OBSERVATIONS ON THE LYMPH FLOW FROM THE SUBMAXILLARY GLAND OF THE DOG.

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(Two Figures in Text.)

CONTENTS.

History of previous work. Giannuzzi[1] (1865) observed that the injection of a dilute solution of sodium carbonate, or of hydrochloric acid into the duct of the submaxillary gland prevented the secretory, but not the vascular effects produced by stimulating the chorda tympani, and that stimulation under these conditions gave rise to marked œdema of the gland. He argued that the increased blood flow caused an increased formation of lymph, which accumulated in the gland tissue because the gland cells no longer carried it off in the saliva.

Heidenhain[2] (1874) confirmed Giannuzzi's observation, but pointed out that no œdema of the gland was caused by protracted stimulation of the chorda tympani after atropin had been given, and that therefore increase of blood-pressure was in itself insufficient to cause increased lymph formation. He further pointed out that if, after a dose of atropin, dilute acid or alkali were injected into the gland duct, the chorda tympani would on stimulation cause œdema. Heidenhain suggested that Giannuzzi's result was rather due to diffusion than to an alteration in the capillary wall, but later[3] (1880) he gave the latter view only.

Cohnheim (1877) when discussing Heidenhain's experiments mentions that hydræmic plethora acts quite independently of secretory

[1] *Ber. d. k. Säch. Ges. d. Wiss.* 1865.
[2] *Arch. f. d. ges. Physiol.* IX. p. 346. 1874.
[3] *Hermann's Hdb.* v. Th. 1, p. 73. 1880.

nerves, for the injection of salt solution into a vein leads to œdema of the submaxillary gland, even after atropin has been given.

In a paper published in 1898, in which the general question of lymph formation is discussed, Asher and Barbèra[1] describe some experiments on the lymph flow from the submaxillary gland of the dog. They collected lymph from the main lymphatic vessel of the neck. After measuring the flow during a considerable period, they produced a flow of saliva from all the salivary glands by placing blotting-paper soaked in dilute vinegar upon the dog's tongue. The vigorous flow of saliva produced, was accompanied by a greatly increased flow of lymph.

These observers conclude, partly as a result of their observations on the submaxillary gland, partly as the result of other experiments that, without glandular activity, there is no lymph formation, whatever the blood-pressure may be.

As an example of the figures given by Asher and Barbèra, I quote the following:

Medium sized dog. Morphia narcosis. Cannula in both lymph ducts.

Time	Total lymph flow	Flow per min.	
9—12	29 c.c.	0·15 c.c.	Glands resting.
1—2	25 ,,	0·42 ,,	Blotting-paper soaked in vinegar placed on tongue. Active flow of saliva.

The anatomy of the submaxillary lymphatics. The lymphatics from the submaxillary gland leave it at the hilus, and enter a large lymphatic gland, which lies along the carotid artery at its point of bifurcation into the external and internal carotid vessel, and is overlapped by the sterno-thyroid and sterno-mastoid muscles. These lymphatic vessels are variable in number and arrangement: usually they number three or four; some are superficial, and some are deep to the digastric muscle, and as a rule one of them runs with the submaxillary artery for some distance after leaving the hilus. The lymphatic gland also receives a number of lymphatics from the deep structures of the head and neck; from its inferior border arises a large lymphatic vessel, which passes downwards along the neck to end on the left side in the thoracic duct, and on the right side in the internal jugular vein at its junction with the subclavian vein. In its course, this vessel, which I shall refer to as the 'cervical lymphatic vessel,' lies embedded in fatty connective tissue

[1] *Zeitsch. f. Biol.* p. 198. 1898.

in close relation to the common carotid artery, overlapped by the sterno-mastoid muscle, and receives tributaries near its termination.

