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<td>KOBAYASHI, DAIJO</td>
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Experimental Periarterial Sympathectomy.

Report II.

By DAJO KOBAYASHI, M. D.

Of the Orthopaedic Laboratory (in charge of Prof. Dr. Hiromu Ito), of the Medical Faculty of the Kyoto Imperial University, Japan.

Introduction.

In my first report previously published in No. 1 (the year 1924) of the Nihon-Geka-Hokkan ("Archiv fuer Japanische Chirurgie"), I gave the results of the investigation which I had made concerning Leriche's operation for arterial femoralsis. In the present report, I propose to deal with the three following questions, namely:

1. Is the increment of blood-flow after Leriche's operation upon the arteria femoralis durable (the latter part of the second question of my first report)?

In this report, I shall deal with the first question: "Is the increment of blood-flow after Leriche's operation upon the arteria femoralis durable (the latter part of the second question of my first report)?"
Since Leriche published his views concerning the effectiveness of arterial denudation, many scientists have tried the operation clinically, the result being that some of them say that its effect is lasting, while according to others it is only temporarily effectual. Arterial denudation is based on the hypothesis that the main sympathetic nerve fibres exist in the outer wall of the artery, but according to Potts the sympathetic supply for the vessels of the lower extremity reaches the main vessels at intervals along their course, while Kramer has reached the same conclusion in regard to the upper limb. If so, it will be possible to bring about a durable increase in blood-flow at and below the part operated upon by effecting Leriche's operation at a part of the arteria femoralis.

The third question given in my first report, too, not yet having been fully answered, I intend to complete the investigation into the matter by reporting in this paper the result of my microscopic observation in this respect.

The result of the experiments made on dogs by me in my endeavour to solve the three foregoing questions.

Experimenal Periarterial Sympathectomy.
All the experiments in this connection were made according to Leech's method. The outer wall of the art. femoralis was next denuded at Scarpia's triangle to the length of about 2 cm. and the art. saphena magna passed under the art. femoralis on the central side near the point of combination (confluence) of the art. femoralis. A thin string was passed under the art. femoralis close to the point at which it combines with the art. femoralis. A small hole was made vertically with a pointed knife at the proximal part from the point of confluence. Further, arterial denudation was made vertically with a pointed knife at the proximal part from the point of confluence. A small hole was made vertically with a pointed knife at the proximal part. A thin string was passed under the art. femoralis. A small hole was made vertically with a pointed knife at the proximal part.

Experiments.

Experiments were tried in the same manner as those recorded in my previous reports, with this exception that arterial denudation was effected to the length of from 2 to 7 centimetres. Experiments were tried on dogs, the animals being narcotised by a hypodermic injection of urethane at the rate of 2 grammes per kilogramme of the weight of their body. After narcotisation the animal was laid on its back and the hair was shaved from Scarpia's triangle on both sides down to one-third of the thigh, and after the part so shaved and the skin incision was made on one side to a length of from 10 to 12 cm., according to the size of the animal. A thin string was passed under the art. femoralis at the point where it combines with the art. femoralis, and the art. saphena magna was bound at a distance of from 4 to 5 cm. from the point at which it combines with the art. femoralis. Then, the art. saphena magna was ligatured, and the art. saphena magna and the art. femoralis were ligatured together at a length of from 10 to 12 cm. according to the size of the animal. The string was passed under the art. femoralis, and the art. saphena magna was ligatured at a distance of 4 to 5 cm. from the point at which it combines with the art. femoralis. Then, the art. saphena magna was ligatured, and the art. saphena magna and the art. femoralis were ligatured together at a length of from 10 to 12 cm. according to the size of the animal.

Discussion by reference to the clinical value of the operation. In addition, I will advert to three clinical cases in which Leech's operation was effected, and which are dealt with elsewhere.
The above preparatory operation finished, I passed on to the operation of extracting blood, the object of the latter operation being to measure the speed by causing all the blood flowing through the femoral vessels to flow into a peculiar pipette made for the purpose.

<table>
<thead>
<tr>
<th>Date</th>
<th>B.H. (°c)</th>
<th>R.T. (°c)</th>
<th>R.</th>
<th>L.</th>
<th>Diff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXP. XVI</td>
<td>00:32:50</td>
<td>7.992</td>
<td>7.968</td>
<td>0.024</td>
<td></td>
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<td></td>
<td>00:32:50</td>
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<td>0.073</td>
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</tbody>
</table>

**Notice:** B.H. = Body heat of the dog in the anus (°c); R.T. = Room temperature; R. = Right side; L. = Left side; Diff. = Difference between the right and left sides.

---

Blood-flow per min. c.c.

EXP. XVI

29/XII.
Blood-flow per min. cc.

(9/6 1924) EXP. XIX. 86 days after the operation.

No. 24 dog. Wt. 8.2 Kg. (ca. 7 ems. denudat. on the right side.) (ca. 4 ems. denudat. on the right side.)

Blood-flow per min. cc.

(9/6 1924) EXP. XX. 108 days after the operation.

No. 14 dog. Wt. 8.0 Kg.

Blood-flow per min. cc.

(9/6 1924) EXP. XIX. 118 days after the operation.

No. 25 dog. Wt. 6.5 Kg. (ca. 4.5 ems. denudat. on the left side.)

Blood-flow per min. cc.

(9/6 1924) EXP. XX. 118 days after the operation.

No. 14 dog. Wt. 8.0 Kg.

Blood-flow per min. cc.

(9/6 1924) EXP. XIX. 86 days after the operation.

No. 24 dog. Wt. 8.2 Kg.

Blood-flow per min. cc.

(9/6 1924) EXP. XX. 108 days after the operation.

No. 14 dog. Wt. 8.0 Kg.

Blood-flow per min. cc.

(9/6 1924) EXP. XIX. 118 days after the operation.

No. 25 dog. Wt. 6.5 Kg.

Blood-flow per min. cc.

(9/6 1924) EXP. XX. 118 days after the operation.

No. 14 dog. Wt. 8.0 Kg.

Blood-flow per min. cc.

