On the Aortic Nerves in Dogs. §

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A figure of Cyon¹⁾ of the depressor nerve in the dog is quoted in some widely read text-books of physiology, such as of Starling²⁾ and others, which gives definitely an impression that this nerve takes in the dog a somewhat different course to that in the rabbit, while Ellenberger and Baum properly, referred to in their book "Anatomie des Hundes"³⁾ the finding of Kreidmann.⁴⁾ Fig. 4 of Cyon in Pflügers Arch. and Fig. 21 in his monography, which were not quoted in Starling, are rather similar to the common figure of the depressor nerve in the rabbit.

A doubt whether such a different course is rather common in the dog led us to a biological study of this matter and further to our own experiments, and they will be given in the following pages in the order here mentioned.

BIBLIOGRAPHICAL.

Although a rather complete review re this matter is briefly given in a recent publication of Koch⁵⁾ the previous experiments are here arranged in the chronological order and rather at length in order to

§ Read before the XIII Meeting of the Jap. Physiol. Soc., 1934 (Jap. J. of Med. Sci., Biophysics, 1934, 3, 221*)

1) E. von Cyon, Pflügers Arch., 1898, 70, 132 ff., Die Nerven des Herzens, Berlin 1907, 116 ff.

2) Starling, Principles of human physiology, 5. ed., London 1930, 752.

3) Ellenberger and Baum, Anatomie des Hundes, Berlin 1891, 529.

4) Kreidmann, Arch. f. Anat. u. Physiol., Anat. Abt., 1878, 405.

5) Koch, Die reflektorische Selbststeuerung des Kreislaufes, Dresden u. Leipzig 1931, 19-21.

compare them easily with our present results. With regard to some old references we trust to Kazem-Beck⁶⁾ and Schumacher.⁷⁾

Bendz⁷⁾ saw a strong nerve which starts from the angle of the superior laryngeal nerve and the vagus, afterwards running into the vago-sympathetic sheath and sending branches to the cardiac plexus.

Dreschfeld⁸⁾ failed to find the depressor nerve in dogs. Bernhardt was able to find a depressor nerve in only one out of 4 dogs.⁹⁾ It was very thin so that it was impossible to isolate it while the dog was living. Aubert and Roever¹⁰⁾ were unable to find in dogs a depressor which could be isolated and stimulated.

Kreidmann⁴⁾ found the depressor nerve in the dog. It has two roots, one from the superior laryngeal nerve and another directly from the vagus, and joins to the vagus, to the sympathetic or to the vago-sympathetic trunk; in one dog out of 6, he was unable to find the nerve on the right side. Finkelstein,¹¹⁾ who was able to duplicate the findings of Kreidmann, noted that the same results, with Ludwig and Cyon on other animals, were yielded in all the experiments, five in number.

Roever (1869)⁶⁾ and Langenbacher (1877),⁶⁾ prior to Kreidmann, and Zibulski and Wartonow (1883)⁶⁾ posterior to Finkelstein, observed an isolated depressor in the dog.

Wooldrige¹²⁾ noted that stimulation of the central end of the aortic nerve causes a reduction of the pulse frequency and a fall of the blood pressure. Stimulation of the dorsal ventricle nerve results similarly. Viti¹³⁾ searched for this nerve in 6 dogs; in a single case he discovered a nerve branch coming from the laryngeal and soon joining to the vagus. He looked therefore upon the depressor nerve as seldom occurring in the dog.

Among 4 dogs of Kazem-Beck⁶⁾ the left depressor was in two cases found to follow in the thoracic cavity to the heart; in one case it originated from the upper laryngeal nerve and the angle of that

6) Kazem-Beck, *Arch. f. Anat. u. Physiol., Anat., Abt.*, 1888, 325.

7) Schumacher, *Sitzber. d. K. Akad. d. Wiss., Math.-naturw. Classe*, 1902, III, Ab. III., 133.

8) Dreschfeld, *Unters. aus d. physiol. Lab. in Würzburg*, 1 Part, Leipzig 1867, 331.

9) Bernhardt, *Cit. in Ctrbl. f. med. Wiss.*, 1868, 6 year, 553 and in Kazem-Beck (6).

10) Aubert and Roever, *Pflügers Arch.*, 1868, 1, 211.

11) Finkelstein, *Arch. f. Anat. u. Physiol., Anat. Abt.* 1880, 247-8.

