Title

Supplementary Report on Experiments in Periarterial Sympathectomy.

Author(s)

KOBAYASHI, DAIJO

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Kyoto University
Supplementary Report on Experiments in Periarterial Sympathectomy.

DAIJO 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.

Since Rene Leriche emphasised the use and effect of Periarterial Sympathectomy on the arteria femoralis as a surgical remedy for certain troubles of the lower limbs, a large number of scientists all over the world have eagerly taken the matter up as an object of investigation and criticism.
It will be remembered that by my previous experiments the following two facts were demonstrated, namely,

Experiments in the present instance were likewise made on dogs exactly in the same manner as that described.

Experiments

In other words, how and why is the result of the operation affected by a variation in the length of the denudation?

(1) Why did Leriche in his periarterial sympathectomy extend the distance of the denudation from 2 cms to 8 or 10 cms?

(2) Is it that periarterial sympathectomy affects directly above or below the lig. Poupart or at the distal of the artery? Furthermore, the arteries remaining is devoid of any effect as conceded by Leriche and Brütting.

In the present report, it is my intention to go one step farther towards the elucidation of the real nature of periarterial sympathectomy by describing the results of further experiments made for clearing up the following two points, namely:

(a) Why did Leriche in his periarterial sympathectomy extend the distance of the denudation from 2 cms to 8 or 10 cms?

(b) Is it that periarterial sympathectomy affects directly above or below the lig. Poupart or at the distal of the artery?

Experiments in the present instance were likewise made on dogs exactly as described in my report I and II on Experimental Sympathectomy. It will be remembered that by my previous experiments the following two facts were demonstrated, namely,
that in the case of a healthy dog under normal conditions the maximum difference in blood-flow between the right and left hind legs does not exceed 0.50 c.c. per minute and (2) that during a certain time after periarterial sympathectomy the blood-flow on the operated side rectes, but that for a period of from 4 hours and 30 minutes to 6 hours and 20 minutes there is always an increase in blood-flow. In those of the experiments under report the result of which I wanted to ascertain on the very day they were made, I began by measuring the blood-flow in the under which I wanted to ascertain on the very day they were made, I began by measuring the blood-flow in the

Record of Experiments

In order to clear up the first point referred to in the introduction, I started my periarterial sympathectomies always at a point 1 cm. from the lig. Pouparti.

I/X. EXP. I.

Periarterial Sympathectomy.

No. 1 dog Black

Wt. 10.200 Kg.

(9 c.m. denuded on the left side at 1' il. 12.30.)

Before Periarterial Sympathectomy:

Blood-flow per min. c.c.

Diff.

Hrs.

Ins.

No. 1 dog Black

Wt. 10.200 Kg.

(9 c.m. denuded on the left side at 1' il. 12.30.)

Before Periarterial Sympathectomy:

Blood-flow per min. c.c.

Diff.

Hrs.

Ins.

Record of Experiments

Operations always at a point 1 cm. from the lig. Pouparti.

In order to clear up the first point referred to in the introduction, I started my periarterial sympathectomies always at a point 1 cm. from the lig. Pouparti.

I/X. EXP. I.

Periarterial Sympathectomy.

No. 1 dog Black

Wt. 10.200 Kg.

(9 c.m. denuded on the left side at 1' il. 12.30.)

Before Periarterial Sympathectomy:

Blood-flow per min. c.c.

Diff.

Hrs.

Ins.

No. 2 dog & Brown

Wt. 6.600 Kg.

X.

EXP. II.

Periarterial Sympathectomy.

After Periarterial Sympathectomy:

Blood-flow per min. c.c.

Diff.

Hrs.