(9/6 1924) EXP. XIX. 86 days after the operation.
The following experiments were then tried, with a view to ascertaining what change in blood-flow would be produced by Leriche's operation on both sides of one and the same animal, but with a difference in the length of denudation involved:

Experimental Periarterial Sympathectomy.
In Experiment XI, denudation was made about 5 centimeters lower on the right side than on the left, the result being that the difference in blood-flow between the right and left sides amounted to nearly 2 ccs., as shown in the accompanying table. I believe that the proper conclusion to be drawn from this observation is that in order to obtain greater effect by Leche's operation (periarterial sympathectomy) denudation should be effected over a greater length suggested by Leche, Pottier and their supporters, in whom case the effect will also be of longer duration.

The microscopic examination of various parts of the intima of the aorta and the posterior wall of the aorta revealed that the operation was effective only at the point where it was made.

Microscopic Examination.

In Experiment XIX, denudation was made about 5 centimeters lower on the right side than on the left, the result being that the difference in blood-flow between the right and left sides amounted to nearly 2 ccs., as shown in the accompanying table. I believe that the proper conclusion to be drawn from this observation is that in order to obtain greater effect by Leche's operation (periarterial sympathectomy) denudation should be effected over a greater length suggested by Leche, Pottier and their supporters, in whom case the effect will also be of longer duration.

The microscopic examination of various parts of the intima of the aorta and the posterior wall of the aorta revealed that the operation was effective only at the point where it was made.
Experiment XVII.
The vein cavity was almost round in shape and empty inside. The lamina elastica int. were mostly wave-like in shape, but more or less straight in places. The media was generally close and in some part of it the most external layer was thinner than the rest. Its muscle-fibres and those of lamina elast. ext. existed all around the media, with the exception of the exfoliated part, to which reference has just been made, but it was somewhat uneven in thickness.

Experiment XIX.
The other side (omitted).

Experiment XX.
The other side (omitted).

The lamina elastica ext. on the operated side was thinner than the other side, and it was also of

partly thinner than the media for the other part.

The lamina elastica ext. generally presented a wave-like appearance that is peculiar to them, but in one part they

The vein cavity was almost elliptical in shape, while blood-corpuscles existed inside in the shape of lumps.

The lamina elastica ext. on this side was, on the whole, thinner than that on the other side and it was also of

partly thinner than the media for the other part.

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The lamina elastica ext. on this side was, on the whole, thinner than that on the other side and it was also of

partly thinner than the media for the other part.
varied thickness. Of its part near the external side, the tissues were in places disordered in direction and penetrated into the outer layer, that is, the connective-tissue layer. The layer on this side was generally richer in cells and more deficient in blood vessels than on the other side, while the connective-tissue fibres ran in the shape of rings, almost parallel to each other.

The original adumbration presented, at first sight, the appearance of a connective-tissue layer, but it considerably differed from the same on the opposite side. Almost parallel to each other, varied thickness. Of its part near the external side, the tissues were in places disordered in direction and penetrated into the outer layer, that is, the connective-tissue layer. The layer on this side was generally richer in cells and more deficient in blood vessels than on the other side, while the connective-tissue fibres ran in the shape of rings, almost parallel to each other.
Previous illness: Pneumonia at 7, Rheumatism at 17, Myocardial infarction on February 12, 1934.

Case No. 1. A man aged 64 years. Admitted to hospital on January 25th.

The other side: (Omitted.)

The elastic fibers in the adventitia on this side were considerably fewer than on the other side, and sparsely distributed near the media. In the other hand, the connective-tissue vessels were considerably fewer than on the other side, and sparsely distributed near the media.

Extra Experimental (continued)
History of present Illness:

In February, 1918, apparently without any proximate cause, he felt a violent pain on the instep of his left foot, which pain radiated to the toes and made it impossible for him to sleep. In consequence, he had the big toe amputated in April, but the pain only increased in degree and red swelling was produced and extended up to the knee. He had Ringer's solution hypodermically injected about 120 times but these injections produced no effect whatever except that an ulcer was left behind. About May in the following year, the pain and ulcer gradually vanished and the man was able to resume work. About June of the same year, ulcers were produced on the second and fifth toes and gradually spread until the toes affected had to be amputated in July.

Examination of Local Condition.

In the left leg, arteria femoralis (+), arteria poplitea (+), arteria dorsalis pedis (-). A remarkable change was noticeable from the ankle-joint downwards, that is, the 1st, 2nd, and 5th toes were gone. Irregularly round ulcers were seen in the region of the metatarsophalangeal joint of the big toe, and just in the middle of the ulcers there was seen the extensor hallucis longus tendon and in their place was seen dead skin like that of a mummy.

The dimensions of the ulcers before the operation were: The bigger one, about 9.5 cm. in circumference, and the smaller quantity of secretion. Moszkowicz's test was taken with the following results: Left, 107 sec.; right, 11 sec. It was observed, in being parallel to the major axis of the toes, and its margin being partly undermined and showing a brown color all round and a dilatation of veins was noticed in the upper part thereof. In the upper part of the side limb in color all round and a dilatation of veins was noticed in the upper part thereof. In consequence, he had to have the big toe amputated.
About a month later, spontaneous pain was experienced on the spot of the ulcer and despite all sorts of medical treatment it was neither pain nor fever.

The ulcer gradually grew bigger in size and discharged a small quantity of pus mixed with blood.

Examination revealed it was a small ulcer 2.7 x 6.5cms. Wasseman's reaction was negative.

Operation:

On the 13th February, after lumbar anaesthesia having been administered, the arteria femora!is on the left side was denudated to the length of about 7 ems. Before the denudation the artery was slightly pulsating and its diameter measured about 3 mm. But soon after the operation its diameter increased to 5 mm. and the pulsation of the arterial branches also became extremely active.

Soon after the operation its diameter increased to 5 mm. and the pulsation of the arterial branches also became extremely active. 