12) Wooldrige, *Ibid.*, 1883, 538 & 540.

13) Viti, *Arch. Ital. de. Biol.*, 1884, 5, 191.

nerve to the vagus, joining together and afterwards entering into the sympathetic strand, later it ran again separately, but it joined to the inferior cervical ganglion, and later it branched again and reached to the aortic arc, joining to branches from the inferior cervical ganglion. In the second case, it originated only from the upper laryngeal nerve. In the two other cases, the left depressor nerve began with a root from the upper laryngeal, and joined to the sympathetic trunk or to the vagus in the neck; too close for undertaking isolation. On the right side the depressor nerve was found to have one root from the upper laryngeal nerve in two cases and two roots from that nerve and the vagus, while no depressor nerve was found at all in the remainder. The nerve ran separately only for a while and then joined to the sympathetic trunk. In two cases, the central end of the depressor nerve was stimulated; in one case the pulse rate remained unaltered with a fall of the blood pressure, while the former was found reduced besides the pressure fall in the second instance. Edgeworth¹⁴⁾ measured the thickness of the nervous fibres in the depressor nerve of the dog which leaves the vagus sheath oral to the situation of the inferior cervical ganglion. In a report on the nervous supply of the dog's heart Lim Boon Keng¹⁵⁾ noted: A depressor nerve probably exists either in the vagus trunk or in the communicating branch of the superior laryngeal.

That Cyon¹⁾ noted a peculiar course of the depressor nerve in the dog, that it runs oral from the angle of the vagus and the superior laryngeal nerve, besides that which is rather similar to that of the rabbit, is already above quoted. He stimulated the nerve. François-Franck¹⁶⁾ followed the depressor nerve in the dog as originating from the upper laryngeal nerve, the pharyngeal and the upper cervical ganglion. The latter might originate from the vagus and joined with the branch from the pharyngeal; this new branch pointed further to the branch from the laryngeal, as to form the single depressor nerve which finally merged in the vagus trunk.

In the research of Schumacher,¹⁷⁾ the depressor was found to originate either from the angle of the upper laryngeal with the vagus, or from both the laryngeal and the vagus or from the vagus. In a dog the right depressor was not to be isolated. A branch or branches

14) Edgeworth, J. of Physiol., 1892, 13, 264.

15) Lim Boon Keng, Ibid., 1893, 14, 473.

16) François-Franck, J. de Physiol. et Path. gén., 1899, 1, 753.

17) Schumacher, Anat. Anzeiger, 1902, 21, 1; & (7).

which spring up from the vagus near the branching of the recurrent nerve or the medial cervical ganglion, runs to the aortic arc; and in fact the left nerves to the ventral side of the arc and the right to the dorsal. Sometimes branches from the recurrent nerve or from the stellate ganglion join to the branches above related; i. e. to the depressor.

Ónodi mentioned in his book that he observed in a dog the physiological event that stimulation of the depressor nerve brings about the blood pressure fall.¹⁸⁾

Fischer¹⁹⁾ observed in the dog the depressor springing off usually with a root from the upper laryngeal nerve or the vagus, exceptionally with two roots from them. The course of the depressor at the neck is variable; it is closed in thick, fast sheath of the vago-sympathetic. Being isolated at the height of the 7. cervical spinal column the depressor runs along the vagus towards the heart; the left to the lateral surface of the aortic arc and the right to the medial and finally to the heart muscle between the aorta and the pulmonal artery.

Dogiel described the nerve in the neck as having two roots, one from the vagus and another from the upper laryngeal nerve. When the central end of the vagus nerve was stimulated, the blood pressure fell; cutting the roots, above mentioned, nullified this action.²⁰⁾

Fofanow and Tschalussow noted that the depressor nerve is not often observable, so that they stimulated the vagus i. e. the vago-depressor nerve. When the depressor was to be isolated, they said, they stimulated it.²¹⁾

Perman²²⁾ experimented on 9 dogs; he was able only twice to see a thin root coming from the upper laryngeal nerve and soon entering into the vagosympathetic sheath, for joining to the vagus. In two other cases a small branch springs up from the vagus in the middle neck and after running isolated some centimeters it joins again to the vagus. No depressor nerve was found in the remaining cases.

Jonnesco and Ionescu²³⁾ noted that in a case (dog? cat?) a fibre sprung up from the ganglion nodosum and soon ran into

18) Ónodi, *Die Anatomie und Physiologie der Kehlkopfnerven*, Berlin 1902, 125.

