inserted into the third rib and the onwards by an aponeurosis into the second and first rib.

The rectus sheath is formed ventrally by the extensibility oblique fascis in the whole of its extent, and in the erior half by the internal oblique as well. Dorsally its extent, and in its anterior half by the internal its extent, and in its anterior half by the internal oblique also.

The linea alba separates the recti. There are for any marked tendinous transverse intersections dividing tracti into segments.

The Abdominal Nerves. (Cat).

Solar plexus: receives branches from the splanchnics, and from the vagi. Branches are given off which accompany the arteries to the various viscera.

It is situated in the anterior part of the abdomen lying between the supra-renals on each side. The crura of
the diaphragm forms a posterior relation and the stomach
an anterior. It is made up of several ganglia, the chief
one is the semilunar.

The splanchnics are formed by branches from the lower eight thoracic nerves. There are four on each side in the cat.

Hypogastric plexus: receives nerves from the ganglionated cord situated in the lumbar region.

It contains no ganglia. It sends a branch down on either side of the middle line to supply the bladder and the generative organs. These two branches form the pelvic plexus.

.(JEO) .zevieW lenimobdA eMP

Solar plexus: receives branches from the splanchnics, and the vagi. Branches are given off which accompany the arteries to the various viscera.

It is situated in the anterior part of the abdomenting between the supra-renals on each side. The crura the disphragm forms a posterior relation and the stomatan an anterior. It is made up of several ganglia, the cione is the semilunar.

The splanchnics are formed by branches from the le sight thoracic nerves. There are four on each side in the cat.

Hypogastric plexus: receives nerves from the ganglionated of situated in the lumbar region.

It contains no ganglis. It sends a branch down of ther side of the middle line to supply the bladder are the generative organs. These two branches form the peplexus.

CHOICE OF AN ANAESTHETIC.

I used chloroform and ether as a preliminary anaesthetic in every experiment.

In some cases I injected chloralose into the jugular vein after the cat was anaesthetised. This anaesthetic was very efficient, and did not seem to depress the vital centres to any great extent.

I thought it would be less objectionable if some means could be employed to render the animal anaesthetic without using any drug which might possibly interfere with the reflexes under consideration.

The result was that most of the experiments were made on decerebrated cats.

Another reason for this method was that fewer assistants were required, and there was no fear of an over-dose of chloroform. Respiration sometimes ceased after decerebration but artificial ventilation was used, and this was not a disadvantage because in many of the experiments the chest was opened.

The greatest drawback to the method was the difficulty in controlling the haemorrhage from the vertebral arteries. I lost several preparations due to bleeding from them.

CHOICE OF AN ANAESTHETIC.

every experiment.

In some cases I injected chloralose into the jugular very after the cat was anaesthedded. This anaesthedic was very efficient, and did not seem to depress the vital centres to great extent.

I thought it would be less objectionable if some means could be employed to render the animal anaesthetic without using any drug which might possibly interfere with the reil under consideration.

ebem erew streminegre ent to teem tadt esw fluser ent decerebed cats.

Another reason for this method was that fewer assistant were required, and there was no fear of an over-dose of ohl form. Respiration sometimes ceased after decerebration but artificial ventilation was used, and this was not a disadvante of the experiments the chest was opened.

The greatest drawback to the method was the difficulty controlling the hasmorrhage from the vertebral arteries. I lost several preparations due to bleeding from them.

EXPERIMENTS.

Effects on Muscles.

- I. Reflex originated from afferent nerves of the small intestine.
- A. Postganglionic (superior mesenteric).
 - B. Preganglionic (splanchnics).
 - II. Reflex originated from the stomach, gall-bladder and pancreas.
 - III. Reflex originated from the intercostal nerves.
- in contact with. Upper.
- B. Lower.

Effect on the Circulation.

IV. Reflex originated from the afferent nerves of the small intestine.

Afferent roots delimited.

EXPERIMENTS.

Effects on Muscles.

- I. Reflex originated from afferent nerves of the sma
 - A. Postganglionic (superior mesenteric).
 - B. Preganglionic (splanchnics).
 - II. Reflex originated from the stomach, gall-bladder pancreas.
 - . sevien lateographies the intercostal nerves.
 - A. Upper.
 - B. Lower.

.noiseluctio eds no seelim

ent to sevien inerel's 'ont mor's betanigiro kelles .VI .entrestat flams

.befimileb stoot frevellA

I.A. EXPERIMENTS.

Small Intestine. Post-ganglionic.

(1) A cat was anaesthetised, and the carotid arteries were tied. Then a tracheotomy was performed and a cannula introduced into the trachea and tied in.

The animal was turned over and an incision was made in the middle line of the scalp. The skin was reflected downwards and the perioranium and the temporal muscle were dissected off on the left side. The skull was trephined and the dura mater exposed. The dura mater was opened, and a spatula was introduced in contact with the tentorium cerebelli which is bony in the cat, so that the cerebrum was completely divided from the midbrain. The vertebral arteries were compressed whilst this was done and they were held for some time afterwards until all the bleeding had ceased.

The abdomen was opened in the middle line and the muscles exposed. The superior mesenteric nerve was obtained as far away from the ganglion as possible. The nerve was ligated. There resulted a momentary contraction of both sides of the abdomen. The nerve was cut on the distal side of the ligature and the central end dissected back to the ganglion.

I.A. EXPERIMENTS.

Small Intestine. Post-ganglionic.

(1) A cat was anaesthetised, and the carotid arteries were tied. Then a trachectomy was performed and a cannula intr duced into the traches and tied in.

The animal was turned over and an incision was made in middle line of the scalp. The skin was reflected downward the perforanium and the temporal muscle were dissected off the left side. The skull was trephined and the dura mater posed. The dura mater was opened, and a spatula was intro in contact with the tentorium cerebelli which is bony in the cat, so that the cerebrum was completely divided from the mater. The vertebral arteries were compressed whilst this done and they were held for some time afterwards until all bleeding had ceaued.

The abdomen was opened in the middle line and the musclessposed. The superior mesenteric nerve was obtained as far away from the ganglion as possible. The nerve was ligated. There resulted a momentary contraction of both sides of the abdomen. The nerve was out on the distal side of the ligated the central end dissected back to the ganglion.

The central end was stimulated by a moderately strong faradic current. There was produced by this a reflex contraction of both sides of the abdomen, and a reflex blanching of the intestines followed by a dilation when the stimulus ceased.

(2) A cat was anaesthetised with chloroform and ether. It was decerebrated as before. There was a good deal of intracranial haemorrhage. When the haemorrhage had stopped the ventilation was discontinued.

The animal was placed on its back and the limbs were fixed in symmetrical positions. The skin was incised in the middle line and the abdomen opened through the linea alba. The opening was made as small as possible. The liver and stomach were retracted upwards and the intestines and the solar plexus were seen lying between the supra-renals. The nerve which comes from this ganglion and accompanies the superior mesenteric artery was chosen for dissection. The peritoneum was stripped off it and the nerve exposed for about one inch from the ganglion. The nerve itself was not touched during this dissection.

