ON THE TERMINATION OF THE THORACIC DUCT.

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THE wounding of the thoracic duct during operations at the root of the neck is an accident which, until quite recent years, was regarded as a very grave injury, usually followed by death. In the 1895 edition of Erichsen's "Surgery" it is stated that "the injury has been almost universally fatal." That this is not necessarily so has since been abundantly proved by the published cases, of which W. J. Stuart¹ has collected and tabulated 40. Of this series only five died, and even some of these five deaths appear to have been in no way due to the wounding of the thoracic duct. Stuart estimates the true mortality as probably not greater than 8 per cent., and it is interesting to note that amongst the cases in which the accident was recognised at the time of operation and the duct ligatured there was not a single fatality. In Keen's "Surgery" (1908) E. W. Andrews remarks that "if ligated, distension and rupture will follow unless collateral branches divert the flow;" and again, "ligation involves some theoretical risk, since with a single duct the patient must die unless it can discharge."

Such considerations led us to seek in the anatomy of the terminal portion of the duct some explanation as to why the older surgeons regarded a wound of the duct as such a serious accident, and why the ligation of the duct should appear to be in reality so free from danger. On referring to the literature we find that Poirier and Cunéo² state that the termination of the duct by two distinct branches is fairly frequent. Watson³ says that sometimes the terminal part of the bend of the duct bifurcates and opens by two separate trunks into the subclavian vein. We have only been able to find two definite series of observations, one by Verneuil⁴ and the other by Wendel.⁵ The former found that out of 24 cases the duct was single in 18, double in 3, triple in 2, and six-fold in 1. The latter found that out of 17 cases, it was single in 9, double in 3, three-fold in 1, and multiple in 4.

We now submit a further series of anatomical observations, based upon 40 records, 36 of which are from subjects within 24 hours of death, 1 from a living case in which the termination of the duct was exposed but not cut in the course of an operation, and 3 from careful dissections of formalin-hardened specimens. Our plan was to isolate the duct in the posterior mediastinum and inject it with coloured gelatin, after which it was followed up to its termination. We found that in 18 out of the 40 cases the duct divided and that this division usually occurred while it was lying behind the left common carotid artery about 5 centimetres from its opening. In one case, however, the division only took place 8 millimetres from the termination, while in another the duct was double for 2 centimetres.

As a rule the duct divided into two branches of about equal size, though when they were unequal the upper—i.e., the one most liable to injury—was usually the larger. This we noticed six times and we met with no cases in which the lower branch was markedly larger than the upper. In three out of the 18 cases of bifurcating ducts one of the two branches divided again and the three ducts thus formed communicated with one another by anastomosing channels, so that a wide-meshed plexiform arrangement was present. In two others the division was still more free and there were four openings into the great veins.

It does not follow that because the duct divides before its termination it necessarily has more than one opening into the

veins. In only nine of the 18 double or multiple ducts was this the case; in the other nine the branches united, sometimes in the wall of the vein, but more often before reaching it, and so only one aperture was present. When there was only one opening, whether the duct had been single or double before (we opened the veins in an extra specimen to make up for the one seen during life which, of course, could not be opened), that opening was usually into the lower part of the internal jugular vein below and often under cover of the left flap of the valve which is there. This was the case in 26 of the 40 specimens, and the material at our disposal leaves us little room to doubt that it is normal. In three cases the opening was anywhere between the point of junction of the two veins and one centimetre above, but in addition to these 26 there were two other specimens in which the openings were respectively 19 millimetres and 25 millimetres above the junction.

Only three times were we able to satisfy ourselves that the opening was really into the junction of the internal jugular and subclavian vein. Of the nine cases in which the duct had two or more openings four had two openings close together and one had four openings close together in the normal place—i.e., into the lower part of the internal jugular within one centimetre of its junction with the subclavian. One had one opening in the normal place and another higher up in the internal jugular above the valve. Two had one opening in the normal place and another into the subclavian. One had one opening in the normal place and three others close together in the subclavian.

It is interesting to notice that in only three out of our 40 cases did the duct open partly into the internal jugular and partly into the subclavian, because Lower⁶ regarded this mode of termination as the normal. It is also worth while drawing attention to the fact that in only two of the 40 cases were more than two openings present, so that the case which Verneuil records in which there were six openings is probably a very rare one.