Experimental procedure. The experiments were in all cases performed on dogs. In each case, morphia was injected subcutaneously, the dog was anæsthetised with chloroform, and anæsthesia was maintained by the administration of the A.C.E. mixture after the performance of tracheotomy. The chorda tympani was exposed and dissected out, a cannula placed in Wharton's duct, and the saliva collected was measured. The 'cervical lymphatic vessel' was then exposed low down in the neck, and a cannula placed in it; this cannula was connected to a graduated tube along which the lymph flowed at a pressure never exceeding half an inch of lymph, and usually at zero pressure, and the amount of lymph was measured in each case.

The lymph flow was found to be exceedingly scanty unless the neck was massaged; this therefore was done at intervals of three minutes, and observations of the rate of lymph flow were also recorded every three minutes. The drawbacks attaching to the method are largely overcome by taking the lymph flow during a considerable period and calculating from this the average flow per minute, and by adopting a uniform method and degree of massage. If too much lymph is forced into the cannula during one period of three minutes, and too little during the following period of three minutes, the error is lessened since the mean flow during these two periods is taken. In the same way, a mean is taken of the rate of lymph flow resulting from a series of stimulations of the chorda tympani.

Similarly when pilocarpin is injected, or the cervical sympathetic nerve (isolated from the vagus) is stimulated, the average is taken of the lymph flow during a series of stimuli. When atropin is used, ten or fifteen milligrammes of the sulphate are injected into a femoral vein.

It should be noticed that stimulation of the chorda tympani affects only the submaxillary and the sublingual gland; the flow from the other structures of the neck whose lymphatics enter the cervical lymphatic gland, may be regarded as fairly constant, and the increased lymph flow produced by chorda stimulation may reasonably be assumed to come practically from the submaxillary gland.

RESULTS OBTAINED.

When the submaxillary gland is resting, the lymph flow from the cervical lymphatic is extremely scanty, and does not as a rule amount

to more than ·05 c.c. per minute; this it will be remembered is during massage. The actual flow per minute varies considerably in different experiments, the differences being chiefly dependent upon the size of the dog, and apparently to a slight extent upon the kind of dog. It appeared that rough-haired terriers yielded the largest quantity of lymph; no particular stress can be laid on this fact except in so far as it indicates that the lymphatics vary greatly in capacity in different animals.

Chorda stimulation. Stimulation of the chorda tympani causes a prompt and marked increase in the flow of lymph from the cervical lymphatic. There appears to be some latent period, but the method employed is not sufficiently delicate to show this definitely.

The actual increase in the lymph flow produced by stimulation of the chorda varies considerably in different experiments, the variations being mainly dependent on the differences in the strength of current used in different cases. In four experiments the flow of lymph during the period of chorda stimulation was $2\frac{1}{2}$ times as great as that occurring when the submaxillary gland was resting. And in some of the earlier experiments where stronger currents were used, and a greater flow of saliva was produced, the lymph flow during chorda stimulation was ten times as great as that obtained from a quiescent submaxillary gland.

The rate of the lymph flow sinks to its original value almost as soon as the stimulation of the chorda ceases. Occasionally, the flow of lymph during the three minutes immediately succeeding a stimulation is rather greater than the average flow during rest. And when this occurs, it is usually found that the secretion of saliva has persisted for some minutes after the chorda stimulation has been stopped.

A relation exists between the amount of saliva secreted as the result of chorda stimulation, and the increased lymph flow occurring at the same time; but the relation is not sufficiently exact to be expressed by figures.

In one or two experiments, the secretion of 1 c.c. of saliva corresponded to *an increase* of $\frac{1}{10}$ c.c. in the lymph flow; in most cases, the increase in the lymph flow was smaller than this. Great differences were found in different experiments between the actual amount of saliva secreted per minute, and the increased flow of lymph per minute occurring at the same time as the result of chorda stimulation. It is impossible therefore to say more than that a profuse flow of saliva is accompanied by a greatly increased flow of lymph, and that a scanty flow of saliva corresponds to only a moderate increase in the lymph flow.