19) Fischer, 1904: Cit. in Perman (22); *Arch. f. wiss. u. prakt. Tierh.*, 1906, **32**, 104 f.

20) Dogiel, *Pflügers Arch.*, 1911, **142**, Figg. 5, 34 & 35, & p. 122.

21) Fofanow and Tschalussow, *Ibid.*, 1913, **151**, 542.

22) Perman, *Ztschr. f. Anat. u. Entwicklungsgesch.*, 1924, **71**, 393. f.

23) Jonnesco and Ionescu, *Ztschr. f. ges. exp. Med.*, 1926, **48**, 494.

the sympathetic. They noted it as the depressor with a question mark.

Saying that the depressor nerve undergoes in the neck a large variation, so that it is impossible to give a simple, uniform description, Danielopolu, Aslan and Marcu stimulated the branches from the inferior cervical ganglion running aboral, with either elevation or fall of the blood pressure.²⁴⁾

In 15 dogs Velluda²⁵⁾ stimulated the depressor or the vagus, when he was unable to isolate the depressor, whereby the blood pressure fell with or without an accompanying reduction of the pulse rate. Further he attempted to stimulate the nerve fibres running towards the aorta, which occasioned sometimes blood pressure fall, sometimes elevation.

Schurawlew²⁶⁾ noted that n. cardiacus dexter has two roots, viz. from the vagus and the right inferior cervical ganglion, and the right depressor nerve, which lies in the vago-sympathetic sheath in the neck, comes into the cardiac nerve.

Koch was able to isolate the ramus aorticus without great difficulties, to the length of some centimeters; in one case he found the depressor nerve running along the vago-sympathetic trunk through the whole length of neck, without joining to it.²⁷⁾

Hochrein and Gros²⁷⁾ were able to isolate the depressor nerve, which comes from the upper laryngeal nerve and enters into the vagus, in 3 instances out of 15 dogs, and in two cases it occurred from the upper laryngeal and joins to the sympathetic. In these cases they were able to isolate a nerve from the vagus under the cervical ganglion, which again enters into the vagus after running independently about 2 cms.

A great number of investigations have thus been made in the depressor nerve of the dog, but there are only a few experimentalists who tried to stimulate an isolated depressor, and especially recent investigators seem to be too indifferent to try to isolate that nerve. In fact, Koch noted in his book: The aortic nerve of the dog is still nowadays looked upon almost generally as not suitable for physiological experiments.

24) Danielopolu, Aslan and Marcu, C. r. Soc. Biol., 1926, 95, 112; Danielopolu, Ztschr. f. kl. Med., 1927, 106, 58 & 63.

25) Velluda, J. de Physiol. et Path. gén., 1927, 25, 244.

26) Schurawlew, Ztschr. f. Anat. u. Entwicklungsgesch., 1928, 86, 675.

27) Hochrein and Gros, Pfügers Arch., 1932, 229, 645.

EXPERIMENTAL.

At first we attempted to isolate the aortic nerve in the thoracic cavity after leaving the vagus or the sympathetic trunk. In these dogs the nerve was searched for in the region of the upper neck anatomically; the vago-sympathetic trunk, covered within the sheath together with the depressor, was taken out from the cranial basis to the heart, together with the heart, large vessels and together with the nerve branches from the trunk itself, and soaked in 0.5 per cent acetic acid solution for 24-48 hours, and fixed on a cork plate with pins, followed by careful dissection.

When we were successful to find without fail the aortic nerve in the place of the bifurcation of the upper laryngeal nerve from the vagus, we tried then to isolate the depressor there, followed by stimulation with success. Afterwards the two kinds of experiments were combined in a few cases so that the aortic nerve was isolated at the upper neck and the upper thoracic cavity at once which followed by physiological experimentation.

A dog was administered with 1 c.c. of 2% morphina per kilo of body weight under the skin and fixed supine on the table.

When the nerve was stimulated in the thoracic cavity only, a skin incision was made on the middle line from the height of the larynx to the fourth or fifth rib, then a cannula was inserted into the trachea and connected to a Woulff's flask containing ether-chloroform for conducting the artificial respiration when the thoracic cavity was opened, which was done by resecting the median portion of the upper three ribs on the right side. The vago-sympathetic nerve was uncovered carefully, and the right subclavian vein was doubly ligated at the point crossing that nerve and a short piece between the ligatures was cut off. Branches from the vago-sympathetic trunk, the median (sometimes called as the inferior) cervical ganglion, the subclavian ansa, the stellate ganglion, and the recurrent nerve were searched for carefully, with little damage as possible.