The central end was stimulated by a moderately strong faradic current. There was produced by this a reflex contraction of both sides of the abdomen, and a reflex blanchi of the intestines followed by a dilation when the stimulus ceased.

There was a cat was and ordered with chloroform and ether. I was decembered as before was a good deal of introduced the catallation was discontinued.

The animal was placed on its each and the limbs were fine symmetrical positions. The skin was incised in the middline and the abdomen opened through the lines alba. The opening was made as small as possible. The liver and stome were retracted upwards and the intentines and the solar plan were seen lying between the supra-renals. The nerve which comes from this ganglion and accompanies the superior mesent artery was chosen for dissection. The peritoneum was atripart of it and the nerve exposed for about one inch from the ganglion. The nerve itself was not touched during this dissection.

A ligature was passed round this nerve and tied. There followed this ligation a protrusion of the whiskers and tongue. The respirations were altered in rhythm so that there was a pause for a few seconds.

The nerve was cut on the distal side of the ligature and the central end dissected bodily back to the ganglion. The central end of the nerve was stimulated by a faradic current from the secondary coil of an inductorium. Hand electrodes were used. The secondary coil was placed at ten cm. from the primary. The stimuli were thrown in by a key in the secondary circuit.

On stimulating this nerve there was a protraction of the whiskers and a contraction of both sides of the abdomen which lasted as long as the stimulation.

The muscular contractions were analysed as follows. The external oblique was divided from its attachment to the rectus sheath, and the muscle thrown outwards. It was kept warm with saline.

The free edge of the muscle was held by a hook and forceps and the nerve stimulated as before. The muscle was seen and felt to go into vigorous contraction.

A ligature was passed round this nerve and tied. There re ed this ligation a protrusion of the whishers and tongue. Tempitations were altered in rhythm so that there was a par for a few seconds.

The nerve was out on the distal side of the ligature of the central end dissected bodily back to the ganglion. The central end of the nerve was stimulated by a faradic current of the secondary coil of an inductorium. Hand electrode were used. The secondary coil was placed at ten om from primary. The stimuli were thrown in by a key in the secondary.

on stimulating this nerve there was a protraction of the analas whi whishers and a contraction of both sides of the abdomen whi

The muscular contractions were analysed as follows.

external oblique was divided from its attachment to the receipt warm sheath, and the muscle thrown outwards. It was kept warm saline.

The free edge of the muscle was held by a hook and fore and the nerve stimulated as before. The muscle was seen ar

The internal oblique was exposed. The lower portion was noticed to go into contraction as a result of stimulating this nerve.

It was noticed that the rectus muscle contracted each time the nerve was excited. The whiskers were protracted each time but the tongue was not protruded as it was when the nerve was ligated.

It was found to be almost impossible to investigate the transversalis abdominis because it would necessitate interference with its nerve supply and that of the rectus.

The rectus was next analysed. It was found that the rectus contracted in the whole of its extent when this nerve was stimulated.

The muscle was next divided into three slips by transverse incisions. This could be done without interfering with its nerve supply. It was found that each segment contracted simultaneously when the above nerve was excited.

On placing the fingers against the diaphragm and stimulating during expiration no contraction of this muscle was obtained.

On dissecting the ganglion and the nerve post mortem, it was found that the central end of the nerve supplying the major portion of the small intestine had been stimulated. The other branches of the solar plexus had not been touched.

nolitoq rewol edT .besoure saw supildo lamietni edT gnitalumita to fuser a sa nolitarino otni og of beciton .evren

It was noticed that the rectus muscle contracted each the nerve was excited. The whiskers were protracted each but the tongue was not protruded as it was when the nerve we ligated.

It was found to be almost impossible to investigate the transversalis abdominis because it would necessitate interrested with its nerve supply and that of the rectus.

The rectus was next analysed. It was found that the event ald and the whole of its extent when this nerve was stimulated.

The muscle was next divided into three slips by transve interfering with its traisions. This could be done without interfering with its betoertness transparent contracted si ultaneously when the above nerve was excited.

on placing the fingers against the disphrage and stimulated so that the supering expiration no contraction of this muscle was obtaing during expiration and the nerve post morten, i em ed that the central end of the nerve supplying the majortion of the small intestine had been stimulated. The otherway of the solar plexus had not been touched.

(3) A cat was anaesthetised and then decerebrated as in the previous experiment. Decerebrated rigidity was present.

The abdomen was opened in the middle line and the superior mesenteric nerve isolated as before. The nerve was stimulated by unipolar electrodes. There resulted a contraction of the abdominal muscles on both sides, and there was an occasional flexion of the thighs, on the abdomen.

Whenever this nerve was pulled upon there was a contraction of the abdominal muscles. There was a fairly constant descent of the diaphragm on stimulating the above nerve.

The renal nerve was isolated and the central end stimulated.

On one occasion flexion of the thigh on the same side ensued with descent of the diaphragm, but no obvious contraction of the abdominal muscles resulted.

Both vagi were divided in the neck, no contraction of the abdominal muscles followed this stimulus.

The central end of the superior mesenteric nerve was again excited, but no contraction of the abdominal muscles was noticed.

When the ganglion itself was stimulated the abdominal muscles on both sides became vigorously contracted.

The probable reason that no contraction followed excitation of the nerve itself was that it had been handled too much, and

(5) A cat was anaesthetised and then decerebrated as in the previous experiment. Decerebrated rigidity was present.

The abdomen was opened in the middle line and the supermeasureric nerve isolated as before. The nerve was atimul by unipolar electrodes. There resulted a contraction of the abdominal muscles on both sides, and there was an occasional flexion of the thighs, on the abdomen.

Whenever this nerve was pulled upon there was a contra of the abdominal muscles. There was a fairly constant des

The renal nerve was isolated and the central end stimul one cocasion flexion of the thigh on the same aide ensued descent of the disphragm, but no obvious contraction of the dominal muscles resulted.

no noitestance on , ween ent at behivib even igav atos entention of abdominal muscles followed this stimulus.

The central end of the superior mesenteric nerve was not excited, but no contraction of the abdominal muscles was not muscles on both sides became vigorously contracted.

editions bewolfer neither no contraction followed excits of the nerve itself was that it had been handled too much, a

the animal was commencing dissolution.

It was noticed that as the cutaneous nerves were divided when the skin was reflected that the abdominal muscles gave a twitch.

The splanchnic nerves were isolated but the animal was practically dead so no effect was produced by stimulating them.

Due to the drying of the exposed intestines the blood became inspissated and led to cardiac failure.

Because of the above it was proposed to perform the subsequent experiments on animals in which the intestines had been removed.

The nerves stimulated were verified post mortem.

greater or less extent, and it is seen that in the rectos each

The reaction of the diaphragm veried in different experi-

the stimplus occurring sometimes during expiration and a

No contraction was caused by the stimulus of dividing the

on the other band stimulation of the semiluner ganglic

the animal was commencing dissolution.

ivib erew sevren sucenstuo edt as fadt beolfon saw fl
vez selosum lanimobde edt tedt befoeller saw nina edt nedw
twitch.