Progress after the Operation: On the 1st day from the day of the operation the arteria femoralis showed no pulsation. On the 4th day, the arteria poplitea, tibialis posterior and dorsalis pedis showed no pulsation. On the 7th day, the arteria tibialis showed no pulsation. On the 10th day, the arteria poplitea showed no pulsation. On the 15th day, there was no proliferation of epithelium anywhere.

The same ulcer measured 6.5 cms. on the 1st day and 8.0 cms. on the 19th day, and 6.2 cms. on the 43rd day. No new skin was formed in any part of the ulcer and on the 44th day intense bluish discoloration appeared on the same area. The ulcer never showed any tendency to cure and the patient was unable to determine what was exactly the pain that was caused by the ulcer. The same ulcer measured 6.2 cms. on the 19th day, and also on the 23rd day, 6.0 cms. on the 31st day, and 6.2 cms. on the 43rd day. No new skin was formed in any part of the ulcer and on the 48th day intense gluteal pain was experienced. In short, no tendency to cure was observable anywhere.

History of present Illness: Nothing worthy of special mention.

Case No. 2. E. K... Male. Aged 30 yrs. Admitted to hospital on March 11th, 1924.

Previous Illness: Nothing worthy of special mention.

On the 2nd day from the day of the operation, the arteria poplitea, tibialis posterior and dorsalis pedis showed no pulsation. On the 4th day the arteria poplitea showed no pulsation. On the 7th day, the arteria tibialis showed no pulsation. On the 10th day, the arteria poplitea showed no pulsation. On the 15th day, there was no proliferation of epithelium. On the 19th day, the arteria poplitea showed no pulsation. On the 23rd day, 6.0 cms. on the 31st day, and 6.2 cms. on the 43rd day. No new skin was formed in any part of the ulcer and on the 48th day intense gluteal pain was experienced. In short, no tendency to cure was observable anywhere.
and the dorsum of the foot was reddish and warm, but spontaneous pain was occasionally experienced in the same

Progress after the operation: On the morning of the following day (March 20th), the arteria poplitea pulsated, the pubis, and the dorsum of the foot was rounded and warm, but the patient's condition was still critical. The patient received a treatment to combat the trouble, and the symptoms grew from bad to worse as time went on, the chief complaint of the patient being the pain which he experienced and which was so intense that it prevented him from sleeping at night.

Examination of Local Conditions.

Left big toe (as viewed from the inside).

Size of ulcer: 6.5 ems. in circumference.

Anaemic granulation.

Good granulation.

Nail with partial defect.

On pressing the point marked "X", there would arise a violent pain which transmitted itself up to the knee, while fetid thin pus oozed out of it. The dorsum of the foot down to the toes were slightly cyanotic.

Patellar and achillis jerks were strong. The pulsation of the arteria poplitea, tibialis posterior and dorsalis pedis was imperceptible on the left side, while on the right side the arteria poplitea and poplitea alone pulsated. The hyperaemia (Moszkowicz's) test repeated three times before the operation showed the following result:

<table>
<thead>
<tr>
<th>Date</th>
<th>Right side</th>
<th>Left side</th>
</tr>
</thead>
<tbody>
<tr>
<td>March 15th</td>
<td>21 secs.</td>
<td>1 min. 46 secs.</td>
</tr>
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</table>

On March 17th, the size of the ulcer measured 6.5 cms. as before. Wassermann's test showed no reaction.

Operation.

On March 19th, the operation was effected on the patient under lumbar anesthesia in accordance with Leriche's method. The arteria femoralis being denuded to the length of about 7.5 cms. In the course of the denudation, the pulsation of the arteria femoralis was observed to get stronger. The pulsation of the arteria poplitea, tibialis posterior and dorsalis pedis was perceptible.

Progress after the operation:

On the morning of the following day (March 20th), the arteria poplitea pulsated, and the dorsum of the foot was reddish and warm, but the patient's condition was still critical. The patient received a treatment to combat the trouble, and the symptoms grew from bad to worse as time went on, the chief complaint of the patient being the pain which he experienced and which was so intense that it prevented him from sleeping at night.
On the 5th day the temperature stood at 37.7°C. On the 7th day, the local pain was still present and there was a slight increase in the region of the lesion. The ulcer was almost covered with epithelium and had become smaller and produced no secretion, but pain was still felt when pressure was applied. On the 9th day, the patient had become more mobile and produced a smaller amount of secretion. The arteria poplitea pulsation was stronger than that on the right side. The result of Moszkowicz's test was 78 sec. On the 12th day, the patient left hospital and the ulcer was covered with epithelium, but the ulcer still persisted. The ulcer on the other side was still present.

On the 28th day, the spontaneous pain had diminished, but the ulcer was still present. Moszkowicz's test: 75 sec. On the 34th day, the patient felt the same as before and the ulcer had become smaller, and the spontaneous pain on the other side of the leg was diminished.

On the 49th day, the patient felt the same as before. The result of Moszkowicz's test was 75 sec. On the 56th day, the patient felt the same as before. The result of Moszkowicz's test was 78 sec. On the 68th day, the patient felt the same as before and the ulcer had become smaller. Moszkowicz's test: 78 sec. On the 84th day, the arteria poplitea pulsation was stronger than on the right side. On the 104th day, the patient felt the same as before. Moszkowicz's test: 78 sec. On the 124th day, the arteria poplitea pulsation was stronger than on the right side. On the 140th day, the patient felt the same as before and the ulcer had become smaller. Moszkowicz's test: 78 sec.

On the 157th day, the ulcer was found covered entirely with cuticula and there was no pain felt on whatever spot it might be pressed. Moszkowicz's test: 107 sec. On the 172nd day, the patient felt the same as before and the ulcer had become smaller. Moszkowicz's test: 107 sec.
The patient was now able to walk a distance of 5 miles or so without difficulty. Moszkowicz's test: 80 secs. (the right side, 32 secs.)
Funiculum, 1st, 2nd, and 8th day.

The result of a hyperaemia test taken this day was: Left side, 1 min. 30 sees. and right side, 1 min. 28 sees.