On the left side, the aortic nerve branches from the vagus in the neighbourhood of the median sympathetic ganglion, and runs along the left subclavian artery towards the heart, so that it ends macroscopically on the ventral wall of the aortic arc. There are usually two nerve fibres, seldom a nerve fibre running with the aortic nerve in the similar direction; commonly the aortic nerve is the thicker, but when there were only two strands, the thinner was the aortic nerve.

On the right side the aortic nerve branches from the vagus after giving off the recurrent nerve with one root, unites with one or two branches from the recurrent nerve, sometimes branches from the subclavian ansa, the median cervical ganglion and the stellate ganglion unite to it, and the nerve strand thus constructed runs down to the dorsal wall of the aortic arc; some fibres branching off from that nerve before arriving the arc runs further towards the right pulmonary artery and the right heart ventricle.

Recent publications of heart paranglia of Penitschka²⁸⁾ and of Seto²⁹⁾ are interesting for investigating the origin of the depressor nerve.

We came across no aortic nerve springing from the sympathetic in the thoracic cavity, contrary to the description of some previous authors.

For stimulating the left aortic nerve it is needless to remove the ribs of the ipsilateral side, it is enough to push aside the sternum to that side.

In order to show the course of the aortic nerve in the thoracic cavity an example is given in Fig. 1; the other figures in Fig. 2 (A-Q) show various kinds of the course of the aortic nerve at the upper neck.

Next, when the aortic nerve was to be stimulated in the upper neck, a skin incision was made on the middle line from the jaw to the sternum. At first the aortic nerve was usually uncovered

Fig. 1. An example showing the course of the aortic nerves in dogs.

A=Aortic nerve; G.j.=Ganglion jugulare nervi vagi; N.l.s.=N. Laryngeus superior; G.c.s.=Ganglion cervicale superior; G.c.m.=Ganglion cervicale medium (sometimes called as g.c. inferius).

28) Penitschka, Ztschr. f. mikr.-anat. Forsch., 1931, 24, 24.

29) Seto, Ztschr. f. Zellf. u. mikr. Anat., 1935, 22, 213.

Fig. 2. Showing various kinds of roots of the aortic nerves in dogs.

on the left side because the depressoric action is obtainable invariably on that side, while it is sometimes obscure on the right side. The common carotid, the internal and external carotids, the carotid sinus, were exposed carefully, the bifurcation as the centre, and the upper laryngeal and vago-sympathetic nerves were cleaned from fine nervous fibres and blood vessels by ligating and cutting as well. Then the vago-sympathetic trunk was at the bifurcation of the upper laryngeal nerve uncovered from the sheath by means of a fine pincette. A very fine nerve was then discovered, it is the aortic nerve. It originates from either the vagus or the sympathetic and takes its course up into the jugular ganglion of the vagus or the laryngeal nerve or both with two branches. Otherwise expressed or as usually expressed, the aortic nerve originates with one root either from the jugular ganglion or from the upper laryngeal nerve or with two roots from both, and runs into the vagus or the sympathetic.

Then the right side aortic nerve was prepared similarly.

Usually 1 to 2 cms. is the length of the aortic nerve running isolated. Contrary to the case in the rabbit, there was no aortic nerve which is running isolated through the whole length of neck.

Statistics of the roots of the aortic nerve at the upper neck will be given here:

The left aortic nerve was examined in 36 cases, among which in 8 cases marked with star it was examined only anatomically; the right in 31 cases including 3 cases marked with star. In two dogs the left was only examined, and in other two dogs the right was torn off on examining, so that it was difficult to speak of the origin with certainty.

TABLE.

2 roots from upper laryngeal & jugular ganglion to vagus trunk (Fig. 2. A)	L 2, R 1 : total 3 cases.
2 roots from upper laryngeal & its angle with vagus to vagus trunk (Fig. 2. B)	L 1, R 2 : total 3 cases.
2 roots from upper laryngeal & vagus to vagus trunk (Fig. 2. C)	L 8**, R 7§* : total 15 cases.

{§ In a case two roots were again separable in two branches (Fig. 2. D)}.