The splanchnic nerves were isolated but the animal ware rectically dead so no effect was produced by stimulating boold ent the drying of the exposed intestines the blood became inspissated and led to cardiac railure.

Because of the above it was proposed to perform the su sequent experiments on animals in which the intestines had removed.

metrom taog beliliev evew betslumits sevven enT

RESULTS OF FOREGOING EXPERIMENTS.

The fact that ligature of the superior mesenteric nerve results in a contraction of the abdominal muscles, clearly demonstrates that an afferent sympathetic nerve when stimulated may result in producing a contraction of muscles innervated by cerebro-spinal nerves.

When it is remembered that the superior mesenteric nerve supplies practically the whole of the small intestine, the reaction also explains how disease of the abdominal viscera which involves no nerves supplying the parietal peritoneum may exhibit abdominal rigidity.

Stimulation of this nerve produces a bilateral contraction of the abdominal muscles which involves all the muscles to a greater or less extent, and it is seen that in the rectus each segment contracts independently of the other.

The reaction of the diaphragm varied in different experiments, and even in the same experiment, this was probably due to the stimulus occurring sometimes during expiration and at other times during inspiration.

No contraction was caused by the stimulus of dividing the vagi. On the other hand stimulation of the semilunar ganglion

The fact that ligature of the superior mesenteric nervered to substitute in a contraction of the abdominal muscles, clearly demonstrates that an afferent sympathetic nerve when stimularly result in producing a contraction of muscles innervated cerebro-spinal nerves.

when it is remembered that the superior mesenteric ner supplies practically the whole of the small intestine, the action also explains how disease of the abdominal viscera w involves no nerves supplying the parietal peritoneum may exabdominal rigidity.

Stimulation of this nerve produces a bilateral contract the abdominal muscles which involves all the muscles to greater or less extent, and it is seen that in the rectus esegment contracts independently of the other.

The reaction of the disphragm varied in different expendents, and even in the same experiment, this was probably do to the stimulus occurring sometimes during expiration and a other times during inspiration.

gnibivib to sulumits ent to besuse asw notice of dividing vagi. On the other hand stimulation of the semilumer gang

after vagal division evoked contraction of the abdominal muscles. Hence the afferent path is not even partially contained within the vagus.

rigidity ensued.

The abdomen was opened and the superior mesenteric ner

isolated and ligated as before, and the central end stimulat

A to tamio contraction of the abusiness broaders

a board-like rigidity ensued.

on isolating the splanchule nerves on the right side a

convulsive movement of the whole enimal, with opening of the

and contraction of the abdominal muscles ensued. This

reaction resulted whenever the splanohates on either side wer

touched.

When the contral and of the splanshnies was electrically

stimulated the opening of the jews was well marked, but the

convulsive movement was not set up.

The splenchnies when stimulated produced contraction of

andowinel muscles on the same side with a doubtful cont

ion of the muscles of the opposite side, artificial ventilation

was now used. The intestines were removed.

The two main splanchaids on sither side of the abdomen

were divided:

after vagal division evoked contraction of the abdominal muscles. Hence the afterent path is not even partially cotained within the vague.

I.B. SMALL INTESTINE.

Proganglionic.

(4) A cat was anaesthetised, decerebrated; marked decerebrated rigidity ensued.

The abdomen was opened and the superior mesenteric nerve isolated and ligated as before, and the central end stimulated.

A tetanic contraction of the abdominal muscles producing a board-like rigidity ensued.

On isolating the splanchnic nerves on the right side a convulsive movement of the whole animal, with opening of the jaws and contraction of the abdominal muscles ensued. This reaction resulted whenever the splanchnics on either side were touched.

When the central end of the splanchnics was electrically stimulated the opening of the jaws was well marked, but the convulsive movement was not set up.

The splanchnics when stimulated produced contraction of the abdominal muscles on the same side with a doubtful contraction of the muscles of the opposite side, artificial ventilation was now used. The intestines were removed.

The two main splanchnics on either side of the abdomen were divided.

I.B. SMALL INTESTINE.

Proganglionic.

(4) A cat was anaesthetised, decerebrated; marked decere rigidity ensued.

The abdomen was opened and the superior mesenteric ne isolated and ligated as before, and the central end stimul A tetanic contraction of the abdominal muscles product a board-like rigidity ensued.

On isolating the splanchnic nerves on the right side convulsive movement of the whole animal, with opening of t jaws and contraction of the abdominal muscles ensued. The splanchnics on either side touched.

when the central end of the splanchnics was electrical stimulated the opening of the jaws was well marked, but the convulsive movement was not set up.

The apdominal muscles on the same side with a doubtful con the abdominal muscles on the same side with a doubtful con ion of the muscles of the opposite side, artificial ventile was now used. The intestines were removed.

The two main splanchnics on either side of the abdomen were divided.

The superior nerve was again stimulated, no reflex contraction of the abdominal muscles followed.

The nerves were verified post mortem.

(5) A cat was anaesthetised with chloroform and ether and 50 cc. of chloralose injected into the right external jugular vein.

The abdomen was opened and the splanchnics on the left side exposed in the region of the ganglion. They were four in number. The upper one was much the largest. This was isolated, ligated and divided, and the central end stimulated. There followed a reflex tetanic contraction of both sides of the abdomen, the lower jaw was opened and the tongue protruded.

The splanchnic immediately below this was isolated, ligated and divided. The central was stimulated, as in the above case the muscles on both sides contracted and the jaw was opened.

The other nerves on this were destroyed in the further dissection, so no results were obtained from them.

The splanchnics on the right side were now isolated. They were four in number, the uppermost was the largest as on the left side.

The superior nerve was again stimulated, no reflex cortraction of the abdominal muscles followed.

The nerves were verified post mortem.

(5) A cat was anaesthetised with chloroform and ether and co. of chloralose injected into the right external jugular co. of chloralose injected into the splanehnics on the left side exposed in the region of the ganglion. They were founder. The upper one was much the largest. This was is ed. ligated and divided, and the central end stimulated. followed a reflex tetanic contraction of both sides of the men, the lower jaw was opened and the tengue protruded.

The aplanchnic immediately below this was isolated, li
and divided. The central was stimulated, as in the above
the muscles on both aides contracted and the jaw was opened
The other nerves on this were destroyed in the further
dissection, so no results were obtained from them.

The aplanchnics on the right side were now isolated.

were four in number, the uppermost was the largest as on the

The central end of the uppermost was stimulated as on the left side. The muscles on both sides of the abdomen contracted and the jaw was opened.

Each of the four nerves were similarly isolated and individually stimulated. The muscles on both sides contracted and the jaw opened in each case.

The superior mesenteric nerve was isolated, ligated and divided. The central end was stimulated, no contraction of the abdominal muscles resulted.