The following figures illustrate in tabular form the results described above:

Increase per min.	Gland resting	Gland active (chorda stimulation)	
	Lymph	Lymph	Saliva
I.	·047 c.c.	·105 c.c.	·5 c.c.
II.	·01	·03	·6
III.	·018	·043	·5
IV.	·019	·05	·6
V.	·037	·063	not measured
VI.	·011	·042	

To illustrate the ratio between the flow of saliva and the flow of lymph.

Time	Lymph	Saliva
3 mins.	·116 c.c.	4·0 c.c.
3 „	·106	3·4
3 „	·088	2·1
3 „	·053	1·5
3 „	·041	1·1

Obstruction of Wharton's duct. When the flow of saliva from Wharton's duct is obstructed by clamping the tube along which the saliva passes to be collected, and the chorda is subsequently stimulated, very unexpected results are obtained. Under these circumstances, Wharton's duct becomes enormously distended with saliva, and in some cases it leaks slightly; at the same time the submaxillary gland swells up a good deal. The lymph flow from the gland is greater than that normally occurring when the gland is resting, but smaller than that obtained by chorda stimulation when the saliva flows freely. Further it is found that after removal of the clamp, subsequent chorda stimulation leads to a comparatively scanty flow of saliva; and corresponding to this the flow of lymph produced by chorda stimulation after removal of the clamp is also much smaller than that occurring before the duct is clamped. It ought however to be mentioned that this latter result is not absolutely constant. The scanty flow of saliva which occurs after the removal of the clamp is no doubt due to the lessened irritability of the gland, which is known to result from obstruction of Wharton's duct during chorda stimulation. And it will be subsequently shown that the smaller flow of lymph also occurring under these conditions may be accounted for in the same way.

The following figures illustrate the effects observed:

		Chorda stimulation	
	Gland resting	Wharton's duct clamped	Duct open (normal gland)
I.	·012 c.c. per min.	·028 c.c. per min.	·042 c.c. per min.
II.	·006 „	·013 „	·024 „

Stimulation of the Cervical Sympathetic. The cervical sympathetic has been stimulated in four experiments, and stimulation led in every case to an increased flow of lymph. In one experiment, the increase was so slight as to fall almost within the limits of experimental error. In the other experiments the rate of lymph flow was more than doubled, and approximated to that produced by chorda stimulation. A further point noticed was that the flow of lymph was increased for several minutes after the cessation of the stimulus, and sank to its original rate rather slowly. In this respect, the effects of stimulation of the sympathetic nerve differ from those produced by chorda stimulation. Taking this fact into consideration, it is found that sympathetic stimulation leads to a flow of lymph which, though extended over a longer period, is quite as great as that caused by stimulation of the chorda. In all the dogs employed, the stimulation of the sympathetic led to a scanty flow of saliva.

In one experiment, the chorda and sympathetic were stimulated simultaneously, and the lymph flow thereby produced was slightly greater than that produced by stimulation of either nerve alone.

It is clear, therefore, that although the vascular conditions are totally different in the two cases, both chorda and sympathetic stimulation leads to a definite and approximately equal increase in the rate of flow of lymph.

The following figures illustrate this fact:

Lymph flow per minute.

	Gland resting	Chorda stim.	C. symp. stim.	Joint stimulation
I.	·047 c.c.	·105 c.c.	·108 c.c.	·116 c.c.
II.	·010	·03	·026	—
III.	·016	·045	·025	—
IV.	·011	·042	·028	—

In this table the lymph flow due to stimulation of the cervical sympathetic represents only the flow during the actual period of stimulation.

The action of pilocarpin. The action of pilocarpin is in the main similar to that of the chorda tympani. Its effect on the lymph flow

and salivary flow is less marked than that of chorda stimulation, and occasionally it fails to increase the flow of saliva; in those cases the flow of lymph is not increased at all. Further, pilocarpin acts on all the salivary glands, and the increased lymph flow is due less exclusively to the activity of the submaxillary gland. On the other hand, its action can be prolonged over a considerable period; its effect on the lymph flow is similarly prolonged, and the errors due to massage, which are apt to occur with a brief chorda stimulation, are to a large extent eliminated. In this respect, therefore, it is satisfactory to find that the results of chorda stimulation and of pilocarpin injection correspond so closely.