2 roots from upper laryngeal & vagus to symp. trunk (Fig. 2. E)	L 5, R 2 : total 7 cases.
2 roots from upper laryngeal & its angle with vagus to symp. trunk (Fig. 2. F)	R 1 : total 1 case.
2 roots (?) from upper laryngeal & jugular ganglion to symp. trunk (Fig. 2. G)	L 1, : total 1 case.
1 root from jugular ganglion to vagus trunk (Fig. 2. H)	L 3, R 1 : total 4 cases.
1 root from angle of upper laryngeal & vagus to vagus trunk (Fig. 2. I)	L 3*, R 1 : total 4 cases.
1 root from upper laryngeal to vagus (Fig. 2. J)	L 6****, R 7 : total 13 cases.

{In 2 cases (left) from upper laryngeal very near to ganglion (Fig. 2. K); in one case it leaves once vagus, but again joins to vagus (Fig. 2. L)}.

1 root from jugular ganglion to symp. trunk (Fig. 2. M)	L 1*, : total 1 case.
1 root from angle of upper laryngeal nerve and vagus to symp. trunk (Fig. 2. N)	L 2, R 2 : total 4 cases.
1 root from upper laryngeal nerve to symp. trunk (Fig. 2. O)	L 4, R 4* : total 8 cases.

{In one left case & one right case it joins once to vagus, but leaves it soon and runs towards symp. trunk (Fig. 2. P)}.

1 root from vagus to symp. trunk (Fig. 2. Q)	R 3* : total 3 cases.
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(11 cases marked with star were examined only anatomically.)

If they be further much simplified :

Aortic nerve with 2 roots from upper laryngeal & vagus to vagus	L 11 & R 10, total 21 cases.
Aortic nerve with 2 roots from upper laryngeal & vagus to sympathetic	L 6 & R 3, total 9 cases.
(Aortic nerve with 2 roots	L 17 & R 13, total 30 cases)
Aortic nerve with 1 root from upper larynx to vagus	L 12 & R 9, total 21 cases.
Aortic nerve with 1 root from larynx. or vagus to symp.	L 7 & R 9, total 16 cases.
(Aortic nerve with 1 root	L 19 & R 18 total 37 cases.)

Further if it be compared with the data of Köster and Tschermak on 50 rabbits.³⁰⁾

	Rabbits	Dogs
Depressor with two roots	29	51
Depressor from vagus alone	14	3
Depressor from jugular ganglion	6	5
Depressor from angle of larynx. & vagus	20	9
Depressor from laryngeal alone	25	21

They failed to find the depressor in a few cases, while it was found invariably in the present investigation. In their rabbits there were many cases with the depressor sprung off from the angle; if that be granted this might, possibly, be not impossible to separate it into two roots, both figures may be taken as practically similar.

Now the results of stimulating experiments will be quoted; the dog was first narcotized with morphina and fixed supine on a table. The nerves under question were laid bare in the manner described above. When the nerve was to be stimulated in the thoracic cavity, a cannula was put into the trachea for conducting the artificial respiration, which was started just before opening the thoracic cavity.

At first the results on stimulating the left aortic nerve will be quoted; they are really uniform, excepting only No. 22.

On stimulating the left aortic nerve either in the thoracic cavity or at the upper neck, described above and shown in Fig. 1, the arterial blood pressure fell invariably and the heart beat rate diminished. The aortic nerve was stimulated in 12 dogs only in the thoracic cavity, and in 14 dogs only at the upper neck. In two dogs stimulation was carried out in the thoracic cavity and at the neck. The blood pressure fell ad maximum by seventy per cent of the initial level, as in Nos. 32,

30) Köster and Tschermak, Arch. f. Anat. u. Physiol., Anat. Abt., 1902, 261.

35 & 36 and the heart beat rate by sixty per cent, as in the same cases as above and eighty per cent in No. 33. One example is given in Fig. 3.

In dog No. 21 the left aortic nerve was first several times stimulated in the thoracic cavity with the blood pressure fall and the pulse diminution as shown in Fig. 4a, then its root was uncovered at the upper neck, with the central end prepared for stimulation. It was then repeatedly stimulated, the pressure fell and the heart rate diminished, as demonstrated in Fig. 4b. Afterwards the central end of aortic nerve in the thoracic cavity was again a few times stimulated, but this time no depressoric effect was

Fig. 3. Stimulation of L aortic nerve at upper neck of Dog No. 32 ♂, 17 kilos. 29. XI. 1933. (Reduced to $\frac{1}{2}$).