Ins.
### Periodical Sympathectomy

<table>
<thead>
<tr>
<th>Time (Hrs.)</th>
<th>A.</th>
<th>R.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
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</table>

**Periarterial Sympathectomy**

<table>
<thead>
<tr>
<th>Time (Hrs.)</th>
<th>A.</th>
<th>R.</th>
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</thead>
<tbody>
<tr>
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</tr>
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<td>60</td>
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</tbody>
</table>

**Experimental Periodical Sympathectomy**

<table>
<thead>
<tr>
<th>Time (Hrs.)</th>
<th>A.</th>
<th>R.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
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<tr>
<td>10</td>
<td></td>
<td></td>
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<tr>
<td>20</td>
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<tr>
<td>50</td>
<td></td>
<td></td>
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<tr>
<td>60</td>
<td></td>
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</tr>
</tbody>
</table>
In Experiment I, where the denudation was 2 cm. in length, the greatest difference between the right and left sides was observed 4 hours and 20 minutes after the operation (but under normal conditions being 0.066 cc. in favour of the right side), that difference (0.066 cc.) was added to the difference after the operation in these several instances, care was taken in computing the weighed increases in blood-flow to obtain a difference of 0.447 cc. 

In Experiment IV, where the length of the denudation was 5 cm., there was observed on the operated side an increase of 0.37 cc., 4 hours and 20 minutes after the operation, or an average of 0.447 cc.

In Experiment III, in which the denudation was extended to 3 cm., the increase in blood-flow on the operated side was

In Experiment II, the increase in blood-flow on the operated side was observed 4 hours and 20 minutes after the operation and 0.95 cc. 4 hours and 20 minutes after the operation, or an average of 0.72 cc.

In Experiment I, where the denudation was 2 cm. in length, the greatest difference between the right and left sides was observed 4 hours and 20 minutes after the operation, or an average of 0.72 cc.

In comparing the varied increases in blood-flow after the operation in these several instances, care was taken that observation be made at times which do not differ much after the operation for the reason that a variation in the lapse of time after the operation is followed by a considerable difference in blood-flow for various causes. On surveying the results of the foregoing five experiments, it is found that in Experiments III and IV, where the difference in normal conditions was made for the same reason, the operation (0.968 cc.) in order to read difference. In the case of the other experiments, the same allowance for the operation (0.066 cc.) was added to the difference after the operation, but under normal conditions being 0.066 cc. in favour of the right side, that difference (0.066 cc.) was added to the difference after the operation (but under normal conditions being 0.066 cc. in favour of the right side); the greatest difference between the right and left sides was observed 4 hours and 20 minutes after the operation (but under normal conditions being 0.066 cc. in favour of the right side).
Experiments showed the reverse to be the case. In order to solve this difficulty, I made the following experiments to be accounted for. According to Liebrecht and Brüning, the longer the denudation the better is the effect. But my experiments showed that this was not the case. As the duration of the denudation was extended to 4 or 5 cm. the operated side showed an increase in blood-flow, but the difference

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Duration (cm)</th>
<th>Blood Flow Increase (cc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>2</td>
<td>0.600</td>
</tr>
<tr>
<td>II</td>
<td>3</td>
<td>0.500</td>
</tr>
<tr>
<td>III</td>
<td>4</td>
<td>0.300</td>
</tr>
<tr>
<td>IV</td>
<td>5</td>
<td>0.200</td>
</tr>
</tbody>
</table>

In comparing these two cases, it is observed that the increase in blood-flow was slightly larger where the duration of the denudation was of a length of 4 or 5 cm. the operated side showed an increase in blood-flow, but the difference

Supplementary Report on Periarterial Sympathectomy.
In this particular instance it was distinctly observed that the increase in blood-flow on the side when denudation of the left side was commenced. I further made the following experiment:

<table>
<thead>
<tr>
<th>Time</th>
<th>Blood flow per min. c.c.</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1.100</td>
<td>+</td>
</tr>
<tr>
<td>10</td>
<td>0.786</td>
<td>-</td>
</tr>
<tr>
<td>15</td>
<td>0.804</td>
<td>+</td>
</tr>
<tr>
<td>20</td>
<td>1.369</td>
<td>+</td>
</tr>
<tr>
<td>25</td>
<td>1.408</td>
<td>+</td>
</tr>
<tr>
<td>30</td>
<td>1.489</td>
<td>+</td>
</tr>
<tr>
<td>35</td>
<td>1.408</td>
<td>+</td>
</tr>
<tr>
<td>40</td>
<td>1.384</td>
<td>+</td>
</tr>
<tr>
<td>45</td>
<td>1.376</td>
<td>+</td>
</tr>
<tr>
<td>50</td>
<td>1.357</td>
<td>+</td>
</tr>
<tr>
<td>55</td>
<td>1.349</td>
<td>+</td>
</tr>
<tr>
<td>60</td>
<td>1.341</td>
<td>+</td>
</tr>
<tr>
<td>65</td>
<td>1.334</td>
<td>+</td>
</tr>
<tr>
<td>70</td>
<td>1.327</td>
<td>+</td>
</tr>
<tr>
<td>75</td>
<td>1.320</td>
<td>+</td>
</tr>
</tbody>
</table>

Under ordinary circumstances the increase in blood-flow was observed to be considerable from 16 hours to 4 days.
Supplementary Report on Periarterial Sympathectomy.

No. 9 Dog 8 White Wt. 8,500 Kg.

11/3 XI. EXP. XIII. Periarterial Sympathectomy (3 days after operation).

Blood-flow per min. C.C.
A.M.
11 30 5.46. 3.70. 2.152.
11 45 5.217. 3.42. 1.872.
12 0 5.169. 3.25. 1.579.
12 15 5.329. 3.53. 2.289.
12 30 5.217. 3.42. 1.872.
12 45 5.329. 3.53. 2.289.
1 P.M.
12 0 5.329. 3.53. 2.289.
12 15 5.217. 3.42. 1.872.
12 30 5.169. 3.25. 1.579.
12 45 5.217. 3.42. 1.872.
1 P.M.
12 0 5.329. 3.53. 2.289.
12 15 5.217. 3.42. 1.872.
12 30 5.169. 3.25. 1.579.
12 45 5.217. 3.42. 1.872.

Similarly three days after the operation denudation was next made at the various lengths of 3 cm., 5 cm., and 7 cm. and the blood-flow was examined. The figures showing the difference in blood-flow between the right and left sides was comparatively small. From the experiments so far described it would appear that a 3 cm. denudation produces a better result than in any other instance, but the experiments were open to the objection that the time of observation was short and that there was no particular instance in which a longer denudation showed a better result.

The same dog was then made 9 Dog 8 Black Wt. 8,500 Kg.

11/4 XI. EXP. XIV. Re-examination of Periarterial Sympathectomy (3 days after operation).

Blood-flow per min. C.C.
A.M.
11 30 5.46. 3.70. 2.152.
11 45 5.217. 3.42. 1.872.
12 0 5.169. 3.25. 1.579.
12 15 5.329. 3.53. 2.289.
12 30 5.217. 3.42. 1.872.
12 45 5.329. 3.53. 2.289.
1 P.M.
12 0 5.329. 3.53. 2.289.
12 15 5.217. 3.42. 1.872.
12 30 5.169. 3.25. 1.579.
12 45 5.217. 3.42. 1.872.
1 P.M.
12 0 5.329. 3.53. 2.289.
12 15 5.217. 3.42. 1.872.
12 30 5.169. 3.25. 1.579.
12 45 5.217. 3.42. 1.872.