Lymph flow from cervical lymphatic.

Gland resting	·007	c.c. per	1 min.
Chorda stimulation	·023	„	„
After injection of pilocarpin	·018	„	„

The action of atropin. After the injection of a few (10—15) milligrammes of atropin sulphate into a vein, stimulation of the chorda tympani no longer leads to any increase in the flow of lymph. This result is confirmatory of the observation of Heidenhain, and of Asher and Barbèra.

Atropin does not appear to have any influence on the normal flow of lymph, when the gland is resting. The flow is sometimes slightly greater, sometimes rather less after giving atropin; but the differences are always small, and when an increase occurs, it is not in any way comparable to that normally produced by chorda stimulation. Probably the differences fall within the limits of experimental error.

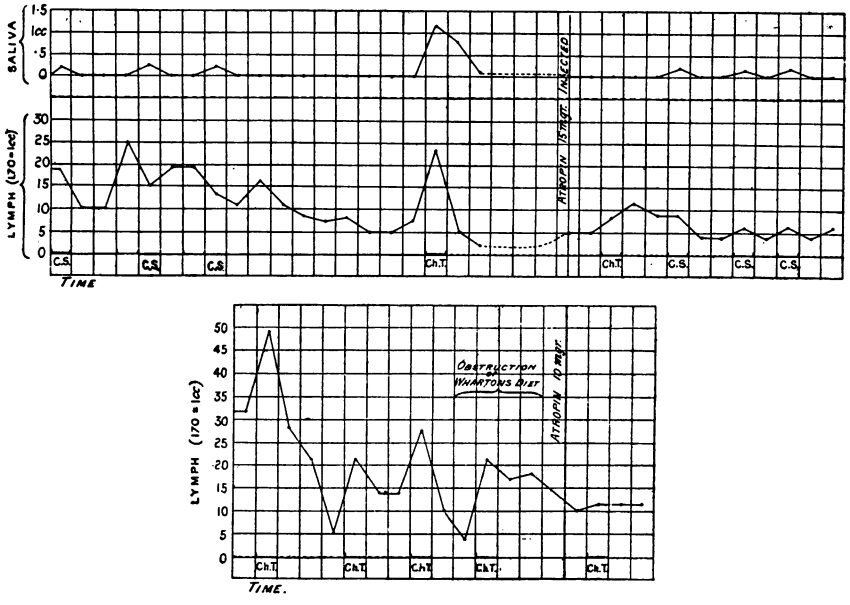
The action of atropin begins three or four minutes after its injection and lasts a long time—in fact, as long as it prevents the flow of saliva. In the only case in which (after giving atropin) chorda stimulation led to an increased flow of lymph, some saliva was obtained at the same time, and it was obvious that the effect of the atropin upon the submaxillary gland had come to an end.

The action of pilocarpin on the lymph flow is at once abolished by atropin.

As regards the cervical sympathetic, my experiments are few in number and inconclusive. In one or two experiments, stimulation of the cervical sympathetic led to an increased flow of lymph after giving atropin, in others, no increased flow of lymph was obtained by the

stimulation. In one experiment, in which atropin was given, stimulation of the cervical sympathetic led to no flow of saliva and no increased lymph flow occurred. The point is an important one, and I hope to make some further experiments in regard to it. Atropin appears to have no influence on the increased lymph flow produced by clamping the submaxillary vein, or injecting large quantities of normal saline solution into a vein.

Some points in the action of atropin are illustrated by the following figures:



Flow of lymph per minute from cervical lymphatic; neck massaged every 3 minutes.