**14th day**

On this day the spontaneous pain abated, so that the patient was able to sleep soundly for the first time since he had fallen ill. (Before the operation he had always been awakened by sharp pain from time to time.) The pulsation of the arteria poplitea was perceptible. On the 3rd day also, the same was perceptible.

**11th day**

The demarcation lines of the big toe became distinctly noticeable.

**6th day**

Arterial pulsation of both lower extremities after the operation.

Phlegmonous swelling of the foot became distinctly perceptible. Though spontaneous pain was occasionally experienced, there was an abatement in the spontaneous pain while on the 5th day the same was perceptible. On the 4th day there was an abatement in the spontaneous pain while on the 3rd day also, the same was perceptible. On the 2nd day after the operation the patient had always been awakened able to sleep soundly. For the first time since he had fallen ill (before the operation) he had fallen asleep all the night.

On this day the spontaneous pain further abated, while on the 11th day the degree of redness and ulcer enlarged a little.

On the 11th day the spontaneous pain abated, so that the patient was able to sleep soundly for the first time since he had fallen ill. (Before the operation he had always been awakened by sharp pain from time to time.) The pulsation of the arteria poplitea was perceptible.

**11th day**

On this day the spontaneous pain further abated, while on the 11th day the spontaneous pain abated, so that the patient was able to sleep all the night.

**14th day**

On this day the spontaneous pain further abated, while on the 11th day the spontaneous pain abated, so that the patient was able to sleep all the night.
On the 18th day, the condition of arterial pulsation was the same as before, while hyperaemia test showed 3 mins.

On the 19th day there was a small quantity of secretion.

On the 20th day, the pulsation of the arteria femoris on the right side was perceptible as before, but that of the arteria poplitea and tibialis posterior was faint, while that of the arteria dorsalis pedis was imperceptible. Hyperaemia test showed 3 mins. 75 secs. locally, while that of the arteria poplitea and the rest was entirely imperceptible. Hyperaemia test showed 3 mins. 75 secs., whereas the pulsation of the arteria femoris only was perceptible locally.

The necrotic bone at the root of the big toe and the 3rd toe dropped this day. Attacks of spontaneous pain became fewer and that of the arteria poplitea barely perceptible, whereas the pulsation of the tibialis posterior and dorsalis pedis was imperceptible. Table below:

<table>
<thead>
<tr>
<th>Side</th>
<th>19th day</th>
<th>20th day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>3 mins. 75 secs.</td>
<td>3 mins. 75 secs.</td>
</tr>
<tr>
<td>Left</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

On the 23rd day, the spontaneous pain increased a little, as also did the phlegmonous swelling, especially on the dorsum of the foot. As for the state of arterial pulsation, it was perceptible in the case of the arteria femoris only and not perceptible in the case of all the rest.

On the 28th day, the 2nd toe became almost necrotic and a fresh ulcer was formed on the inside of the third toe.

On the 29th day, hyperaemia test showed 2 mins. 30 secs. on the right side. On the 32nd day the 2nd toe fell off, a great deal of secretion being noticed. On the 34th day, the pulsation of the arteria femoris became extremely faint locally, while that of the arteria poplitea and the rest was imperceptible. On the 39th day, the big toe and toe fell off, a great deal of secretion being noticed.

On the 49th day, the pulsation of the arteria femoris became extremely faint locally, while that of the arteria poplitea was barely perceptible. Hyperaemia test showed 2 mins. 30 secs. locally, while that of the arteria poplitea and the rest was entirely imperceptible. On the 53rd day, the pulsation of the arteria femoris only was perceptible while that of the arteria poplitea and the rest was entirely imperceptible. Hyperaemia test showed 3 mins. 75 secs., whereas the pulsation of the tibialis posterior and dorsalis pedis was imperceptible. Table below:

<table>
<thead>
<tr>
<th>Side</th>
<th>49th day</th>
<th>53rd day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>3 mins. 75 secs.</td>
<td>3 mins. 75 secs.</td>
</tr>
<tr>
<td>Left</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

The necrotic bone at the root of the big toe and the 3rd toe dropped this day. Attacks of spontaneous pain became fewer and that of the arteria poplitea barely perceptible, whereas the pulsation of the tibialis posterior and dorsalis pedis was imperceptible.
Periarticular Symptomectomy.

On the 91st day, the local symptoms appeared aggravated rather than otherwise. The redness of the dorsum was intensified, the 4th to e became necrotic, the slightest touch producing most violent pain, and the inside of this toe showed tendons which had also become necrotic. In the internal upper part of the big ulcer there was comparatively good granulation, but the lower part on its sides was as much as 20 secs. deeper than what weaker than what was noticed on the 34th day from the operation. On the 157th day, no pulsation of the arteria poplitica was perceiv.
operation is one of the many contributory causes for bringing about the untoward tendency which was noted to recur gradually. It is believed that the cicatrisation due to the operation, subsequent to which the condition Gradually grows worse. It will be gathered from these examples that the effect of Leriche's operation is at its height about one week after the operation, the greatest effect being reached one week or so thereafter, from which time onwards its effect Gradually slows down until on the 73rd day it was 3 mms. As it is, about the same as before the operation.

My clinical investigations also show that the effect of Leriche's operation is at its height about one week after the operation, the greatest effect being reached one week or so thereafter, from which time onwards its effect Gradually slows down until on the 73rd day it was 3 mms. As it is, about the same as before the operation.

Wilhelm K. Kobayashi
The increase in blood-flow in the hind limb after Leriche's operation is not permanent.

Conclusions.

The increase in blood-flow in the hind limb after Leriche's operation is not permanent.

I. The increase in blood-flow in the hind limb after Leriche's operation is not permanent.

The increase in blood-flow in the hind limb after Leriche's operation is not permanent.
the other side 86 days, ro8 days, I I 8 days and 182 days after the operation. (see Experiments XVI, XVII, XVIII, XIX and XX.)