The nerves stimulated and divided were confirmed post mortem.

RESULTS.

The afferent path of this reflex is contained within the splanchnics on both sides.

Each splanchnic contains fibres which when stimulated, produce a reflex contraction in both the homolateral and contral lateral muscles of the abdomen, whether the splanchnic stimulated be left or right.

The central end of the uppermost was stimulated as on the side. The muscles on both sides of the abdomen contrad and the jaw was opened.

Hach of the four nerves were similarly isoleted and in vidually stimulated. The muscles on both sides contracted and the jaw opened in each case.

The superior mesenteric nerve was isolated, ligated and divided. The central end was stimulated, no contraction or the abdominal muscles resulted.

The nerves stimulated and divided were confirmed post

BESULTS.

The afferent path of this reflex is contained within the aplanchnics on both aides.

Each splanchnic contains fibres which when stimulated, produce a reflex contraction in both the homolateral and contraction to both the homolateral and contracted whether the splanchnic stimulated be left or right.

Since the vagi were left intact in these experiments and yet no contraction resulted when the superior mesenteric nerve was stimulated after all the splanchnics were divided, it follows that no afferent fibres are contained in vagi nerves, a conclusion which confirms the results of the first experiments.

Very slight contraction of the abdominal muscles

The nerve to the spleen was dissected and the central on

stimulated: very slight contraction of the honolateral absout

Has musules resulted.

The central and of this narve was stimulated, marked contraction

of the muscles on the same side, but only slight contraction of

the contralateral muscles.

The external policies was included and the nerve again

stimulated, marked contraction of this muscle resulted.

The rectus was divided into segments, and the above nerve

again stimulated, each regment contracted but the reaction was

very alight in the last segment,

The internal phlique contracted each time.

en circumseem resulted when the superior mesenteric ne yet no contraction resulted when the superior mesenteric ne ti, bebivib erew scindonsigs ent lie rette beising were that no afferent fibres are contained in vagi nerver a conclusion which confirms the results of the first experi-

PART II. STOMACH, PANCREAS, ETC.

(13) A cat was chloroformed and kept under this anaesthetic throughout the whole experiment.

Abdomen was opened and the muscles exposed. The nerve to the gall-bladder was isolated and divided and the central end stimulated. Very slight contraction of the abdominal muscles observed.

The nerve to the spleen was dissected and the central end stimulated: very slight contraction of the homolateral abdominal muscles resulted.

The nerve to the liver and stomach was ligated and divided. The central end of this nerve was stimulated, marked contraction of the muscles on the same side, but only slight contraction of the contralateral muscles.

The external oblique was isolated and the nerve again stimulated, marked contraction of this muscle resulted.

The rectus was divided into segments, and the above nerve again stimulated, each segment contracted but the reaction was very slight in the last segment.

The internal oblique contracted each time.

PART II. STOMACH, PANCHEAS, ETC.

(13) A cat was chloroformed and kept under this anaestheti

Abdomen was opened and the muscles exposed. The nervice character was isolated and divided and the central estimulated. Very slight contraction of the abdominal musc beerved.

The nerve to the spleen was dissected and the central abd stimulated: very slight contraction of the homolateral abd nal muscles resulted.

The nerve to the liver and stomach was ligated and divertnes bettered, marked contraction the muscles on the same side, but only slaght contraction the contraction.

The external oblique was isolated and the nerve again attimulated, marked contraction of this muscle resulted.

The rectus was divided into segments, and the above ne again stimulated, each segment contracted but the reaction very slight in the last segment.

.emit dome betoentnos supildo lamietni edT

The superior mesenteric nerve was isolated and the central end stimulated, contraction of the abdominal muscles on both sides ensued.

The nerves were verified post mortem.

(14) A cat was anaesthetised, decerebrated, rigidity slow in onset.

The abdomen was opened and the nerve which supplied the liver and stomach was isolated and ligated. Ligation was followed by a contraction of the muscles on both sides of the abdomen.

The central end of the above nerves was stimulated, a tetanic contraction of both sides of the abdomen resulted.

It was observed that the external oblique and each segment of the rectus contracted. The current used was very weak. alteration

No contraction in the rhythm of the diaphragm was noted. The contractions of the abdominal muscles were about equal on both sides.

The vagi were divided in the neck and the nerve again stimulated, the same contractions followed as before; no difference was observed.

The superior mesenteric nerve was isolated and the cerend attended on the cerend attended on the abdominal muscles on bot sides ensued.

The nerves were verified post mortem.

(14) A cat was anaesthetised, decerebrated, rigidity slow .tesno

The abdomen was isolated and ligated. Ligation was stomach was isolated and ligated. Ligation was ed by a contraction of the muscles on both sides of the abdomen resulted, a tetanic contraction of both sides of the abdomen resulted. It was observed that the external oblique and each segment the rectus contracted. The current used was very weak alteration in the rhythm of the disphragm was note the contractions of the abdominal muscles were about equal

The vagi were divided in the neck and the nerve again stimulated, the same contractions followed as before; no dence was observed.

The superior mesenteric nerve was isolated and the central end stimulated, a contraction of both sides of the abdomen resulted.

The fact that ligation of the first nerve was followed by contraction of the abdominal muscles excluded escape of current, and moreover the strength of current used was very weak.

It was found at the post mortem that the first nerves stimulated supplied the stomach, duodenum, pancreas and liver.

RESULTS.

A reflex rigidity of the abdominal muscles is obtained by stimulation of the nerves which supply the liver, stomach and pancreas.

The vagi take no part in this reflex; this is remarkable since reflex vomiting can be produced by stimulation of the vagi.

The above reflex explains the nature of abdominal rigidity which is met with in gastric and duodenal ulcer.

muscles was out from the ribe, and consequently the nerve supp

The splenic nerve caused slight rigidity.

The renal nerves apparently are not responsible for abdominal rigidity.

The superior mesenteric nerve was isolated and the centend end etimulated, a contraction of both sides of the abdomen resulted.

The fact that ligation of the first nerve was followed contraction of the abdominal muscles excluded escape of our and moreover the strength of current used was very weak.

It was found at the post mortem that the first nerves stimulated supplied the stomach, duodenum, pancreas and liv

RESULTS.

A reflex rigidity of the abdominal muscles is obtained atimulation of the nerves which supply the liver, stomach a pancress.

The vagi take no part in this reflex; this is remarks since reflex vomiting can be produced by stimulation of the The above reflex explains the nature of abdominal rigit which is met with in gastric and duodens! ulcer.

The renal nerve caused slight rigidity.

The renal nerves apparently are not responsible for abdominal rigidity.

PART III. INTERCOSTALS.

(8) A cat was anaesthetised with chloroform and ether and then decerebrated. Artificial ventilation was used. The decerebrate rigidity was well marked.

The abdominal muscles were exposed, and the eleventh intercostal nerve isolated.

As the nerve was ligated a contraction of the abdominal muscles followed. The nerve was divided on the distal side of the ligature, and the central end dissected backwards.