		Stimulation of chorda tympani	
	Resting gland	Before giving atropin	After giving atropin
I.	·047 c.c.	·105 c.c.	·044 c.c.
II.	·011	·042	·017
III.	·005	·014	·006
IV.	·008	·015	·008
Earlier experiments. Massage at irregular intervals.			
V.	·005	·046	·01
VI.	·005	·048	·002

Effects of venous obstruction and lymphagogues. When the submaxillary vein is clamped, the flow of lymph from the gland is considerably increased. Stimulation of the chorda during this period of obstruction leads to a still greater flow of lymph. No œdema of the gland was noticed in these experiments, presumably because the massage at regular intervals forced on the lymph into the efferent vessels. The increased lymph flow consequent on clamping the submaxillary vein still occurs after atropin has been given.

The injection of a considerable quantity (say 500 c.c.) of normal saline solution into the femoral vein is followed by a great increase in the flow of lymph from the cervical lymphatic both before and after giving atropin (cp. Cohnheim, *supra*). Some of the lymph obtained in this way comes of course from the other structures of the head and neck. No œdema of the gland was produced by this method, but this again may have been due to the regular massage.

Summary and Conclusions.

The essential features of the results just described may be summarised as follows:

1. Stimulation of the chorda tympani, stimulation of the cervical sympathetic and the injection of pilocarpin all lead to an increased flow of lymph from the submaxillary gland.

2. After giving atropin, chorda stimulation no longer causes any increased flow of lymph: the effect of atropin upon the lymph flow produced by cervical sympathetic stimulation is not clear.

3. Whenever the irritability of the gland is lowered by obstructing Wharton's duct, less lymph is obtained by stimulating the chorda than when the gland is normal.

4. The injection of a large quantity of dilute salt solution or clamping the submaxillary vein leads to an increased flow of lymph both before and after giving atropin.

Some of these results confirm those already obtained by previous observers. The increased lymph flow produced by chorda stimulation was observed by Cohnheim. More recently, Asher and Barbèra using a different method found that glandular activity led to an increased flow of lymph. Both Cohnheim and Heidenhain found that after giving atropin, chorda stimulation did not cause any increased flow of lymph, and Cohnheim noticed that the injection of salt solutions

into the body led to œdema of the submaxillary gland before and after giving atropin.

A point to consider in the facts given above is why chorda stimulation should normally cause an increased flow of lymph, and should not do so after atropin has been given. At first sight, it seems possible that atropin decreases the permeability of the capillary wall, so that increased blood-pressure no longer leads to the transudation of fluid through the capillary walls. This explanation however has been discussed and rejected by Heidenhain. He found that the injection of atropin did not prevent the œdema, which is produced by injecting a strong solution of sodium carbonate into the gland duct (shown by Giannuzzi). And he argued in consequence that the permeability of the vessels is unaffected by atropin. Cohnheim came to the same conclusion, since he observed that atropin did not prevent the œdema of the gland which is brought about by hydræmic plethora. My own experiments support this view; they show that after atropin has been given an increased flow of lymph from the submaxillary gland still occurs in consequence of the injection of dilute salt solution, and also as the result of clamping the submaxillary vein. The fact that increase of venous pressure causes an increased flow of lymph was considered by Cohnheim to be due to an increase in the permeability of the capillary wall incident to the abnormally slow circulation of blood under these circumstances. And at present, no other explanation seems to present itself.

It is clear from the effect of atropin that increased flow of lymph produced by chorda stimulation cannot be accounted for on the supposition that it is mechanically squeezed out of the gland by the distension of the blood vessels. Nor will such mechanical means account for the increased flow of lymph produced by stimulation of the cervical sympathetic.

The only conclusion then that appears possible is that the increased flow of lymph normally following chorda stimulation is independent of variations of blood-pressure brought about by arterial dilatation. With regard to this increased flow I adopt the view of Asher and Barbèra that it is in some way due to the activity of the gland cells. I have shown that there is a broad relation between the amount of lymph and the amount of saliva, whether produced by chorda stimulation or by pilocarpin; that when the irritability of the gland is lowered by obstructing Wharton's duct, less lymph is obtained on stimulating the chorda: and lastly that an increased flow of lymph is caused by stimulating the cervical sympathetic nerve.