In my report II on Experimental Periarterial Sympathectomy (p. 138) 1 described how denudation was effected to the extent of 3 cm. was greater than on the other side where the denudation was of a length of 7 cm.
In the above three experiments, the maximum difference between the right and left was 3.78 c.c.s, where the denudation was 5 cm. (Experiment IX) and 1.690 c.c.s where it was 7 cm. (Experiment X). While the various results of the several denudations did not show a very great difference, they were sufficient to show that the increase in blood-flow was distinctly greater when the denudation was of a length of 3 cm. (Experiment VIII) than in the case of Experiment IX and X where it was of greater length. In short, as a result of Experiments V and VI, it was able to ascertain that, so far as dogs are concerned, there was no essential difference in the effect of a denudation upon the blood-flow under the control whether the length of the denudation was 3 cm. or greater (5 cm. or 6 cm.), while by Experiment VII, VIII, IX, and X it was ascertained that the greatest result was obtained by a denudation of a length of 3 cm.

In the above three experiments, the maximum difference between the right and left was 2.578 c.c.s where the denudation was 3 cm. (Experiment VIII), 0.905 c.c.s where it was 5 cm. (Experiment IX) and 1.690 c.c.s where it was 7 cm. (Experiment X). While the various results of the several denudations did not show a very great difference, they were sufficient to show that the increase in blood-flow was distinctly greater when the denudation was of a length of 3 cm. (Experiment VIII) than in the case of Experiment IX and X where it was of greater length. In short, as a result of Experiments V and VI, it was able to ascertain that, so far as dogs are concerned, there was no essential difference in the effect of a denudation upon the blood-flow under the control whether the length of the denudation was 3 cm. or greater (5 cm. or 6 cm.), while by Experiment VII, VIII, IX, and X it was ascertained that the greatest result was obtained by a denudation of a length of 3 cm.
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reserved part.

No
II
dog & Brown
Wt. 5.450 Kgm.

As shown
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above
graph,
there
was
even
in
normal
conditions
a
difference
of
0.017 c.c. in
favor of the
operated
side.

This
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part
of
I
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immediately
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and
hemorrhage
was
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intra t.
Peripheral
Sympathectomy
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experiments
(I -X),
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Pouparti,
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Pouparti
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Supplemet etary
report
on
experiments
in
Peripheral
Sympathectomy.
It will be seen from the above that no difference was observable under normal conditions, but that observation

<table>
<thead>
<tr>
<th>Time (minutes)</th>
<th>Pre-operative (cc.)</th>
<th>Post-operative (cc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.528</td>
<td>1.528</td>
</tr>
<tr>
<td>10</td>
<td>1.566</td>
<td>1.566</td>
</tr>
<tr>
<td>20</td>
<td>1.598</td>
<td>1.598</td>
</tr>
<tr>
<td>30</td>
<td>1.624</td>
<td>1.624</td>
</tr>
<tr>
<td>40</td>
<td>1.648</td>
<td>1.648</td>
</tr>
<tr>
<td>50</td>
<td>1.666</td>
<td>1.666</td>
</tr>
<tr>
<td>60</td>
<td>1.686</td>
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<td>1.728</td>
<td>1.728</td>
</tr>
<tr>
<td>90</td>
<td>1.750</td>
<td>1.750</td>
</tr>
<tr>
<td>100</td>
<td>1.772</td>
<td>1.772</td>
</tr>
</tbody>
</table>

After Periarterial Sympathectomy
and examined the difference in blood-flow consequent to the following results.

In Experiment XIII, the greatest difference between the two sides was 0.094 cc. at 4 hours and 20 minutes; the increase in blood-flow on the operated side was smaller still than in the case of the previous experiment; whereas in blood-flow. The difference between the greatest discharges.

Hennich Ahréns has recently published the view that Leriche's treatment is disadvantageous in various respects. When the denudation was of a length of only 1 cm., but it was still within the limit of the physiological

Experiments XIV, where the denudation was of a length of 2 cm., the greatest differences were 0.120 cc. at 4 hours and 20 minutes; the increase in blood-flow on the operated side was thereby greater than when the denudation was of a length of 1 cm., but it was still within the limit of the physiological

In Experiment XIII, the greatest difference between the two sides was 0.094 cc. at 4 hours and 20 minutes; the increase in blood-flow on the operated side was thereby greater than when the denudation was of a length of only 1 cm., but it was still within the limit of the physiological

After Periarterial Symphatectomy.