When this nerve was stimulated a contraction of the abdominal muscles on both sides, but apparently more marked on the same side, resulted.

The parietal peritoneum was next stimulated by a faradic current. Both sides of the abdomen went into vigorous contraction, but when the liver and intestines were similarly excited no contraction resulted. This shows that the contraction was not due to escape of current.

The parietal pleura was next stimulated, there followed a contraction of the abdominal muscles most marked on the same side as the nerve stimulated.

Even when the whole of the attachment of the abdominal muscles was cut from the ribs, and consequently the nerve supply

PART III. INTERCOSTALS.

become trained to the control of the best seed and ether and decome decome decome the decome trained to the decome decome trained to the decome decom

The abdominal muscles were exposed, and the eleventh i betslost evren latsoo

As the nerve was ligated a contraction of the abdomina muscles followed. The nerve was divided on the distal aid the ligature, and the central end dissected backwards.

When this nerve was stimulated a contraction of the ab nal muscles on both sides, but exparently more marked on the same side, resulted.

The parietal peritoneum was next stimulated by a fered ourrent. Both sides of the abdomen went into vigorous conton, but when the liver and intestines were similarly excit contraction resulted. This shows that the contraction was due to escape of current.

ownlot erent, betalumits then asw surely latered of the same contraction of the abdominal muscles most marked on the same side as the nerve stimulated.

Even when the whole of the attachment of the abdominal muscles was cut from the ribs, and consequently the nerve as

to all the muscles except the lowermost portion of the rectus was destroyed, a contraction of this latter portion followed stimulation of the parietal pleura.

But when the visceral pleura was stimulated no contraction followed. This shows that the above reactions were reflex in character and not due to escape of current.

(9) A cat was anaesthetised with chloroform and ether, then decerebrated. Artificial ventilation was used. Decerebrate rigidity was well marked.

All the intercostal nerves were isolated on the right side and divided from their peripheral ends.

On stimulating the central end of the lower intercostal nerves there followed a general contraction of the abdominal muscles slightly more marked in the homolateral muscles.

As the nerves stimulated approached the head end of the preparation the contraction following the excitation of their central ends became more limited to the homolateral muscles.

A contraction was obtained from the lowest intercostal to the second inclusive. But the stimulation of the central end of the first did not produce any contraction in the abdominal muscles.

to all the muscles except the lowermost portion of the recovered, a contraction of this latter portion follows stimulation of the parietal pleura.

But when the visceral pleura was atimulated no contractors were reflect character and not due to escape of current.

(9) A cat was anaesthetised with chloroform and ether, the cerebrated. Decerebrat best used. Decerebrat rigidity was well marked.

All the intercoatal nerves were isolated on the right and divided from their peripheral ends.

On stimulating the central end of the lower intercosts
nerves there followed a general contraction of the abdomina
muscles slightly more marked in the homolateral muscles.

As the nerves stimulated approached the head end of the preparation the contraction for the homolateral muscles

the second inclusive. But the stimulation of the central of the first did not produce any continuction in the abdomin muscles.

The parietal pleura was dissected out on the left side.

There followed stimulation of it, contraction of the abdominal muscles most marked on the same side.

Stimulation of the pleura in the first intercostal space produced no abdominal contraction, and stimulation of that in the second very slight contraction, confined to the same side.

All the lower spaces gave a contraction corresponding with the contraction obtained from the nerve on the opposite side.

The phrenic nerve on the right side was isolated, ligated and divided on the distal of the ligature. The central end was stimulated, practically no contraction of the abdominal muscles resulted, although when the intercostals were stimulated there was a vigorous contraction.

The left phrenic was similarly treated with the same result.

(10) A cat was anaesthetised, artificial ventilation used.
Onset of decerebrate rigidity slow.

The abdominal muscles were exposed by dividing the linea alba in the whole of its extent.

There followed stimulation of it, contraction of the abdominuscles most marked on the same side.

Stimulation of the pleura in the first intercostel approduced no abdominal contraction, and stimulation of that the second very slight contraction, confined to the same stall the lower spaces gave a contraction corresponding the contraction obtained from the nerve on the opposite sid The phrenic nerve on the right side was isolated, light and divided on the distal of the lighture. The central en muscles resulted, although when the intercostals were stimulated was a vigorous contraction.

The left phrenic was similarly treated with the same

(10) A cat was anaesthetised, artificial ventilation used.

Onset of decerebrate rigidity slow.

The abdominal muscles were exposed by dividing the lin

The seventh intercostal was isolated on the right side, and ligated. Ligation was followed by a contraction of the abdominal muscles on the same side.

The central end of the above nerve was stimulated by a faradic current. There resulted a contraction of the homo-lateral abdominal muscles, and a slight contraction of the contralateral muscles.

The external oblique was separated from its attachment to the anterior sheath of the rectus, and the nerve again stimulated. This muscle was seen to go into vigorous contraction.

The rectus was next divided into three segments, it was found that due to stimulation of this same nerve the upper segment of the above muscle became contracted, but the middle and lower segments did not contract.

The intercostal nerve two spaces lower down was isolated, ligated and divided, and the central end of this nerve was stimulated. When the central end of the above nerve was stimulated there resulted a contraction of all the segments of the rectus.

The rectus on the opposite side was now observed. It was found that each segment contracted when the lower of the two intercostal nerves was stimulated.

The seventh intercostal was isolated on the right side

The central end of the above nerve was stimulated by a faradic current. There resulted a contraction of the home lateral abdominal muscles, and a slight contraction of the tralateral muscles.

The external oblique was separated from its attachment the anterior sheath of the rectus, and the nerve again stined.

This muscle was seen to go into vigorous contraction.

The rectus was next divided into three segments, it was found that due to stimulation of this same nerve the upper ment of the above muscle became contracted, but the middle lower segments did not contract.

The intercostal nerve two spaces lower down was isolar ligated and divided, and the central end of this nerve was stimulated. When the central end of the above nerve was stimulated a contraction of all the segments of the rector of the opposite side was now observed. It found that each segment contracted when the lower of the twent intercostal nerves was stimulated.

The external oblique was isolated on this side as had been previously done on the opposite side. It was found that this muscle contracted when the above nerves were stimulated.

The contractions of the contralateral muscles were much less marked than of the homolateral muscles.

The diaphragm was next investigated. The cupola of the diaphragm was separated from its costal attachment on the right side, and the central ends of the above intercostal nerves stimulated, there was apparently a contraction of this muscle, but it seemed to vary with the period of respiration.

(11) A cat was anaesthetised with chloroform and ether. Decerebrated. Rigidity well marked.

The lower three intercostal nerves on the right side were isolated and their central ends stimulated as before.

The right half of the diaphragm was freed from its costal attachment, but the phrenic nerve left intact. On stimulating these nerves no contraction of the right half of the diaphragm resulted.

The phrenic nerve on the right side was isolated and divided. The lower end was stimulated by a very weak current, a marked contraction of the diaphragm followed.