For convenience of reference we may tabulate the different methods of opening in the following way:—

A. Single ducts opening into the lower centimetre of the internal jugular vein	19
B. Single ducts opening into the junction of the internal jugular and subclavian veins	3
C. Double ducts joining and opening into the lower centimetre of the internal jugular	7
D. Double ducts joining and opening more than one centimetre above the junction of the internal jugular and subclavian	2
E. Double ducts with two openings into the lower centimetre of the internal jugular vein	4
F. Double ducts with two openings, one into the lower centimetre of the internal jugular, the other into the same vein higher up	1
G. Double ducts with two openings, one into the lower centimetre of the internal jugular, the other into the subclavian vein	2
H. Multiple ducts with four openings all into the lower centimetre of the internal jugular vein	1
J. Multiple ducts with four openings, one into the lower centimetre of the internal jugular, the other three into the subclavian	1
Total	40

By adding together cases A, C, E, F, G, H, and J, it will be seen that in 35 cases out of the 40 cases the duct opened wholly or partly into the lower centimetre of the internal jugular. From the foregoing it will be noted that in nearly half our cases (18 out of 40) the duct was double and that if a surgeon accidentally divided one of these in the root of the neck it is unlikely that, provided the wound was occluded by ligature, any inconvenience would result. It is, of course, unwise to found a definite percentage on 40 cases, but our experience with statistics of other parts of the body makes us believe that the range of error is not likely to be very great, while the difficulties and tediousness of procuring suitable material, injecting and dissecting the specimens must serve as our apology for not presenting a larger series.

It does not follow that even if the duct does not divide in the neck its section must necessarily give rise to serious symptoms because it has been pointed out that occasionally there is a communication in the thorax between the thoracic duct and the right lymphatic duct, and if this were present

¹ Edinburgh Medical Journal, 1907.² Leaf's Translation, 1903.³ Journal of Anatomy, vol. vi., p. 427.⁴ Le Système Veineux, 1855.⁵ Deutsche Zeitschrift für Chirurgie, Leipsic, 1898.⁶ Quoted by Poirier and Cunéo, loc. cit.

the chyle might be diverted to the veins of the right side. We did not find this communication injected in any of our specimens, but our dissection seldom went lower than the fifth thoracic vertebra. Moreover, the main duct has sometimes been found to open into one of the azygos veins.⁷ No doubt the division of the thoracic duct in the neck is a remnant of its plexiform character in lower mammals. In the ox, for example, a plexiform termination is normal, according to Chauveau, while in the horse, pig, dog, and cat a division and reunion so as to form a ring is very common. The union between the thoracic and right lymphatic ducts is a repetition of the avian arrangement where the duct opens into the precaval veins of both sides.

In four out of our 18 cases of double ducts we noticed that the vertebral vein passed between them, which is not surprising when it is remembered that the duct sometimes passes in front of, and sometimes behind, the root of this vein. In one case the branches passed one in front of and one behind the first part of the subclavian artery; this was a specially plexiform termination and had four openings into the veins. As a rule, however, nothing passed between the two or more terminal branches when they were present.

The subclavian, jugular, and broncho-mediastinal ducts were seen on several occasions, though the injection never passed into them. The subclavian duct was most often seen and was always remarkable for being closely connected with a lymphatic gland of moderate size (from 1 to 2 centimetres) which lay near the outer border of the scalenus anticus. Out of 12 cases in which it was dissected out, this duct joined the thoracic duct in ten, while in the other two it opened separately just below the opening of that duct. The left jugular duct was seen ten times and in nine of these it opened into the thoracic duct. This observation is of little value, because in those other cases where the duct was not seen it probably opened somewhere else. In one of these cases there were two jugular ducts, one joining the thoracic duct and the other opening into the internal jugular vein a few millimetres higher up. The usual place for the jugular duct to join the thoracic duct was 1 to 2 centimetres from the termination of the latter. The broncho-mediastinal duct was only seen four times, and probably often opens separately into the great veins. In all these four cases it opened into the thoracic duct some distance from its termination.

During our investigations of the termination of the duct into the great veins it was necessary to open the latter, and in doing so we gained some definite knowledge of the jugular vein. In 32 out of the 40 cases the valve consisted of two pocket-shaped semilunar flaps which were almost always right and left, though the right one often had a tendency to be somewhat anterior and the left posterior. As a rule these two flaps were not set on quite horizontally, but their anterior ends were higher than their posterior. In most cases the valve was about one centimetre above the termination of the internal jugular, though in a few cases it was a good deal higher. Of the eight exceptional cases one showed complete absence of the valve and in another it was very rudimentary. In three specimens only one cusp was present, but that was in every case the left. In three specimens there were three cusps, and in all of these the extra cusp was very small and was situated on the posterior surface of the vein between the hinder attachments of the other two.