Supplementary Report on Experiments in Periarterial Symphatectomy.
An instance of the left art. femoral is merely being freed from the surrounding parts.

No. 17 dog o White
Wt. 3.600 Kgm.

(Operated: A.M. 11.30.)

Before Operation

No. 16 dog o Brown Wt. 5.300 Kgm.
merely being freed from the surrounding parts.

An instance of the left art. femoral.

No. 17 dog o Reddish brown Wt. 5.500 Kgm.

(Operated: A.M. 11.50.)

After Operation

<table>
<thead>
<tr>
<th>Time (A.M.)</th>
<th>Time (P.M.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>00</td>
</tr>
<tr>
<td>05</td>
<td>10</td>
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<tr>
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<td>15</td>
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<tr>
<td>15</td>
<td>20</td>
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<td>20</td>
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<tr>
<td>50</td>
<td>55</td>
</tr>
<tr>
<td>55</td>
<td>00</td>
</tr>
</tbody>
</table>

Blood loss during operation.

Total 45.0 c.c.

Before Operation

No. 15 dog o White Wt. 3.000 Kgm.
merely being freed from the surrounding parts.

An instance of the left art. femoral.
An instance of the later art remnants merely being freed from the surrond parts.

Supplementary Report on Experiments in Reduced Simplicity of

The results of the foregoing experiments were thus either uniform or that even though some difference in

<table>
<thead>
<tr>
<th>Time (h)</th>
<th>Blood Flow (c.c.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.005</td>
</tr>
<tr>
<td>1.5</td>
<td>0.014</td>
</tr>
<tr>
<td>3</td>
<td>0.014</td>
</tr>
<tr>
<td>4.5</td>
<td>0.014</td>
</tr>
<tr>
<td>6</td>
<td>0.014</td>
</tr>
<tr>
<td>7.5</td>
<td>0.014</td>
</tr>
<tr>
<td>9</td>
<td>0.014</td>
</tr>
<tr>
<td>10.5</td>
<td>0.014</td>
</tr>
<tr>
<td>12</td>
<td>0.014</td>
</tr>
<tr>
<td>13.5</td>
<td>0.014</td>
</tr>
<tr>
<td>15</td>
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<tr>
<td>16.5</td>
<td>0.014</td>
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<tr>
<td>18</td>
<td>0.014</td>
</tr>
<tr>
<td>19.5</td>
<td>0.014</td>
</tr>
<tr>
<td>21</td>
<td>0.014</td>
</tr>
<tr>
<td>22.5</td>
<td>0.014</td>
</tr>
<tr>
<td>24</td>
<td>0.014</td>
</tr>
</tbody>
</table>

The blood-flow was perceptible between the right and left, such difference vanishing about 20 hours after the operation.

In Experiment XIX, no difference was perceptible between the blood-flow in the right and left limbs, except at 4 hours 40 minutes after the operation. In Experiment XXI, the greatest difference (0.66 g. c.c.) was observed at the operated side on the other side than the operated side. In Experiment XXII, the greatest difference was between the left and right limbs, except the physiological difference, and subsequent to 72 hours and 40 minutes after the operation, the blood-flow was actually greater on the other side than on the operated side. In Experiment XXIII, the greatest difference was observed at the operated side on the other side than the operated side.

In Experiment XXIV, the greatest difference (0.689 g. c.c.) was observed at 4 hours and 40 minutes after the operation. At other times the difference in blood-flow between the right and left sides did not exceed the physiological difference except at 4 hours 40 minutes after the operation. In Experiment XXV, the greatest difference (0.625 g. c.c.) was observed at 4 hours and 40 minutes after the operation.