The external oblique was isolated on this side as had previously done on the opposite side. It was found that the muscle contracted when the above nerves were stimulated.

The contractions of the contralateral muscles were muscless marked than of the homolateral muscles.

The disphragm was next investigated. The cupols of the disphragm was separated from its costal attachment on the reside, and the central ends of the above intercostal nerves attimulated, there was apparently a contraction of this musc but it seemed to very with the period of respiration.

.rente bna mrotoroldo diw besitedteens saw jao A (11)
.beirem llew vibigin .bejardereo

The lower three intercostal nerves on the right side w .erored as betsload

The right half of the disphraym was freed from its cos attachment, but the phrenic nerve left intact. On stimula these nerves no contraction of the right half of the disphrence nerves no contraction of the right half of the disphrence nerves no contraction of the right half of the disphrence nerves no contraction of the right half of the disphrence nerves no contraction of the right half of the disphrence nerves no contraction of the right half of the disphrence nerves no contraction of the right half of the disphrence nerves no contraction of the right half of the disphrence nerves no contraction of the right half of the disphrence nerves no contraction of the right half of the disphrence nerves no contraction of the right half of the disphrence nerves no contraction of the right half of the disphrence nerves no contraction of the right half of the disphrence nerves no contraction of the right half of the disphrence nerves no contraction of the right half of the disphrence nerves no contraction of the right half of the disphrence nerves no contraction of the right half of the disphrence nerves no contraction of the right half of the disphrence nerves no contraction of the right half of the disphrence nerves nerves

The phrenic nerve on the right side was isolated and ded. The lower end was stimulated by a very weak ourrent, marked contraction of the diaphragm followed.

The central end of the latter nerve was stimulated by a weak current, no contraction of the abdominal muscles ensued, but when a strong current was used there was a definite contraction of the above muscles.

The renal nerve on the left side was isolated and the central end stimulated. No contraction of the abdominal or other muscles followed.

(12) A cat was anaesthetised and then decerebrated, rigidity well marked. Artificial ventilation used.

The intercostal nerves of the eleventh and twelfth spaces on the right side were isolated and divided and their proximal ends dissected back towards the vertebral column.

The attachment of the left half of the diaphragm was divided from the ribs, but its nerve supply was not interfered with.

The central ends of the above nerves were stimulated by means of hand electrodes. No effect was produced in the left half of the diaphragm. The strength of the current was increased but no effect was observed.

The central and of the latter nerve was stimulated by weak current, no contraction of the abdominal muscles encu but when a strong current was used there was a definite co ion of the above muscles.

The renal nerve on the left side was isolated and the central ond stimulated. No contraction of the abdominal other muscles followed.

(12) A cat was and estimation and then decembered, rigid well marked. Artificial ventilation used.

The intercostal nerves of the eleventh and twelfth and on the right side were isolated and divided and their proxends dissected back towards the vertebral column.

The attachment of the left half of the disphragm was from the ribs, but its nerve supply was not interfered wit the central ends of the above nerves were stimulated be means of hand electrodes. No effect was produced in the half of the disphragm. The strength of the current was i creased but no effect was observed.

The right half of the diaphragm was now isolated as on the left side, and the nerves again stimulated. A very feeble contraction of this portion of the muscle resulted.

The contraction was not so marked as in previous experiments. The rigidity is produced in the homoleteral muscles from

the upper intercostals, but in both homelateral and contra-

The right half of the disphragm was now isolated as on left side, and the nerves again stimulated. A very feeble contraction of this portion of the muscle resulted.

The contraction was not so marked as in previous expandents.

RESULTS.

Reflex abdominal rigidity follows stimulation of most of the intercostal nerves.

The rigidity is produced in the homolateral muscles from the upper intercostals, but in both homolateral and contralateral when the lower intercostals are stimulated.

The effect on the diaphragm seems to be limited to the portion of it on the side of the intercostals stimulated.

This reflex explains how abdominal rigidity may be produced in cases of pneumonia and pleurisy.

The visceral pleura resembles the visceral peritoneum, since electrical stimulation of it does not evoke any contraction in the abdominal muscles. But the parietal pleura is comparable to the parietal peritoneum, because when stimulated reflex abdominal rigidity follows.

The phrenic nerves contain very few afferent nerves producing abdominal rigidity.

RESULTS.

Reflex abdominal rigidity follows stimulation of most

The rigidity is produced in the homolateral muscles for the upper intercostals, but in both homolateral and contrallateral when the lower intercostals are stimulated.

the effect on the diaphragm seems to be limited to the control of it on the side of the intercostals stimulated.

This reflex explains how abdominal rigidity may be proint on sees of pneumonia and pleurisy.

The visceral pleurs resembles the visceral peritoneum since electrical stimulation of it does not evoke any control in the abdominal muscles. But the parietal pleurs is parable to the parietal peritoneum, because when stimulated reflex abdominal rigidity follows.

The phrenic nerves contain very few afferent nerves of ducing abdominal rigidity.

PART IV. EFFECT ON THE CIRCULATION.

(16) A cat was anaesthetised with chloroform and ether and 50 cc. of chloroform injected into the right external jugular vein.

The superior mesenteric nerve was isolated and a ligature tied round it as far from the ganglion as possible. The nerve was cut through on the distal side of the ligature and the proximal end dissected back to the ganglion.

The abdomen was now closed. A cannula was inserted into the left carotid artery. The cannula was connected with a recording manometer fitted with a time marker and a signal.

The abdomen was opened again and the central end of the superior mesenteric nerve stimulated.

When the secondary coil was at 12 cm. from the primary, there was a slight rise in blood pressure.

As the secondary coil was brought to 10 cm. the rise in blood pressure became much more marked, and at 9 cm. the rise was considerable.

More chloroform was administered, and the nerve again stimulated; as a consequence there was a rise in blood pressure but the rate of pulsation was diminished to one half the usual number, and the amplitude increased about three times.

PART IV. EFFECT ON THE CINCULATION.

(16) A cat was ansesthetised with chloroform and sther and relugat relugat learnest the right external jugular of coloroform injected into the superior mesenteric nerve was isolated and a light of the round it as far from the ganglion as possible. The next through on the distal side of the lighture and the proximal end dissected back to the ganglion.

The abdomen was new closed. A cannula was inserted in the left carotid artery. The cannula was connected with a recording manometer fitted with a time marker and a signal. The abdomen was opened again and the central end of the superior mesenteric nerve stimulated.

When the secondary coll was at 12 cm. from the primary there was a slight rise in blood pressure.

As the secondary coil was brought to 10 cm. the rise is blood pressure became much more marked, and at 9 cm. the riwas considerable.

More chloroform was administered, and the nerve again atimulated; as a consequence there was a rise in blood probut the rate of pulsation was diminished to one half the unnumber, and the amplitude increased about three times.

The alteration in rhythm ended abruptly but outlasted the stimulus for a considerable time.