2. But in case the artery is operated on to a greater length, the increase in blood-flow is of much longer duration than when the operation is of a shorter length. In regard to the difference of blood-flow between the right and left sides, EXP. XXI and EXP. 10 (in my first report) amounted almost equally to nearly 2 ccs., but in the former case denudation was made about 5 cms. longer on the opposite side and was examined 21 days after the operation, but in the latter, about 2 cms. was done and examined only 3 days after the operation.

3. According to the result of histological investigation, after the denudation of the artery, the lamina elastica externa becomes in some cases thinner than that on the other side, but the lamina elastica interna preserve the usual wave-like appearance and no alteration is observed in the media either (see Experiment XIX).

The conclusion to be drawn from the above is, I think, that in case adventitia is denuded by Leriche's operation, there is an increase for a short time in blood-flow under its control, but the increase in blood-flow is checked again as a result of the cicatrization which soon takes place.

Explanation of the plates.

(I). Picture of the right art. femoris of the EXP. XXII (21 days after the operation).

(c) is the elastic fibres' layer of the Adventitia, which is exchanged here and there, of round cells around them.

(b) is hyaline layer in the connective tissue-layer, were a lot of capillaries' dilatation and infiltration.

(The other side 86 days, 108 days, 118 days and 122 days after the operation. (see Experiments XIX, XIX, XVII, XXII.)
Experimental Sympathetic Sympathectomy.

Experim e ntal Periarterial Sympathectomy.

Effect on Blood-flow after the section of the Adominal Sympathetic Trunk.

Before discussing the results of my experiments bearing on this question I will relate a brief description, announced by many investigators, of the anatomy of the communication of the sympathetic nerves to the hind limb of animals. The sympathetic nerves pass to the hind limb after combining with the spinal nerve fibers, touch the main vessels at various points as they go.

The sympathetic nerve fibers to the hind limb after combining with the spinal nerve fibers, touch the main vessels at various points as they go.

Histotrich and A. Haeli, Bayliss and Bradf.ord, Weерзhoff, Мüller.

Picture of the left art. femoralis (223 days after the operation).

(1) Picture of the left art. femoralis (223 days after the operation).

(2) Picture of the right art. femoralis (opposite side of the (1) specimen).

(3) Picture of the right art. femoralis (opposite side of the (2) specimen).

(4) is the connective tissue-layer.

(5) is the elastic fibers-layer.

(6) is the elastic fibers-layer, where we cannot see hyperaemia as that of (1).

(7) is the elastic fibers-layer, this is, 'plexus lumbaris', and go to the hind limb (Gaskell, Мüller, Langley).

The centrifugal fibers to the hind limb start either from the sixth lumbar or from the second sacral (L. R. Мuller).

The sympathetic fibers to the hind limb, after combining with the sympathetic nerves to the hind limb of animals, announced by many investigators, of the anatomy of the communication of the sympathetic nerves to the hind limb of animals.
S. Lowescher (1882) observed that the influence of the vasomotor apparatus was stronger at the tip of the foot

"Abdominal muscles caused by the cutting experiments be advanced by either the plexus that the phenomenon was perhaps due to the strong expiratory action of the cutting -- a fact which has been noticed by directly injuring a plexus into the vessel." In announcing this result of his cutting, and which the arteries were restored to the condition before the cutting at the end of 2 or 4 minutes after the cutting, and the arteries received a maximum about 20 to 40 seconds after the cutting of its floor got slightly as a result, the observation reached a maximum amount of a day, that the arteries in the muscles of the hind limb showed a rise which lasted about 20 days.

H. Eassell (1929) observed on cutting the abdominal sympathetic trunk of a dog, that the arteries in the periphery of the hind limb showed a rise which lasted about 20 days.

Principal Pieces of Literature bearing on my Experiments

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peripheral sympathetic

it remarked that on the abdominal sympathec-

tomy was next effected and the abdominal organs being pushed aside to the upper part and the right side

vomiting of the abdominal cavity, the peritoneum

or (when the sympathetic trunk on the right side was cut) to the left side of the peritoneal cavity, the peritoneum

the nerve along the median line.

Shaving hair off the abdominal wall and dissecting the spot as usual, the skin was cut open 1 to 3 cm. around

Perineural Sympathectomy

Perineural sympathetic c

and g were weak up

rument of the hind limb and also by 5°C to 7°C, and that the colour of the blood

and grew weaker toward the knees and the thigh. Wierzbiński (1895) remarked that on the abdominal

(1902) announced that he had observed a vasodilator reflex occurring on the hind limb in consequence of

The method of experiment.

Experiments

and finally comparing the result of the operation with that produced by perineural sympathectomy.

and hourly comparing the result of the operation with the rate of blood-flow on the side opposite to the operated side.

In making experiments on the basis of the anatomical and physiological information above quoted, I cut the

cutting the abdominal sympathetic.

Hayfliss (1902) announced that he had observed a vasodilator reflex occurring on the hind limb in consequence of

showing through the veins during this time had looked brighter than usual.

sympathetic begins to the temperature of the hind limb had risen by 5° to 7°C, and that the colour of the blood

and grew weaker toward the knees and the thigh. Wierzbiński (1895) remarked that on the abdominal

(1902)
The sympathetic trunk was torn on the left side of the aorta abdominis or on the right side of the vena abdominis. The openin~ of the incision being enlarged upwards and downwards the aorta abdominis was pushed aside to the right side or the vena abdominis to the left side (as the case may be) carefully with the fingers of the left hand when the abdominal (sympathetic) trunk would be easily found either below the aorta (or vena) and extending between the parietalis and the branching point of the vasa abdominales. The sympathetic trunk was then cut with a small half-moon shaped knife at the desired point between two ganglia. In this connection it would be somewhat difficult to expose the interstitial space between the 4th and 5th ganglia, as it is usually underneath the parietalis. But this would be easy by finding either below the aorta (or vena) and lying back when the abdominal (sympathetic) trunk would be easily seen on the right side of the vena abdominis or on the left side of the vasa abdominales was exposed upwards or downwards a little.

The rate of blood-flow was calculated by means of a kymograph or stop-watch. In case preliminary operation and experiment were made on the same day as the operation, the opening was merely cramped. The rate of blood-flow in both feet was then measured by inserting a pipette directly into the vena ilizaris, everythin~ in this connection being done in the same manner and with the same care as in the case of periartrial sympathectomy.