As to the further question of how the activity of the gland causes more lymph to be formed, I would suggest the following view. It is assumed that during chorda stimulation the primary changes occur in the gland cells, which take up water and salts from the lymph and discharge them as saliva. The percentage of salts in saliva is about ·3—·5; that in lymph is about ·8; consequently, the lymph will become more concentrated, osmosis will occur and water will pass from the blood into the lymph until the osmotic pressures are again balanced. On this view, the blood and lymph form a self-regulating mechanism; as fast as water is taken up from the lymph by the cells, it is restored to the lymph from the blood, but no excess of lymph is produced. It might be maintained that this concentration of lymph due to salivary secretion causes more fluid to reach the lymph from the blood than leaves the lymph to form saliva.

But when the secretion of saliva is very rapid, the percentage of salts in saliva is increased, as shown by Heidenhain, Werther, Langley and Fletcher. It then becomes more nearly equal to the percentage of salts in the lymph, and very little concentration of the lymph will occur; and the excess of fluid entering the lymph from the blood over that leaving the lymph to form saliva ought to be smaller. But it is precisely under this condition—namely rapid secretion of saliva—that the lymph flow is most increased. It seems to me probable that during glandular activity whether due to chorda stimulation or to cervical sympathetic stimulation, waste products of metabolism leave the gland cells and enter the surrounding lymph spaces. These metabolites raise the osmotic pressure of the lymph; water passes from the blood, and the metabolites enter the blood until the osmotic pressures in the blood and lymph are balanced[1]. The water, which in

[1] A further point may be mentioned in support of this view. If the lymph could be previously diluted, the passage of metabolites into it might merely raise the concentration to its normal value, and no increased flow of lymph would follow glandular activity. In one experiment, the following figures were obtained:

	Lymph flow.		
	Gland resting	Active	Increase produced
No venous obstruction	·017 c.c. per min.	·042 c.c.	·025 c.c.
Submaxillary vein clamped	·036 c.c.	·048 c.c.	·012 c.c. per min.

Cohnheim has shown that the lymph produced as a result of venous obstruction is more dilute than normal lymph from the same organ; and no doubt this holds good for the submaxillary gland. Under these circumstances, the passage of metabolites into the lymph does not make it so concentrated as normally. Less fluid passes from the blood by osmosis, and the lymph flow produced by chorda stimulation is smaller than usual.

this way enters the lymph from the blood, forms the increased flow of lymph actually produced by glandular activity.

In conclusion, I wish to express my sincere thanks to Dr Langley and to Professor Starling for their advice and help in the course of these experiments.

The expenses of this research have been defrayed by a grant from the Research Committee of the Royal Society.

PROTOCOLS.

I. Medium-sized dog. Morphia (1 grain) injected subcutaneously. Anæsthetised with chloroform. Anæsthesia maintained by A.C.E. mixture. Tracheotomy performed. Chorda tympani exposed. Cannula placed in Wharton's duct. Cannula placed in cervical lymphatic. Lymph and saliva collected and measured. Neck massaged and record taken every 3 minutes.

Lymph c.c.	Saliva c.c.	
·25	5·4	
·5	5·4	Cerv. symp. stim. 3 mins.
·85	5·5	Coil at 5.
·95	5·5	
1·15	5·5	
1·30	5·5	Cerv. symp. stim. 3 mins.
1·60	5·6	Coil at 5.
1·80		
2·0	5·6	Chorda T. stim. 3 mins.
2·3	7·1	Coil at 5.
2·50		
2·7	7·2	Chorda T. stim. 2 mins.
3·0	8·6	Coil at 5.
3·1		
3·2	8·7	Joint stimulation of
3·55	9·3	chorda tymp. and cerv. symp. 3 mins.
3·75	9·4	
3·85	9·4	Inject. pilocarp. nitr. 8 mgr.
3·95		
4·05	9·7	Inj. pilocarp. nitr. 12 mgr.
4·25	9·7	
4·45	9·8	Chorda T. stim. 3 mins.
4·8	9·9	Coil at 5.
5·05	9·9	Flow of saliva temporarily obstructed.
5·4		Obstruction removed.
		10 mgrs. atropin injected into femoral vein
5·55	10·0	
5·65	No flow	Chorda stim. 3 mins.
5·85	of saliva	Coil at 5.
5·95		Symp. stim. 3 mins.
6·1		Coil at 5.
6·2		

II. Dog, medium size. Preparation as in No. I. To convert lymph flow along graduated tube into cubic centimetres (170=1 c.c.).

Lymph	Saliva	
208		
240	good flow	Chorda stim. 3 mins.
288		Coil at 6.
316		
337		
342	good flow	Chorda stim. 3 mins.
364		Coil at 6.
378		
392	good flow	Chorda stim. 3 mins.
419		Coil at 6.
429		
433	Wharton's	Chorda stim. 3 mins.
454	duct clamped	Coil at 5.
471	No saliva	Chorda stim. 3 mins.
489	4·40	Coil at 5.
	10 mgrs. atropin sulphate injected. Clamp removed.	
504	No flow	Chorda stim. 3 mins.
515		Coil at 5.
519		

III. Large Dog. Preparation as in No. I. except 1½ grain morphia given. Cervical sympathetic nerve isolated and record taken every 3 minutes. Lymph flow is measured along a scale (170 = 1 c.c.).

Lymph	Saliva c.c.	
300	1·8	Cerv. symp. stim. 3 mins.
318	1·9	Coil at 9.
322		
338	1·9	Cerv. symp. stim. 3 mins.
363	2·1	Coil at 9.
378		
396	2·15	Cerv. symp. stim. 3 mins.
414	2·3	Coil at 9.
427		
438		
454		
465	2·4	
473		
480		
488		
493		
498		
505	2·4	Chorda tymp. stim. 3 mins.
527	3·6	Coil at 9.
532	4·5	
534		
572	5·3	Inject. 15 mgrs. atropin sulphate into femoral vein.
577	5·3	
582	5·3	Chorda tymp. stim. 3 mins.
591	5·3	Coil at 8.
602		
610	5·3	Cerv. symp. stim. 3 mins.
619	5·4	Coil at 12.
623		
627	5·4	Cerv. symp. stim. 3 mins.
634	5·45	Coil at 8.
638	5·45	Cerv. symp. stim. 3 mins.
645	5·65	Coil at 7.
649		
655		

IV. Medium-sized dog. Preparation as in No. I. Submaxillary veins exposed. Neck massaged and record taken every 3 minutes. Lymph flowed along a calibrated tube (170=1 c.c.).

Lymph	Saliva c.c.	
112	·8	
121		
130	·8	Chorda tymp. stim. 3 mins.
159	2·9	Coil at 6.
163	3·3	
166		
176		
181		Wharton's duct obstructed.
186	3·4	Chorda stim. 3 mins. Coil
196	3·4	at 6. Enormous distension of duct; some leakage.
208		
230		Clamp removed from duct.
236		
245	3·4	Chorda stim. 3 mins. Coil
256	3·9	at 6.
269		
272		
300	4·0	
318	4·0	Chorda stim. 3 mins. Coil
334	4·2	at 6.
343	4·2	Chorda stim. 2 mins. Coil
375	5·0	at 4.
380		Submax. vein clamped.
394		
410		
443		
452	5·0	Chorda stim. 3 mins. Coil
473	6·0	at 4.
486		
507		Clamp removed.
527	6·0	
545	6·0	Chorda stim. 3 mins. Coil
573	6·4	at 3.
582	7·2	
595	7·4	Chorda stim. 3 mins. Coil
615	8·4	at 3.
641	8·5	
651		Submax. vein clamped.
664	8·5	Chorda stim. 3 mins. Coil
693	9·4	at 5.
720		Clamp removed.