The alteration resembled heart block. The result was obtained many times, but the administration of chloroform was apparently necessary for its production. The abdominal muscles contracted as on the previous occasions.

During a period of apparent heart block produced by the stimulation of the above nerve, the vagiwere divided in the neck. The period of inhibition was much shortened.

Throughout these stimulations the respirations were quickened.

The post mortem confirmed the nerves involved in this experiment.

(17) A cat was anaesthetised with chloroform and ether. The carotid arteries were tied high up in the neck. A tracheal cannula was inserted because artificial respiration was necessary.

The cat was decerebrated, and the superior mesenteric nerve isolated as in former cases. The abdomen was closed and the animal turned on its belly. Curare was injected into the internal saphenous veins.

The alteration in rhythm ended abruptly but outlasted stimulus for a considerable time.

The alteration resembled heart block. The result was obtained many times, but the administration of chloroform apparently necessary for its production. The abdominal mucontracted as on the previous occasions.

During a period of apparent heart block produced by the stimulation of the above nerve, the vagiwere divided in the The period of inhibition was much shortened.

Throughout these stimulations the respirations were quickened.

The post mortem confirmed the nerves involved in this experiment.

(17) A cat was and ethetised with chloroform and ether. carotid arteries were tied high up in the neck. A trached cannula was inserted because artificial respiration was necessary.

the cat was decerebrated, and the superior mesenterio that seed as in former cases. The abdomen was closed and the animal turned on its belly. Curare was injected into the internal saphenous veins.

The laminae were now removed exposing the spinal cord from the fourth post thoracic vertebra to the sixth dorsal vertebra.

All the posterior roots exposed on the left side were divided extra-thecally.

A cannula was inserted into the right carotid artery and connected with a recording manometer. The animal was turned on its left side.

The previously exposed superior mesenteric nerve was stimulated by hand electrodes, the secondary coil being about 10 cm. from the primary. A marked rise in blood pressure resulted. The lowest nerve was divided on the right side of the spinal cord, and the superior mesenteric nerve again stimulated. The rise in blood pressure was just as high as on the first occasion.

The nerve next above the last divided was cut, and the central end of the superior mesenteric nerve again excited. The resulting rise in blood pressure was not so marked as in the previous cases, although the arterial pressure was just as great as in the beginning of the experiment.

After each succeeding nerve was severed the superior mesenteric nerve was stimulated. There was a diminished rise in blood pressure after each nerve was cut and finally no response at all.

the learne of galacque bevomer won erew estimal entreverse the learner of andertev singular the formation and entreverse the side were entreverse the leaf and besong a stoom related entreverse the side were galactic and the leaf and the side were the sally.

connected with a recording manometer. The animal was turn its left side.

The previously exposed superior mesenteric nerve was a lated by hand electrodes, the secondary cold being about 10 from the primary. A marked rise in blood pressure resulted The lowest nerve was divided on the right side of the spins cord, and the superior mesenteric nerve again stimulated. The nerve mesenteric nerve again stimulated rise in blood pressure was just as high as on the first occurs in blood pressure was just as high as on the first occurs.

tral end of the superior mesenteric nerve again excited.

resulting rise in blood pressure was not so marked as in the previous cases, although the arterial pressure was just as as in the beginning of the experiment.

After each succeeding nerve was severed the superior a teric nerve was stimulated. There was a diminished rise i pressure after each nerve was out and finally no response s

The arterial pressure had by this time fallen slightly so the animal was allowed to recover, and the nerve again stimulated. No rise in blood pressure was recorded.

The nerves divided were ascertained post mortem. They were the 13th thoracic, 12th thoracic, 11th thoracic and 10th thoracic.

(18) A cat was anaesthetised with chloroform and ether. The cat was then decerebrated. The abdomen was opened in the middle line, and the superior mesenteric nerve isolated and ligated as far from the ganglion as possible. The nerve was divided distal to the ligature, and the proximal end dissected back to the ganglion. The abdomen was now closed.

The spinal cord was now exposed from the mid-dorsal region to the lower lumbar region. A ligature was passed under the 9th, 10th, 11th, 12th and 13th thoracic roots, and the 1st and 2nd post thoracic roots on the left side.

The proximal end of the superior mesenteric nerve was now stimulated by hand electrodes connected with the secondary circuit of an induction coil. The abdominal muscles contracted as on previous experiments.

The arimal was allowed to recover, and the nerve again stin lated. No rise in blood pressure was recorded.

The nerves divided were ascertained post mortem. The the 15th thoracic, 18th thoracic, 18th thoracic and 10th th

(18) A cat was ansesthetised with chloroform and ether.

cat was then decerebrated. The abdomen was opened in the
line, and the superior mesenteric nerve isolated and ligate
for from the ganglion as possible. The nerve was divided
distal to the ligature, and the proximal end dissected back
the ganglion. The abdomen was now closed.

The spinal cord was now exposed from the mid-dorsal reto the lower lumber region. A lighture was passed under to the lower lumber region. A lighture was passed under to the loth, lith, lith, lith and lith thoracle roots, and the left side.

The proximal end of the superior mesenteric nerve was stimulated by hand electrodes connected with the secondary circult of an induction coil. The abdominal muscles contrad ed as on previous experiments.

The whole of the small intestine was now resected, because it interfered with the stimulation of the superior mesenteric nerve, and on previous occasions has led to inspissation of the blood. Before the ligature was tied round the mesentery the blood in the small intestines was massaged into the general circulation.

The dura was opened at the level of the 9th and 10th dorsal nerves. The posterior root of the 9th nerve was divided inside the dura on each side. The superior mesenteric was again stimulated, a contraction of the abdominal muscles followed almost to the same extent as on the first occasion.

The 10th thoracic posterior roots were divided inside the dura on both sides. The superior mesenteric nerve was again stimulated. The abdominal muscles contracted, but only the posterior two thirds.

The 11th thoracic posterior roots were divided extrathecally on each side, and the superior mesenteric nerve stimulated. The abdominal muscles contracted to much the same extent
as on the previous occasion.

The 12th thoracic posterior roots were divided extrathecally. The superior mesenteric nerve was again stimulated. The resulting contraction of the abdominal muscles was more The whole of the small intestine was now resected, becaute interfered with the stimulation of the superior mesenter nerve, and on previous occasions has led to inspissation of blood. Before the ligature was tied round the mesentery to blood in the small intestines was massaged into the general circulation.

The dura was opened at the level of the 9th and 10th depress. The posterior root of the 9th nerve was divided in the dura on each side. The superior mesenteric was again atimulated, a contraction of the abdominal nuscles followed most to the same extent as on the first occasion.

The loth thoracic posterior roots were divided inside dura on both sides. The superior measurerie nerve was aga stimulated. The abdominal muscles contracted, but only the posterior two thirds.

The 11th thoracic posterior roots were divided extrath cally on each side, and the superior mesenteric nerve stimued. The abdominal muscles contracted to much the same extended to much the previous occasion.

the transfer of the superior rotated posterior of the design and the standard of the sew serior of the abdeminal muscles was more of the abdeminal muscles was more

limited to the hinder part of the muscles than on previous occasions.