Upper curve: by Hürtle's spring manometer;
Upper line: its zero-line.
Lower curve: by Hg-manometer;
Lower line: its zero-line and time recording in second. Coil distance 14 cms.

Fig. 4. Stimulation of L aortic nerve in thoracic cavity (A & C) and at upper neck (B). Dog No. 21 ♀, 10 kilos. 13. IX. 1933. (Reduced to $\frac{2}{3}$).

"C" shows the effect of stimulation of aortic nerve in thoracic cavity after sectioning the aortic nerve at upper neck.

Upper curve: blood pressure by Hg-manometer; middle line: its zero-line; lower line: time in second.

seen, which is also illustrated in Fig. 4 c. Stimulations of the central end of aortic nerve at the neck gave depressoric effect as before.

This fact shows that all the depressoric fibres contained in the aortic nerve, branching from the vagus in the upper thoracic cavity and running to the ventral wall of the aortic arc, are contained in the aortic nerve isolated in the upper neck; it may be approximately said that the aortic nerve isolated as such in the thoracic cavity and that in the upper neck is one and same nerve.

Similar experiments were obtainable in dog No. 22; only with the difference that in this dog stimulation of the aortic nerve at the neck as well as in the thoracic cavity resulted sometimes in a blood pressure elevation followed by a fall. The pulse rate diminished invariably on stimulation. After cutting the aortic nerve at the neck, for stimulation, no alteration was recorded in the blood pressure curve on stimulating the aortic nerve in the thoracic cavity.

And this was the single case where stimulation of the left aortic nerve yielded a pressoric effect, though not invariably, among 28 dogs experimented on.

Now the results on the right side will be presented, which are somewhat dissimilar to the opposite side, above given. In about two-thirds of the cases the blood pressure fell with simultaneous reduction of the heart beat rate, but in the remaining cases the stimulation brought about mostly no influence upon the blood pressure and the pulse rate, and an elevation in the blood pressure occurred in a few cases, with or without accompanying reduction of the pulse rate.

In 14 dogs the aortic nerve was stimulated in the thoracic cavity; the depressoric effect was evidently seen in 5 cases, the amount of reduction being usually from ten to twenty per cent of the initial pressure, in only one dog was a fall as large as forty per cent registered. If the magnitude of fall in these cases be compared to that attendant on stimulating the contralateral aortic nerve, the right was proved as somewhat inferior to the left, excepting a single case where the right nerve had a little larger influence upon the blood pressure reflexly. The pulse rate was noted to be reduced usually. No reduction of the pulse rate was observed in a single case. In other four cases a small fall was noted in the blood pressure, and in one case the pulse rate became smaller.

In the remaining five cases no alteration was occasioned by stimulating the aortic nerve at all. The pulse rate underwent no alteration either.

In 14 dogs the right aortic nerve was stimulated faradically at the upper neck. In 4 dogs the arterial pressure fell clearly, as from ten to forty per cent of the preliminary level, and the pulse rate diminished evidently, as from thirty to forty per cent of the preliminary. But the magnitude of the fall and the retardation were as a rule smaller compared with the effect of the left aortic nerve. We know that it is risky to say the above comparison is an exact one, though the results were occasioned by the same strength of faradic current, but it is undoubtedly the general tendency, because it was noted in almost all cases.

In three other dogs, the depressoric effects were noted though in a lesser degree, only in one case the pulse rate remained unaltered.

In five other cases, no alteration occurred on stimulating the aortic nerve in the arterial pressure and the pulse rate. And in two other dogs the stimulation occasioned, on the contrary, an elevation (from five per cent to thirty per cent) in the blood pressure, though there was also some fall in one dog; but the pulse rate decreased in this dog invariably and did not alter in another dog.

In the following dogs the aortic nerve was stimulated, but its course was not verified by conducting an autopsy. Since it is sure, we believe, that it was the aortic nerve, the results will be here appended and they harmonized really with the foregoing. The left aortic nerve was stimulated in two dogs in the thoracic cavity, which resulted in a blood pressure fall by about twenty five per cent and a reduction of pulse frequency by twenty five or seven per cent. The right aortic nerve was also in two dogs in the thoracic cavity, the fall and the reduction were little or somewhat smaller than the above figures. In one dog the left aortic nerve at the neck elicited the blood pressure fall from 96 mms. Hg. to 52 mms. Hg. with a reduction of pulse from 198 beats to 84 beats a minute. When the right aortic nerve was stimulated with much stronger stimuli, such as coil distance 12 cms. against 20 cms., the effects were just the half. In the last dog the right aortic nerve at the neck brought about in the blood pressure curve sometimes only a blood pressure fall, which reached a considerable magnitude, but sometimes a fall on beginning the faradization with coil distance of 5 cms., followed by an evident elevation during the stimulation. After discontinuing the stimulation the pressure fell somewhat largely under the preliminary level. The pulse rate diminished a little throughout regardless the various behaviour of the arterial pressure. The left aortic nerve in this dog caused always a large fall of pressure and a large reduction of pulse.