Before cutting the sympathetic trunk on one side, the sympathetic trunk on the other side (the non-operated side) was exposed in the same manner and at the same point as the operated side; and the sympathetic trunk on the operated side was then cut. This was done in order to make the effect of the exposure of the sympathetic trunk on the blood-flow in the hind limb equal on both sides.

On the sympathetic trunk being cut, the opening (incision) in the abdomen was immediately sewn up twofold (in case experiment was to be made on the same day as the operation). The opening was immediately sewn up twofold.

In case preliminary operation and experiment were made on the same day, the operation for exposing the aorta femoris was effected first and then the sympathectomy. In any other case, the former operation only was made on the first day.

P.S. In case preliminary operation and experiment were made on the same day, the operation for exposing the sympathetic trunk was somewhat difficult to expose the interstitial space between the 4th and 5th ganglia in this connection. It would be easy by finding either below the aorta (or vena) and lying back, when the abdominal (sympathetic) trunk would be easily seen on the right side of the vena abdominis or on the left side of the vasa abdominales was exposed upwards or downwards a little. Before cutting the sympathetic trunk on one side, the sympathetic trunk on the other side (the non-operated side) was exposed in the same manner and with the same care as in the case of periartrial sympathectomy.

The rate of blood-flow per minute was calculated by means of a kymograph or stop-watch.

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On the sympathetic trunk being cut, the opening (incision) in the abdomen was immediately sewn up twofold (in case experiment was to be made on the same day as the operation). The opening was immediately sewn up twofold.
In neither case, laparotomy was effected again upon the completion of the experiment, in order to ascertain

**Experiments**

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<tbody>
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<td>EXP. I</td>
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</table>

The results of these experiments are tabulated as follows:

- The operation was performed on the left side of the dog.
- The region between the 4th and 5th ganglia on the left side.
- Laparotomy and the region of the 5th and 6th ganglia.
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- Laparotomy and the region of the 5th and 6th ganglia.
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In my opinion, this decrease in blood-flow is to be ascribed to the exposure of the peritoneal cavity to the outer atmosphere. A decrease of about 0.1 cc. or more, showed in a number of days after the operation, the blood-flow on both sides was still the same. In all the cases of the above experiments (except Experiments 1D and 1B), the blood-flow showed a decrease of about 0.5 cc. or less.

To sum up the results of the above four experiments, as already stated in my first report, the difference between the blood-flow per cc. of both sides was about 0.55 cc. or less.

|------|------|-------|------|-----------|------------|------|--------------------|------|-------|
| 3.08.25 | 12:00 | 38.0°C | 7.50 | 5.00 | 3.50 | 0.50 | 1.666 | 1/5 | 24.
| 15.08.25 | 12:00 | 38.8°C | 7.50 | 5.00 | 3.50 | 0.50 | 1.666 | 1/5 | 24.
| 23.08.25 | 12:00 | 39.5°C | 7.50 | 5.00 | 3.50 | 0.50 | 1.666 | 1/5 | 24.
| 1.09.25 | 12:00 | 38.0°C | 7.50 | 5.00 | 3.50 | 0.50 | 1.666 | 1/5 | 24.

In my opinion, this decrease in blood-flow is to be ascribed to the exposure of the peritoneal cavity to the outer atmosphere.
In the case of Experiment 1, I stirred the part surrounding the exposed part to a greater extent than in the other cases and thereby stimulated the spinal nerves existing in the same region. It was probably owing to the effect of this stimulation on the vasodilator that the particular experiment showed a different result from other experiments. The hypothesis advanced by Gaskell that the increase in blood-flow directly after the operation is due simply to the strong expiratory action of the abdominal muscles seems to me not entirely satisfactory.

The fact that the operation is followed by an increase in blood-flow which reaches a maximum about 35 seconds after the operation but that there is a considerable decrease in blood-flow from about 3 minutes after the operation is due simply to the strong expiratory action of the abdominal muscles seems to me not entirely satisfactory. After sympathectomy, the blood-flow was always greater on the operated side than on the other.

The rate of blood-flow was always greater on the operated side than on the other side, and the colour of the blood in the veins was also brighter on the operated side than on the other.

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The operation, while a considerable decrease in blood-flow was already observed 8 minutes after the operation, had no considerable effect on the blood-flow, which is given in one of the following tables, this increase in blood-flow occurred only 35 seconds to 3 minutes after the operation, which is shown in the following tables.

After sympathectomy, the blood-flow on the operated side was found to increase to a remarkable extent, as shown in the following tables.

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After sympathectomy, the blood-flow on the operated side was found to increase to a remarkable extent, as shown in the following tables.
No. 4 dog □ WT 6.20 Kg. 23/V. EXP. I. V. 4 days after the operation.

Sympathectomy (Area: the 4th and 5th and 6th ganglia on the left side).

<table>
<thead>
<tr>
<th>Hrs</th>
<th>Mins</th>
<th>A.M.</th>
<th>P.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0600</td>
<td>245</td>
<td>0700</td>
<td>240</td>
</tr>
<tr>
<td>0700</td>
<td>300</td>
<td>0800</td>
<td>300</td>
</tr>
<tr>
<td>0800</td>
<td>350</td>
<td>0900</td>
<td>350</td>
</tr>
<tr>
<td>0900</td>
<td>400</td>
<td>1000</td>
<td>400</td>
</tr>
</tbody>
</table>

Blood-flow per min. C.C. Past hrs. aft. oper.

No. 3 dog □ WT 3.50 Kg.

Daijo Kobayashi.

No. 2 dog □ WT 6.00 Kg. 23/V. EXP. I. V. 14 days after the operation.

Sympathectomy (Area: the 4th and 5th and 6th ganglia on the left side).

Blood-flow per min. C.C. Past hrs. aft. oper.

No. 1 dog □ WT 4.00 Kg.

Sympathectomy (Area: the 4th and 5th and 6th ganglia on the left side).