The 13th thoracic posterior roots were divided extrathecally, and the superior mesenteric nerve stimulated. A contraction of the abdominal muscles was produced.

The 1st post thoracic posterior roots were divided outside the dura mater on each side. The superior mesenteric nerve was stimulated. Only the merest flicker of a contraction apparently resulted, a marked difference from the effect produced on the previous occasion.

The muscle was directly stimulated, and found to contract readily. The external popliteal nerve was exposed and ligated and cut. The central end was stimulated, a reflex was easily obtained.

Post mortem examination confirmed the posterior roots divided. The anterior roots in each and every case were intact. The nerve stimulated was the superior mesenteric.

limited to the hinder part of the muscles than on previous

traction of the abdominal muscles was produced.

The lat post thoracio posterior roots were divided our the dura mater on each side. The superior mesenteric nerves to dura mater on each side. The superior mesenteric nerves as stimulated. Only the merest flicker of a contraction apparently resulted, a marked difference from the effect or duced on the previous occasion.

The muscle was directly stimulated, and found to controved to controve was exposed and lighted and out. The central end was stimulated, a reflex was easily obtained.

Post mortem examination confirmed the posterior roots divided. The anterior roots in each and every case were the nerve stimulated was the superior mesenterio.

DESCRIPTION OF BLOOD PRESSURE TRACINGS.

Experiment 16.

- Number 1. Rise in blood-pressure following stimulation of the proximal end of the superior mesenteric nerve. The secondary coil was at 12 cm. from the primary.
- Number 2. Rise in blood-pressure produced by stimulating the proximal end of the superior mesenteric nerve. The secondary coil was at 10 cm. in A, and at 9 cm. in B.
- Number 3. "Heart Block" following stimulation of the central end of the superior mesenteric nerve. Beats before stimulation 240 per min. after 120 per min. Duration of brachycardia 44 secs. Stimulus 9 cm. Amplitude during brachycardia 3 times greater than normal.
- Number 4. Idem. Duration 61 sec. Amplitude 3 times Stimulus 6 sec. Beats 240, and 120 per min.
- Number 5. Shortening of the period of brachycardia due to division of the vagi. The right vagus was divided at A. and the left vagus at B. Duration after section of both vagi 7 sec.

DESCRIPTION OF BLOOD PRESSURE TRACINGS.

Experiment 16.

Number 1. Hise in blood-pressure following stimulati
the proximal end of the superior mesenteric nerve. The se
ary coil was at 12 cm. from the primary.

Number 2. Rise in blood-pressure produced by stimula the proximal end of the superior mesenteric nerve. The seary coil was at 10 cm. in A, and at 9 cm. in B.

Number 3. "Heart Blook" following stimulation of the central end of the superior mesenteric nerve. Eents befor stimulation 240 per min. after 120 per min. Duration of brachycardia 44 secs. Stimulus 9 cm. Amplitude during brachycardia 3 times greater than normal.

Number 4. Idem. Duration 61 sec. Amplitude 8 tim

Number 5. Shortening of the period of brachycardia d division of the vagi. The right vagus was divided at h. as left vagus at B. Duration after section of both vagi 7 section

BLOOD PRESSURE TRACINGS.

Experiment 17.

Number 1. Rise in blood-pressure due to stimulation of the proximal end of the superior mesenteric nerve after division of the 9th, 10th, 11th, 12th and 13th thoracic roots on the left side.

Number 2. Rise in blood-pressure after division of the right 13th thoracic root.

Number 3. Rise in blood-pressure after division of the 12th thoracic root.

Number 4. Rise in blood-pressure after division of the llth thoracic root.

Number 5. Reflex abolished after severance of the 10th thoracic root.

BLOOD PRESSURE TRACINGS.

Experiment 17.

Mumber 1. Rise in blood-pressure due to stimulation the proximal end of the superior mesenteric nerve after direct the 9th, 10th, 11th, 12th and 15th thoracte roots on the side.

Number 2. Rise in blood-pressure after division of t

Number 3. Hise in blood-pressure after division of talk thorsele root.

Number 4. Rise in blood-pressure ofter division of lith thoracie root.

Number 5. Reflex abolished after severance of the lo

RESULTS.

Reflex rise in blood pressure always accompanies the reflex abdominal rigidity, so one may assume that the afferent path is the same in both.

The stimulation of the superior mesenteric nerve is painful because opening of the jaws and protraction of the whiskers as well as a rise in blood pressure, is produced.

The stronger the stimulus the greater the rise in blood pressure.

In one case "heart block" was produced. Section of the vagi during this phenomenon shortened it to about a quarter of its previous duration.

The 10th thoracic root is the uppermost afferent path in this reflex, rise in blood pressure arising from the superior mesenteric nerve.

The 1st post thoracic posterior root is the lowest afferent nerve involved in the reflex rigidity of the abdominal muscles produced by stimulation of the superior mesenteric nerve.

RESULTS.

abdominal rigidity, so one may assume that the afferent paths same in both.

The stimulation of the superior mesenteric nerve is proceeders opening of the jaws and proteaction of the whiskers well as a rise in blood pressure, is produced.

The stronger the stimulus the greater the rise in bloopressure.

In one case "heart block" was produced. Section of vagi during this phenomenon shortened it to about a quarter its previous duration.

The loth thoracte root is the uppermost afferent path this reflex, rise in blood pressure arising from the superimesenteric nerve.

The lawest ent to rotresed pleated to the abdominal musc nerve involved in the reflex rigidity of the abdominal musc evren produced by stimulation of the superior mesenteric nerve.

SUMMARY OF CONCLUSIONS.

- Stimulation of a nerve containing sympathetic fibres is capable of producing a contraction in muscles innervated by cerebro-spinal nerves.
- 2. In the splanchnics are the afferent paths for the reflex rigidity produced by stimulation of the superior mesenteric gland.nerve.
- 3. The posterior roots concerned in the above reflex are the 10th, 11th, 12th and 13th dorsal and the 1st post thoracic.
- 4. A rigidity of the abdominal muscles can be produced by stimulation of the proximal end of the intercostal nerves.
- 5. Stimulation of the sympathetic nerves supplying the stomach, gall-bladder and pancreas, results in a reflex contraction of the abdominal muscles. The vagi do not contain the afferent path of this reflex.

SUMMARY OF CONCLUSIONS.

- 1. Stimulation of a nerve containing sympathetic fibres capable of producing a contraction in muscles innerva
- 2. In the splanchnics are the efferent paths for the reference as a reference of the superior mese gland, nerve.
- 3. The posterior roots concerns in the above reflex are
- d besuborg ed use selecut fuscies can be produced by an intercostal ne
- 5. Stimulation of the sympathetic nerves supplying the stomach, gall-bladder and panoreas, results in a reflection of the abdominal muscles. The vagi do no contain the afferent path of this reflex.