Negative cases were thus often witnessed in the right side stimulation; in every case we tried to stimulate all fibres which lay under any doubt; still there were negative cases.

Some significance should be laid upon these findings in the right side, while we were able to obtain an uniform result on the left side. Not only were there cases where stimulation of that nerve elicited non-influence upon the circulatory system, but also the influences were smaller compared to the contralateral side even in the cases where the depressoric effect was proved evidently.

An often related fact that the left aortic nerve acts more powerfully than the right in the rabbit harmonizes with the present findings.

How must we explain the negative cases on stimulating the right nerve? It is apparently advisable to assume mingling of some pressoric fibres there, because a blood pressure elevation was recorded though only in a few cases, on stimulating it and it is proved that on the other hand in cats the right aortic

nerve acts reflexly only to raise the arterial blood pressure,³¹⁾ which suggests existence of the pressoric fibres. Stimulation of the central end of this nerve does not however bring about any alteration in the pulse rate. Provided that both kinds of fibres were mingled so as to counteract well and to nullify the antagonistic effects in respects to the blood pressure, the pulse rate should be discovered as still decreasing; the experimental outcome disproves. No retardation of the pulse rate was noted in those cases where the blood pressure remained unaltered despite stimulation of the nerve under question.

It is then reasonable to take this nerve in these negative cases as not containing any afferent nerve such as effecting reflexly the heart rate and the arterial blood pressure in the long run.

In passing, the results of stimulating the central end of vagus trunk after branching off the aortic nerve in the thoracic cavity, tried in some cases, will be mentioned. In 6 cases the left trunk was stimulated with a negative outcome in respect to the blood pressure, but out of 8 cases, where the right trunk was stimulated, the blood pressure fell a little in 2 cases. In one case the pressure elevated a little. Tschermak³²⁾ once noted on stimulating the central end of vagus at the cardia a fall followed by an elevation. An attempt to stimulate the right vagus in the neck was also tried after preparing and stimulating the aortic nerve. In five cases the aortic nerve acted depressorically and the vagus none; the reverse was discovered in two cases. In three cases both nerves acted depressorically and in one case caused both an elevation and a fall. Similar data are mentioned by Tschermak ten years ago in the experiments on rabbits.

SUMMARY.

The depressor or aortic nerve was anatomically and physiologically investigated in dogs.

The nerve which is capable of causing reflexly a blood pressure fall and a pulse retardation was discovered in all the cases in the left side. The nerve in the right side whose course is wholly the same as the left nerve, acted in the same manner, though in a somewhat inferior strength roughly speaking, in about two thirds of cases, while in the rest it was impossible to elicit any reflex so far as the circulatory system is concerned. In a few cases a pressoric action was registered.

The aortic nerve has its root from the upper laryngeal nerve or the vagus, near it, or two roots from both, or some such place, which unite sooner or later. The aortic nerve then joins downwards invariably to the vagus or sometimes to the sympathetic trunk after running isola-

31) Hirohata and Hasimoto, *Tohoku J. of Exp. Med.*, 1936, 28, 231.

32) Tschermak, *Med. Klinik*, 1925, 21, year, 995.

ted, commonly for a few centimeters. In order to isolate the depressor the common sheath of the vagus and sympathetic must be carefully opened. The aortic nerve thus prepared has usually a sufficient length for stimulation with induction currents.

In the upper thoracic cavity the aortic nerve branches from the vagus in the neighbourhood of the median cervical ganglion on the left side, and of the branching of the recurrent nerve on the right side, and runs towards the aortic arc, to the ventral respectively to the dorsal wall. In two cases, which were all those which we especially investigated, the depressor fibres in the aortic nerve prepared in the thoracic cavity were proved as contained in the aortic nerve prepared at the upper neck.