Blood-flow per min. C.C. Past hrs. aft. oper.

No. 3 dog □ WT 6.00 Kg. 23/V. EXP. II. V. 9 days after the operation.

Sympathectomy (Area: the 4th and 5th and 6th ganglia on the left side).

Blood-flow per min. C.C. Past hrs. aft. oper.

No. 4 dog □ WT 6.20 Kg. 23/V. EXP. III. V. 9 days after the operation.

Sympathectomy (Area: the 4th and 5th and 6th ganglia on the left side).

Blood-flow per min. C.C. Past hrs. aft. oper.

No. 1 dog □ WT 6.50 Kg.

Sympathectomy (Area: the 4th and 5th and 6th ganglia on the left side).

Blood-flow per min. C.C. Past hrs. aft. oper.

No. 2 dog □ WT 5.50 Kg. 23/V. EXP. IV. V. 4 days after the operation.

Sympathectomy (Area: the 4th and 5th and 6th ganglia on the left side).

Blood-flow per min. C.C. Past hrs. aft. oper.

No. 3 dog □ WT 6.00 Kg.

Sympathectomy (Area: the 4th and 5th and 6th ganglia on the left side).

Blood-flow per min. C.C. Past hrs. aft. oper.

No. 4 dog □ WT 6.50 Kg.
**Experimental Procedures**

**Perirenal Sympathectomy.**

Blood:flow per min. C.C.

<table>
<thead>
<tr>
<th>Time (Hrs.)</th>
<th>Value (Mill.)</th>
<th>Diff. Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>16.99</td>
<td>10.60</td>
</tr>
<tr>
<td>5</td>
<td>16.99</td>
<td>10.60</td>
</tr>
<tr>
<td>10</td>
<td>16.99</td>
<td>10.60</td>
</tr>
<tr>
<td>15</td>
<td>16.99</td>
<td>10.60</td>
</tr>
</tbody>
</table>

No. 4 dog 

650 Kgm.

B. H. (N.T.) N.

L.

DIFF.

EXP. V.

6 days after the operation.

**Perirenal Sympathectomy.**

Blood:flow per min. C.C.

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</table>

No. 5 dog 

750 Kgm.

B. H. (N.T.) N.

L.

DIFF.

EXP. VI.

6 days after the operation.

**Perirenal Sympathectomy.**

Blood:flow per min. C.C.

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</tbody>
</table>

No. 6 dog 

850 Kgm.

B. H. (N.T.) N.

L.

DIFF.

EXP. VII.

6 days after the operation.

**Perirenal Sympathectomy.**

Blood:flow per min. C.C.

<table>
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<td>10.60</td>
</tr>
<tr>
<td>15</td>
<td>16.99</td>
<td>10.60</td>
</tr>
</tbody>
</table>

No. 7 dog 

950 Kgm.

B. H. (N.T.) N.

L.

DIFF.

EXP. VIII.

6 days after the operation.

**Perirenal Sympathectomy.**

Blood:flow per min. C.C.

<table>
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<td>10.60</td>
</tr>
<tr>
<td>15</td>
<td>16.99</td>
<td>10.60</td>
</tr>
</tbody>
</table>

No. 8 dog 

1050 Kgm.

B. H. (N.T.) N.

L.

DIFF.

EXP. IX.

6 days after the operation.

**Perirenal Sympathectomy.**

Blood:flow per min. C.C.

<table>
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<tr>
<th>Time (Hrs.)</th>
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</tr>
<tr>
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<td>16.99</td>
<td>10.60</td>
</tr>
</tbody>
</table>

No. 9 dog 

1150 Kgm.

B. H. (N.T.) N.

L.

DIFF.

EXP. X.

6 days after the operation.

**Perirenal Sympathectomy.**

Blood:flow per min. C.C.

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</tr>
<tr>
<td>15</td>
<td>16.99</td>
<td>10.60</td>
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</tbody>
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No. 10 dog 

1250 Kgm.

B. H. (N.T.) N.

L.

DIFF.

EXP. XI.

6 days after the operation.

**Perirenal Sympathectomy.**

Blood:flow per min. C.C.

<table>
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To sum up the results of the foregoing experiments.

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I think that this is to be accounted for by the difference in the time which elapsed after the operation between the right and the left sides.

Sympathectomy was effected on both sides exactly under the same conditions; but why is it that the rate of blood-flow was not equal on both sides, as above stated, despite the fact that the right and the left sides.

The increase in blood-flow on the right side in Experiment VII is also to be explained in the same manner as in the above experiment. To add that due allowance should also be made for the effect of the sympathectomy previously made on the left side.

Experimental Pretreatment: Sympathectomy.
<table>
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<tr>
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<th></th>
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<tbody>
<tr>
<td>17/XI</td>
<td>Sympathectomy (betw. the 4th and 5th on the left side.)</td>
<td>1</td>
<td>6.77</td>
<td>2.012, 4.000</td>
<td>3.000</td>
<td>0.670</td>
<td>5.06</td>
</tr>
<tr>
<td>18/XI</td>
<td>Sympathectomy (betw. the 1st and 2nd on the left side.)</td>
<td>2</td>
<td>7.20</td>
<td>3.000</td>
<td>1.715</td>
<td>14.300</td>
<td>1.461</td>
</tr>
<tr>
<td>11/XII</td>
<td>Sympathectomy (betw. the 4th and 5th on the left side.)</td>
<td>3</td>
<td>6.77</td>
<td>2.012, 4.000</td>
<td>3.000</td>
<td>0.670</td>
<td>5.06</td>
</tr>
<tr>
<td>12/XII</td>
<td>Sympathectomy (betw. the 1st and 2nd on the left side.)</td>
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<td>7.20</td>
<td>3.000</td>
<td>1.715</td>
<td>14.300</td>
<td>1.461</td>
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</tbody>
</table>
In this case experiment was made when the dog was on the verge of death, beginning with the right side. The animal died soon after this first experiment, which, however, showed a slight increase in blood-flow on the operated side. From this it would appear that if the dog had continued in a vigorous state, the rate of blood-flow on the left side would have been found by far greater.