In Experiment XXVI, no difference was perceptible between the blood-flow in the right and left limbs, except the physiological difference, and subsequent to 72 hours and 40 minutes after the operation, the blood-flow was actually greater on the other side than on the operated side. The difference was within the limits of the physiological difference, and subsequent to 72 hours and 40 minutes after the operation, the blood-flow on the operated side was observed to be greater than on the other side from 4 hours and 40 minutes after the operation.

The results of the foregoing five experiments were thus either uniform or that even though some difference in blood-flow was perceptible between the right and left, such difference vanished about 20 hours after the operation.
In short, the effect of this treatment was found to be of shorter duration and limited to fewer hours than that of periarterial sympathectomy, even if some effect was to be perceived shortly after the operation.
VIII, where the denudation was of a length of \( c \) cm, than in the case of the two other experiments, where a

Periarterial Symphatieectomy is premised on the hypothesis that the sympathetic nerve fibers exist in the periarterial wall of the arteries, and the operation is intended to cause the dilatation of the blood-vessels in the distal by putting an end to the control of the vasoconstrictors.

Among some other recent views, mention may be made of that of Japko who has affirmed that the sympathetic nerve fibers come to the hind limbs with mixed nerves (all these have affirmed that the sympathetic nerve fibers come to the hind limbs with mixed nerves and that the experiment revealed no longer sensory sensory epithelial nor the vessels effectuated with the mixed nerves and entered the vessels did not go to the periphery above the vessels, but decended with the long vagal fibers.

1low is this phenomenon to be accounted for?}

Since Jaboulay attempted to ascertain the real nature of this operation, many investigators have taken the matter up and numerous views have been published on this subject.
Supplementary on experiments in limbic symptoms.

1. Dumpert and Flick cut off part of the femoral artery on which periarterial sympathectomy had been effected and then sewed it up in its old place and injected various stimulants into the blood-stream in order to observe that which they claimed to be in support of their view. At the same time Braencker, Hahn, and Fränzleunck published the view that vascular nerves enter segmental in the vessel wall, which without any connection with the spinal nerves, emerges directly from the sympathetic trunk and goes to the periphery along the vessel. Hahn also remarks that there are two kinds of efferent nerve fibres in vessels, namely, those which enter segmental and a long centripetal course existing as periarterial plexus, and a long cephalic course existing as periarterial plexus.

2. All the results of experiments made by such noted investigators as quoted above, however, are not calculated to solve the puzzle of why in the case of dogs denudation longer than 3 cm's is followed by a very slight increase in blood-flow, so this is evidently a question that requires further and more minute investigations to solve.

For the present I have to content myself with merely pushing the fact that such was the result of experiments made by myself. For the present I have to content myself with merely pushing the fact that such was the result of experiments made by myself.

To sum up:

(1) Periarterial sympathectomy on the artery femoralis of dogs would appear to be followed by the most pronounced increase in blood-flow when denudation is of a length of 3 cm's from a point I can immediately below the lig. Poupart, while long denudations result in a smaller increase in blood-flow.

(2) Immediately below the lig. Poupart, while long denudations result in a smaller increase in blood-flow in the hind limb when denudation is of a length of 3 cm's from a point I can pronoucend increase in the blood-flow in the hind limb when denudation is of a length of 3 cm's from a point I can.

Braencker, Hahn and Fränzleunck, especially, have pointed out that the view in which they claim to be in support of their view, at the same time periarterial sympathectomy and been effected and then observed and forming effects in the old place and injected various stimulants and enter segmental in the vessel wall. More especially, Dumpert and Flick cut out a part of the femoral artery on which periarterial sympathectomy has been performed on experiments in limbic symptoms.
limb than in the case of Jenu<latiun of a length of 3 cm (beginning at 1 cm immediately below the Poupart). (III) The effect of a mere detachment of arterial branches from the femoral upon the block-flow in the hind limb in the case of denudation of a length of 3 cm's (beginning at 1 cm immediately below the Poupart).

*Bibliography*