The actual opening of the thoracic duct was almost always obliquely through the wall of the vein and having a direction downward, forward, and to the right. Usually there was a dilatation in the venous wall forming a pouch resembling the ampulla of Vater in the duodenum, and the mouth of this, when the duct was empty, played the part of a valve or pair of valves. In a few cases the orifice was guarded by a permanent fold of endothelium, but more often the valves disappeared on stretching the wall of the vein and, though physiologically functional, could not be described as definite morphological structures. In three of the 40 cases the vertebral vein opened into the above-mentioned pouch, but in most of them it opened a little lower down into the back of the junction of the internal jugular with the subclavian vein. More rarely the opening was distinctly into the innominate vein, though seldom more than a few millimetres to the right of a line continuing down the inner margin of the internal jugular vein.

The point of opening of the left superior intercostal vein was seen in almost every case and was always into the innominate below and to the right of the orifice of the vertebral. Its exact point of opening, however, varied greatly.

Summing up the contents of this communication, we noticed: 1. That the thoracic duct divided in the root of the neck in 18 out of 40 cases (nearly 50 per cent.) 2. In 9 of these it joined again, in 7 it opened by two orifices, and in 2 by four orifices. 3. In 35 of the 40 cases (87·5 per cent.) the duct opened wholly or partly into the lower centimetre of the internal jugular vein. 4. That it usually opened into a pouch and that the opening of this acted as a valve, though a definite morphological valve was only occasionally seen. 5. That the duct passed sometimes in front, sometimes behind, and sometimes on both sides of the vertebral vein. 6. That the internal jugular valve was a very constant bicuspid structure rarely absent, but occasionally tricuspid or unicuspid. Comparing our results with those of the two smaller series referred to, we find that our proportion of multiple ducts is much greater than that of Verneuil, ours being 18 out of 40 and his being only 6 out of 24; whilst our figures agree closely with those of Wendel, 8 multiple out of 17, who also used injected ducts for his dissections.

We conclude that, as there appear to be multiple ducts in nearly half of all cases, some at least of the reported cases of injury must have involved damage to a division and not to the whole duct, the ligature of which would cause no serious hindrance to the chylous flow into the veins. In the few cases which have recovered spontaneously after chylorrhœa of many days, or even weeks, it is probable that a second channel already existed, either of the common kind which we have described or of some rarer sort, such as a large communication with an azygos or some other vein.

EPSOM SALTS AS A POISON:

WITH A RECORD OF A CASE OF UNUSUAL SYMPTOMS DUE TO THIS DRUG.

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As a therapeutic agent Epsom salts are commonly considered to be particularly free from danger. There are, however, records of six cases in which the administration of the drug was followed by untoward symptoms of a very grave character, five of these rapidly terminating fatally. There appears to be considerable room for debate as to the manner in which the salt exerts its morbid effects. In registering another case of "poisoning" by this drug I have for purposes of comparison and contrast appended summarised reports of these six cases, and at the same time I have ventured to offer suggestions as to the probable modes of action of the drug.

At 2.30 P.M. on August 19th, 1908, I was summoned to see a boy, aged three and a half years. The patient's mother stated that 25 hours previously, during her temporary absence from the room, the patient had taken a heaped-up tea-spoonful of Epsom salts from a packet which he had found lying on the table, imagining it to be sugar. Finding his mistake, but wishing to remove traces of his guilt, the little fellow washed the salts down with a mouthful of milk. On returning to the room a few minutes later she found him retching and apparently suffering considerable pain in the stomach. Nausea and retching continued throughout the day. About 7 P.M. the abdominal pain, which was of a gripping, spasmodic character, was very severe, and actual vomiting became a prominent symptom. Thirst was also very distressing. There had been no action of the bowels. At this stage a pharmaceutical chemist was consulted who prescribed castor oil; this was at once rejected. Throughout the night the patient continued to suffer severe pain and vomited at frequent intervals. No further assistance or advice was sought until 2.30 P.M., although in the meantime the child had rapidly become worse.

The boy was now obviously critically ill. He lay in bed on his back, his face pinched, eyes sunken, and skin pale. His mind was perfectly clear. About every two minutes he had colicky attacks which made him draw up his legs. The temperature was 100·5° F.; pulse 160 and small; tongue was very dry, the papillæ standing out prominently. Thirst was intense; the bowels had not acted. About half an ounce of urine

⁷ Wendel, loc. cit.