Sympathectomy (between the 3rd and 5th ganglia on the left side.)
from these experiments it would appear that the anatomical condition of sympathetic nervous fibers to the hind limb differs between different dogs.

Experiments II. III. IV. V. VI. VII. VIII. IX. X. XI and XIII and XXI. XXII. XXIII and XXIV were made to ascertain the results of sympathectomy.

It is now time for me to have a general survey of the results of the foregoing experiments (Nos. II-XIX).

<table>
<thead>
<tr>
<th>Weight</th>
<th>Blood-flow before</th>
<th>Blood-flow after</th>
<th>Diff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 lbs</td>
<td>6,986 cc</td>
<td>6,986 cc</td>
<td>0</td>
</tr>
<tr>
<td>11 lbs</td>
<td>6,985 cc</td>
<td>6,985 cc</td>
<td>0</td>
</tr>
<tr>
<td>12 lbs</td>
<td>6,984 cc</td>
<td>6,984 cc</td>
<td>0</td>
</tr>
<tr>
<td>13 lbs</td>
<td>6,983 cc</td>
<td>6,983 cc</td>
<td>0</td>
</tr>
</tbody>
</table>

From these experiments it would appear that the anatomical condition of sympathetic fibers to the hind limb differs between different dogs.

They would seem to show that the difference (in blood-flow) between the operated side and the other was entirely unaffected by the weight of the animal and the length of time elapsed after the operation, as well as by the period after the operation.

It seems now time for me to have a general survey of the results of the foregoing experiments (Nos. II-XIX).
Experimental Periarterial Sympathectomy.

Sympathectomy (between the 6th and 7th ganglia; on both sides.)

27/VI. EXP. XX. B. 3 days after the operation.

The side shown: below the 5th and 6th, the right side.

Symphatization (the right side: below the 5th and 6th, the right side.)

P.M. 20. 36°.5 (21°) 14.769. 14.769. 0.

L. 30. 36°.5 (21°) 13.369. 13.765. 0.224.

No. 20a dog. Wt. 6.85 Kgm.

Of the foregoing experiment, Experiment No. 20a showed that the anatomical condition of sympathetic nerve fibres going from the region between the 6th and 7th ganglia to the foot was almost equal on both sides, whereas Experiment No. 20b showed that a larger number of nervous fibres seemed to emanate from the region between the 6th and 7th ganglia and Experiment No. 20c showed that more nervous fibres seemed to emanate from between the 5th and 6th ganglia to the foot than from the region between the 6th and 7th ganglia to the foot and 7th ganglia to the foot was almost equal on both sides. whereas Experiment No. 20d showed that the anatomical condition of sympathetic nerve fibres going from the region between the 5th and 6th ganglia to the foot was almost equal on both sides, whereas Experiment No. 20e showed that a larger number of nervous fibres seemed to emanate from the region between the 6th and 7th ganglia and Experiment No. 20f showed that more nervous fibres seemed to emanate from between the 3rd and 4th ganglia than from between the 5th and 6th. But these results having been obtained from a comparison of the right and left sides of a few animals, it is hardly necessary to add that they have to be verified by many more experiments before they can be offered as a general statement covering all cases.

27/VIII. EXP. XX. A. 3 days after the operation.

Symphatization (the left side: below the 5th and 6th, the left side.)

P.M. 20. 36°.5 (21°) 14.769. 14.769. 0.

L. 30. 36°.5 (21°) 13.369. 13.765. 0.224.

No. 30a dog. Wt. 8.80 Kgm.

3/7. EXP. XX. A. 3 days after the operation.

The left side shown: below the 5th and 6th, the left side.

Symphatization (the left side: below the 5th and 6th, the right side.)

P.M. 20. 36°.5 (21°) 14.769. 14.769. 0.

L. 30. 36°.5 (21°) 13.369. 13.765. 0.224.

No. 30b dog. Wt. 6.85 Kgm.
Comparison Between Periarterial Sympathectomy and Abdominal Sympathectomy in respect of their Effect upon Blood-Flow.

According to my experiments, (1) the increase in blood-flow is by far greater in the case of abdominal sympathectomy. (2) The effect of abdominal sympathectomy appears to be of much longer duration.

It may then be asked what produces these differences between the two?

As sympathetic nerve fibres reach the artery of the lower limb at intervals along their course, it would seem hard to obtain satisfactory results by effecting periarterial sympathectomy at a limited point. My experiments on animals and clinical examples showed its effect to be only of short duration, as stated above.

On the other hand, I was able by means of abdominal sympathectomy completely to cut off, at a point, the course of communication of the sympathetic system to the periphery. Moreover, owing to the cicatrisation after the operation produced in a short time, the effect of the operation was lost.

For these reasons I would recommend abdominal sympathectomy rather than Leriche's operation for spontaneous gangrene and other diseases of the same nature, although I have not yet had any opportunity to clinically test this theory of mine.

Conclusion.

1. In case the abdominal sympathetic trunk is cut, the blood in the veins presents a deep crimson colour (as Werthoff says) and the rate of blood-flow rapidly increases.

Conclusion

Daijo Kobayashi
Experimental Periarterial Sympathectomy.

The increase lasts about 3 minutes after the operation, after which the rate of blood-flow shows a considerable abatement. Though it is by far greater than on the non-operated side, the rate on the operated side ranges between 0.900 c.c. (Experiment No. 13) and 2.000 c.c. (Experiment No. 19). And this difference between the two sides is by far greater in the case of abdominal sympathectomy than in the case of periarterial sympathectomy.

In the light of my experiments in which the abdominal sympathetic trunk was cut at one or two points in different regions between the 1st and 7th lumbar ganglia, I believe that it is practicable by this means completely to cut off the communication between the sympathetic centrum and the periphery in a given point.
Specimen of the dog (Experiment XIX.)

A and B are cut-ends of the left abdominal sympathetic trunk (betw. the 3rd and 4th ganglia). C is the right sympathetic trunk.
Bibliography:
