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THE DEEP CERVICAL FASCIA AND ITS RELATION TO SUPPURATION.

By E. S. MEYERS, M.B., F.R.A.C.S.,

Department of Surgical Anatomy and Operative Surgery, University of Queensland.

IT has been pointed out elsewhere (1) that there are certain general principles of great importance with regard to fascial arrangement in the neck. Amongst the most important are the following:—

- (a) Most skeletal muscles are surrounded by fascia. The exceptions are those lying on bone, cartilage, &c. Here the covering is found only on one side. This is an obvious but important consideration.
- (b) The strength and arrangement of this investing fascia varies tremendously. Sometimes it forms a strong closed investment known as a sheath; at other times there is merely a thin enveloping layer.
- (c) Where muscles are in contiguity, or, as in the neck, where they overlie one another, the fascial layer separating two muscles is common to these two muscles. In the living this is a fact of paramount importance, and has been lost sight of in descriptions based on the study of the dead.
- (d) Fascia should be regarded as a living structure with the capacity of a living structure to respond to stimuli in its own particular way.
- (e) Where large vessels have a relationship with muscles, they have a common partition of fascia interposed between them, but each component is completely enclosed in a fascial sheath.

It was also pointed out that there are the following fascial layers in the neck:—

- (1) An investing layer known as the “investing layer of the deep cervical fascia.”
- (2) Beneath this is a second layer enclosing the sternohyoid and omohyoid muscles. This layer becomes continuous with, and in point of fact, gives rise to a major portion of the sheath of the internal jugular vein, such sheath extending throughout the length of the vein from beginning to end, and being continued along its tributaries.

- (3) Deeper again, we have the third layer which encloses the sternothyroid muscles, becoming continuous with, and in fact, forming part of the carotid sheath—viz., its medial wall. Like the sheath of the internal jugular vein, this sheath also extends continuously over the artery and its tributaries throughout its course in the neck.

The carotid sheath may be considered as being completed by the fascia covering the anterior muscles of the vertebral column, including the scalene.

The vein and artery are completely separated, each having its own sheath, by a partition between them.

This third layer also provides a sheath for the thyroid gland, and also becomes continuous with the fascia covering the constrictor muscles.

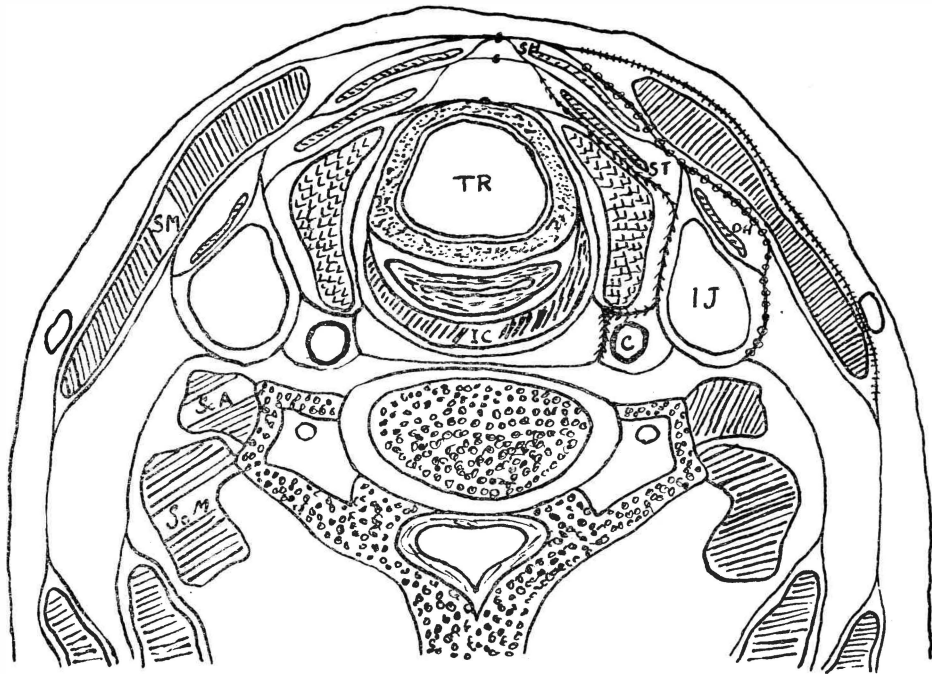


Fig. 1.

SCHMATIC TRANSVERSE SECTION OF THE NECK.

C—common carotid; IC—inferior constrictor; IJ—internal jugular; OH—omohyoid; SH—sternohyoid; SM—sternomastoid; ST—sternothyroid; SCA—anterior scalene; SCM—medial scalene; TR—trachea.

If we study the various muscles enclosing the food and air passages, specialised glands of the neck and their enveloping fascia, it will become

apparent that, by reason of such enveloping, and by the bindings of adjacent envelopes, there are formed a number of spaces surrounded completely by fascia. As a result of infection, collections of pus may accumulate in such places, and under certain conditions spread from one space to another. As may be learned by observation, all the spaces are completely closed.

There are, however, certain areas where the fascia delimiting the space is not strong. Under certain conditions, these weak areas have to withstand the pressure—liquid or gaseous—of the products of inflammation: at times the pressure is great enough to cause solution of their continuity—thus we get the spread of suppuration from one space to another.

The spaces in question are:—

- (1) Space containing the internal jugular vein and its tributaries.
- (2) Space containing the internal carotid artery and its tributaries.
- (3) The space containing the parotid gland or the lateral pharyngeal space.
- (4) Fascial space containing the thyroid gland.
- (5) The space containing the submaxillary gland, enclosed in its so-called sheath.
- (6) The retrovisceral space.

SIMPLIFICATION OF CONCEPT OF THE SPACES.

The sheaths of the internal jugular vein and the common carotid artery extend throughout the whole length of the neck, and at the point where they disappear into the skull these sheaths receive attachment to the bony margin of the foramina, through which they pass.

The common carotid artery and its continuation, the internal carotid artery, are surrounded by a very dense sheath, which bears a very constant relationship throughout the neck to the fascia covering the muscles of the pharynx and oesophagus. It is the strong medial wall of the carotid sheath that forms the lateral boundary of the retrovisceral space.

Now it will be noted that, deep in the upper part of the neck, the internal carotid artery passes posterior to the stylopharyngeus muscle, the sheath of which, in conformity with the general arrangement, forms a partition between the vessel and the muscle (Fig. 2). In addition, the carotid sheath gains a firm attachment to the stylomandibular ligament, properly so-called (1).

The carotid sheath is separated from the sheath of the thyroid gland by a common partition, and all vessels to the gland must pierce the sheath of the thyroid gland before supplying the latter.

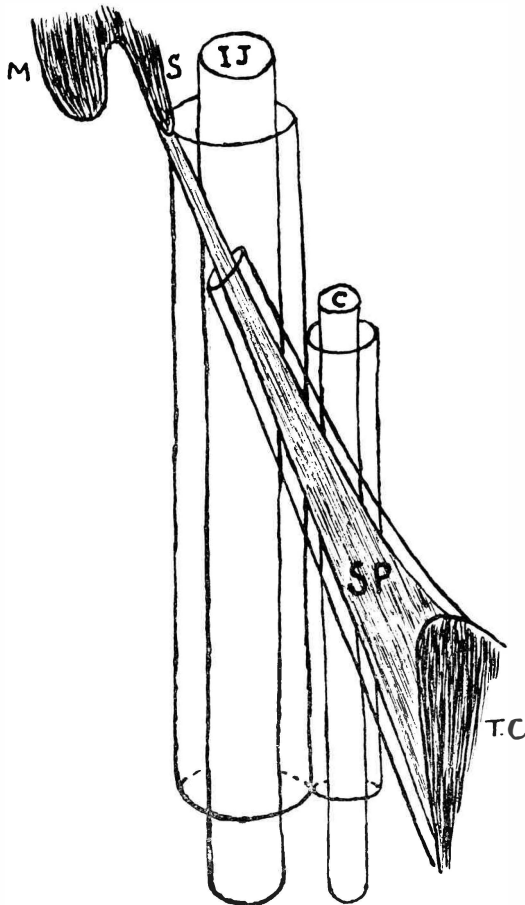


Fig. 2.

RELATION OF THE DEEP VESSELS OF THE NECK—
SCHEMATIC.

C—common carotid; IJ—internal jugular;
M—mastoid process; S—styloid process; SP—
stylopharyngeus; TC—thyroid cartilage.

The sheath of the internal jugular vein has a very similar relation to that of the carotid artery. It is much thinner, however, and it is more laterally placed, but it, too, is connected to the muscles coming from the styloid process and to the styloid process itself. The venous supply from this vessel to the thyroid gland, it should be noted, crossed the carotid artery on its way to supply the thyroid gland, whose sheath they too must pierce.

We may thus consider the neck as being composed of a number of structures running for the most part in a crano-caudal direction. Some of these structures, such as blood vessels, food and air passages, are hollow, while others, the muscles, are solid or, more accurately, semi-solid. These structures are all surrounded by fascial envelopes, and we may see from the accompanying diagram (Fig. 3) how these envelopes would appear if the structures they surround were removed, leaving the fascial envelopes intact.

We note from the diagram that contiguous structures share a common fascial partition, and if we imagine a vertebrate having the arrangement shown in the diagram, we see, in addition to the sheaths of the vessels and passages, a fascia-contained space known as the retrovisceral space.

These fascial sheaths can be very easily demonstrated, and are well illustrated in Singer (2) as tubes of fascia surrounding the structures they enclose. If we had only to consider then an imaginary vertebrate such as the diagram suggests, the story of the spread of pus within the fascial sheaths and spaces would be a simple matter.

We have, however, a more complex organism to consider, and perhaps the most important factor to be considered is the fact that the larynx and associated structures move up and down in the process of deglutition.

In order to accomplish this purpose we have two sets of muscles—the elevators and depressors of the pharynx. The elevating muscles are those inserted on to the hyoid bone and the thyroid cartilage, and they constitute on each side a series of obliquely running muscles that lead to some degree of complexity of fascial arrangement.

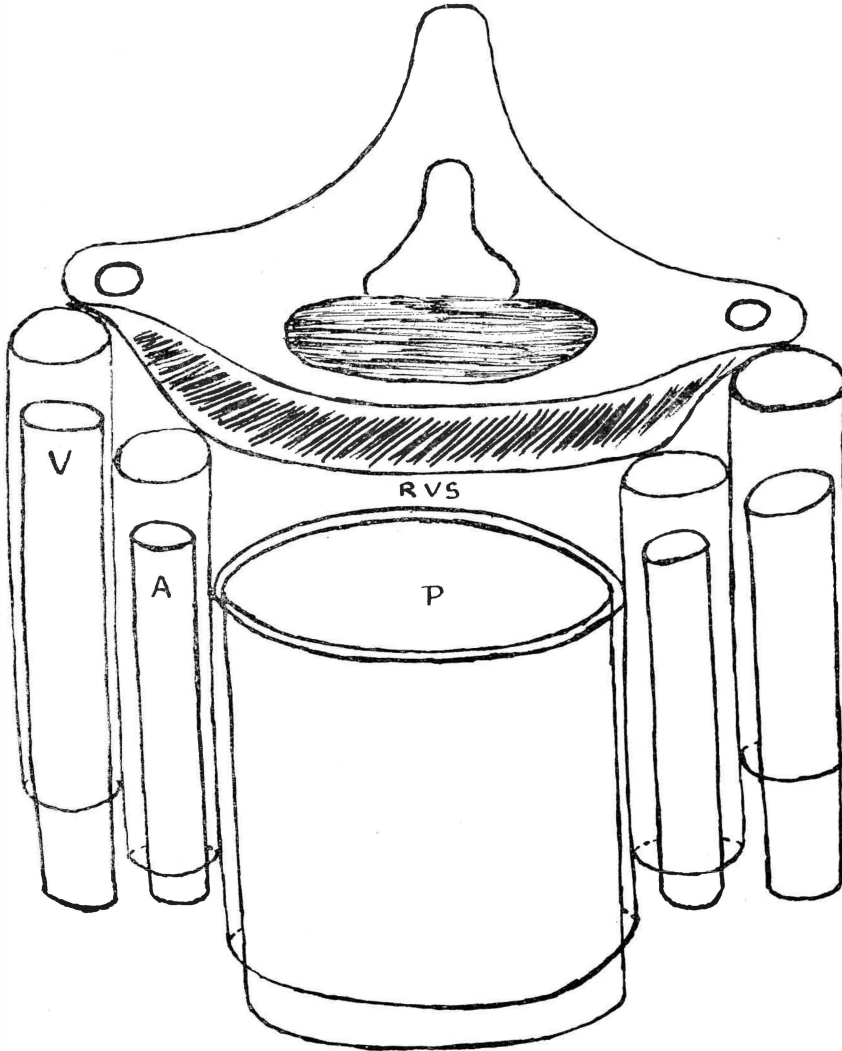


Fig. 3.

FASCIAL ENVELOPES—SCHEMATIC.

A—artery; P—pharynx; RVS—retrovisceral space; V—vein.

Now each of these muscles, in so far as its fascial sheath is concerned, conforms to the general laws already enunciated.

The carotid and jugular sheaths run posterior to the stylopharyngeus muscles, crossing at an angle as shown in the diagram (Fig. 2). Each structure is enclosed in its own sheath, the muscle sheath and the vessel sheath respectively, each assisting in promoting the orderly function of its contained structure. It would appear that where vessels run across muscles, nature conserves tissue and provides a common dividing partition.

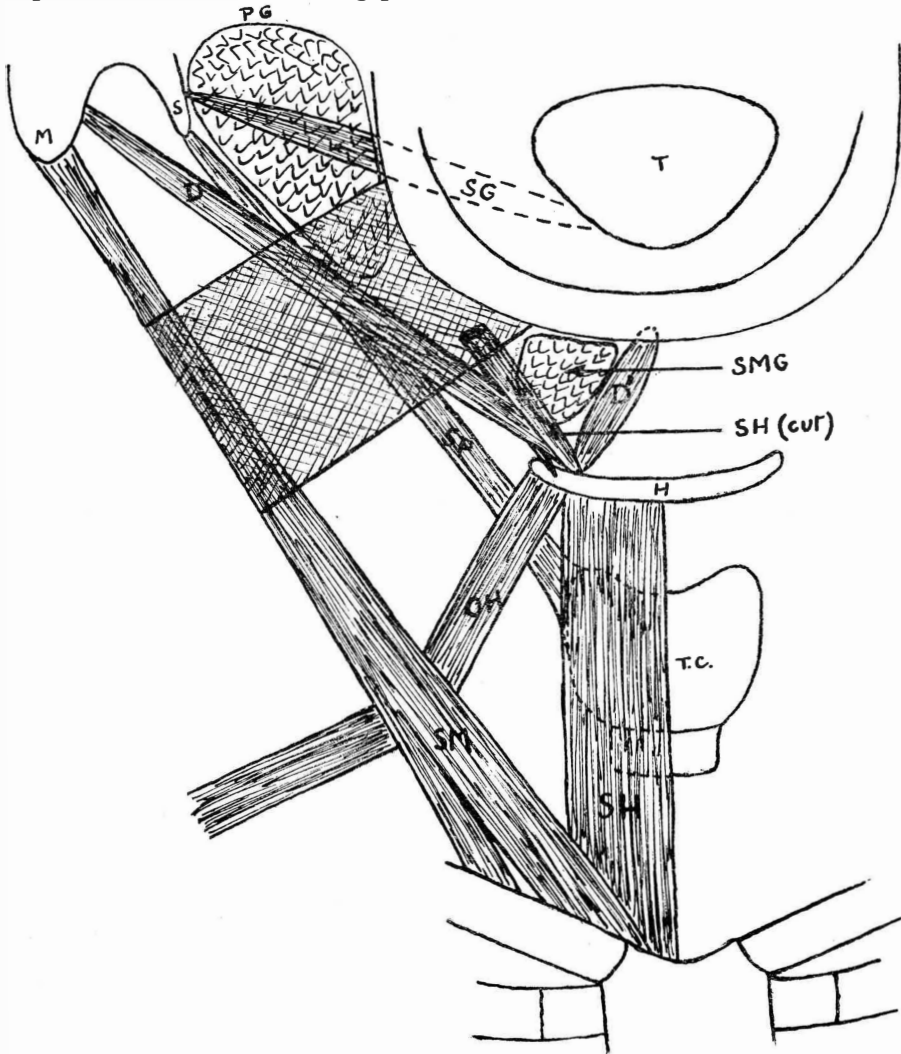


Fig. 4.

LATERAL PHARYNGEAL AND SUBMAXILLARY SPACES—SCHEMATIC.

D—posterior belly of the digastric; D'—anterior belly of the digastric; H—hyoid; M—mastoid process; OH—omohyoid; PG—parotid gland; S—styloid process—SG—styloglossus; SH—sternohyoid; SHy—stylohyoid; SM—sternomastoid; SMG—submaxillary gland; SP—stylopharyngeus; T—tongue; TC—thyroideus cartilage.

A glance at the diagram (Fig. 2) will show the arrangement, and it will be seen that we have now, in addition to the retrovisceral space, two other fascial-lined spaces—viz., the lateral pharyngeal space and the submaxillary space (Fig. 4).

These spaces have been brought into being by the fascial connection running between the digastric, stylohyoid, styloglossus, stylopharyngeus, medial pterygoid and constrictor muscles and their attachments to the styloid process and mandible. The muscular boundaries of the lateral pharyngeal space are the posterior belly of the digastric, stylopharyngeus, styloglossus, stylohyoid, superior constrictor, and medial pterygoid muscles.

As has already been indicated, the carotid and jugular sheaths run posterior to the stylopharyngeus, and are firmly attached to the styloid process in their lateral and anterior aspects.

THE LATERAL PHARYNGEAL SPACE.

We have thus formed a somewhat wedge-shaped space. On the lateral aspect it is bounded by the fascia over the parotid gland. Posteriorly it is bounded by the fascia over the sternomastoid; anteromedially by the fascia over the medial pterygoid; medially by the fascia over the constrictor; posteriorly by the sheaths of the great vessels and their attachments. Superiorly it reaches as high as the base of the skull in the region of the fascia covering the palatine vessels. Inferiorly, on its lateral aspect, it is closed by the fascia over the digastric and stylohyoid; and on its inferior and medial aspect the space is closed by the fascia covering the styloglossus and stylopharyngeus and their attachment to the mandible. It will be noted on examination that, in this area, there is a muscular gap which is bridged by a very weak layer of fascia, and it is this area that easily yields to pressure when any undue strain is put upon it. The fascia here is further weakened as it is through it that arteries pass from the external carotid on their way to the tonsil and pharyngeal wall.

It is through this area that pus, under the conditions indicated, may escape from the lateral pharyngeal into the submandibular space and *vice versa* (Figs. 4 and 5).

The submaxillary space has been described on a previous occasion (1), but we would call attention again to the strong fascial area on the inferior and lateral boundaries of the parotid gland, which separate it from the submaxillary gland. In any spread of infection from one space to another the usual path of spread is through the weaker portion of the fascial wall already described.

THE THYREOID GLAND AND ITS SHEATH.

In regard to this gland, reference to the transverse section of the neck (Fig. 1) will show that the thyreoid gland is placed between the sternothyreoid muscle laterally and the constrictor muscle medially. The superior pole of the gland is similarly placed between the sternothyreoid and constrictor muscles, but in this region on its posteromedial aspect, there is an additional muscle to

be considered—viz., the cricothyroid. The sternothyroid and cricothyroid muscles are in this area attached to their insertions, and it is owing to this that the superior pole of the thyroid comes to be firmly bound down to neighbouring structures. This binding down is further strengthened by the sheaths of the vessels entering and leaving the upper pole of the gland. The attachments of the upper pole of the gland are sometimes referred to as the suspensory ligament of the upper pole.

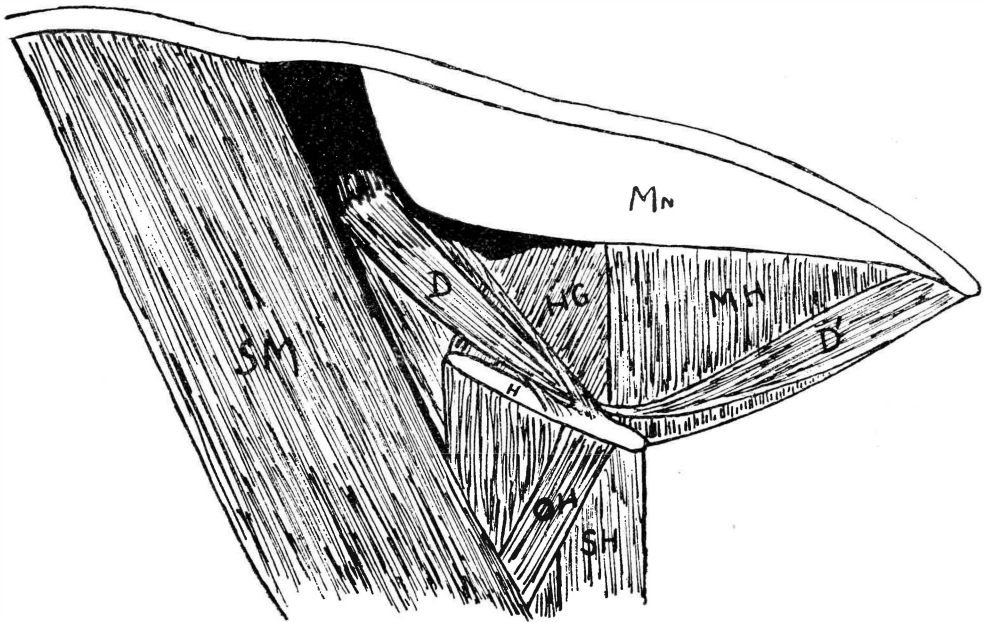


Fig. 5.

ADJOINING SPACES—SUBMAXILLARY AND LATERAL PHARYNGEAL.

D—posterior belly of the digastric; D'—anterior belly of the digastric; H—hyoid; HG—hyoglossus; Mn—mandible; MH—mylohyoid; OH—omohyoid; SH—sternohyoid; SM—sternomastoid.

It must be remembered, of course, that no two poles are in all probability absolutely alike either in position or in configuration. Just as we have this variation so too do we have a very great variation in the blood supply by way of the superior thyroid artery to the upper pole. In its course this vessel runs along the posterior border of the thyrohyoid muscle, and at the lowest point of this muscle the superior thyroid artery disappears beneath the insertion of the sternothyroid muscle. It is in the latter region that we find that the artery exhibits great variation both in its position and in its method of branching. Different surgeons have different methods of securing the superior thyroid artery in thyroidectomy. Some secure it by retracting the sternothyroid muscle, others by dividing it and turning the divided ends up and down; and others again by detaching the muscle from its insertion on to the oblique line of the thyroid, and at the end of the operation, re-attaching it by suturing.

To recapitulate, then, we have four types of fascial sheaths—

- (1) Those enclosing muscles.
- (2) Those enclosing blood vessels.
- (3) Those enclosing food and air passages.
- (4) Those formed by utilisation of portions of the fascia of the above types, such as lateral pharyngeal, retrovisceral, submaxillary and thyreoid.

THE ROOT OF THE NECK.

The junction of the neck and trunk is a very interesting area to those engaged in the study of the arrangement of the fascia. We have to consider certain differences of arrangement from those found in the mid-region of the neck, which may be looked upon as the typical area. It is, of course, very different from the uppermost portion of the neck.

There are then the following special features for us to consider:—

- (1) Here it is that the great vessels become continuous with their parent trunks and the latter's other large tributary trunks.
- (2) Certain muscles receive their insertion into the bony margins of the thoracic inlet, and at these areas the fascia becomes blended with the periosteum of the bone.
- (3) The fascia surrounding the food and air passages, the great vessels and that covering the prevertebral muscles, by reason of the bottle-neck arrangement at the thoracic inlet, all converge, and in this way the fascial spaces become closed inferiorly.

The spaces containing the vessels are closed by the merging of the sheaths with the pericardium, and Barlow (3) has shown from experiments on the cadaver that fluid under pressure does not pass lower down than the third thoracic vertebra in the case of the retrovisceral space.

The arrangement of the fascia in the deeper portions of the supra-clavicular area, by reason of the structural conditions, presents unusual features, but once again the general principles already enunciated apply.

The sheath of the subclavian artery is continuous below with that of the axillary, and runs medially to the root of the neck, where it becomes continuous with the sheath of the common carotid artery (Fig. 6).

In the so-called second part it disappears behind the anterior scalene muscle, and here again we note the common partition between the sheath of a large vessel and a muscle that it is crossing at an angle. Posterior to the vessel Sibson's fascia provides the posterior portion of the sheath of the subclavian artery. The subclavian vein is separated from the artery of the same name by the insertion of the anterior scalene muscle. This vein is surrounded by its own sheath. In its medial portion this becomes continuous with the fascia over

the origin of the subclavius muscle while laterally the posterior portion of the sheath is shared in common with the anterior scalene muscle on which the vein rests. The anterior portion of the sheath forms a common partition between the vein and adjoining portion of the subclavius muscle.

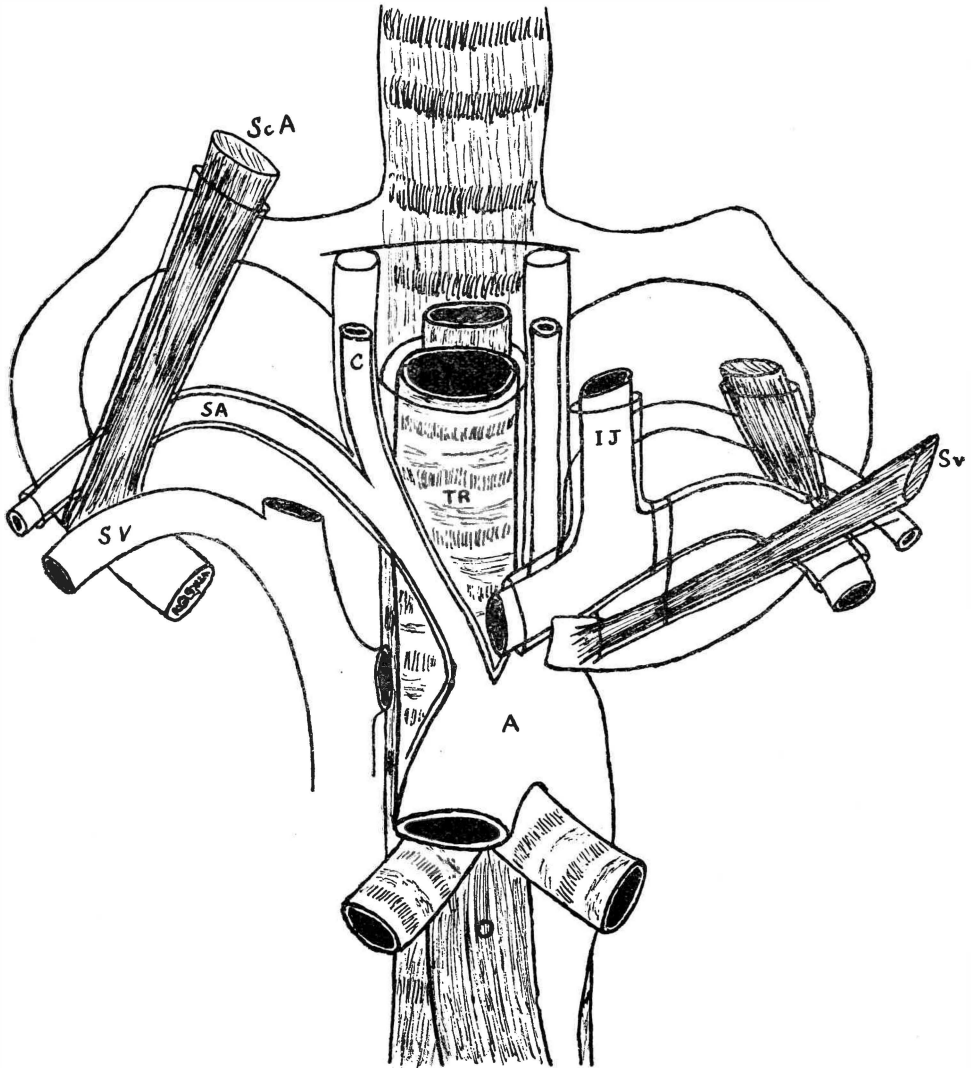


Fig. 6.

ROOT OF THE NECK—SCHEMATIC.

A—arch of the aorta; C—common carotid; IJ—internal jugular; O—oesophagus; Sv—subclavius; SA—subclavian artery; ScA—anterior scalene; SV—subclavian vein; TR—trachea.

THE CONTINUITY OF THE FASCIA.

The unity and continuity of the cervical fascia as a whole must be recognised as a fact of major importance in considering problems in relation to it. As has frequently been stressed, the consistency of fascia varies a great deal according to the demands that are made upon it. In the weaving of this fascia there are many intricacies of woof and warp, the study of the intimate threads of which are beyond the scope of this paper. We may say, however, that as a result of this weaving there are produced materials which provide many types of mechanisms for the efficient working of the human machine. There is, too, an important consideration that has not so far been mentioned—namely, that the tributary branches of the larger vessels pass from one space to others. These vessels carry with them a continuation of the sheath of the parent vessel, and thus under normal conditions there is no break in the continuity of the fascial arrangement. In other words, the spaces remain closed.

Under certain conditions, however, there is an interruption in this continuity, and under these conditions, the products of inflammation in one space may escape therefrom and enter another. Thus we may get a spread of infection from the large venous spaces to the other spaces, and ligation of the internal jugular vein in infections from the middle ear to prevent the spread of infection is a practice that is in consonance with the findings described.

The jugular sheath and the carotid sheath give off as continuations the sheaths surrounding the external carotid artery and the common facial vein respectively. When the continuity of the latter is broken, the sheaths surrounding the larger vessels are in communication with the lateral pharyngeal space, and the way is open to the spread of infection from the former to the latter space.

In a similar manner to the arterial and venous connections there is a very important connection by way of lymphatic vessels. This is a very common route of indirect extension of an infection from one space to another. A lymphatic gland may become the site of abscess formation, and in this way we may have the start of a train of events commencing in the uppermost portion of the neck and ending in the thorax.

The lymphatic glands are placed between the muscles and the vessels, and when pus escapes from the gland capsule it may extravasate into the sheath of the muscle or vessel or both.

PATHOLOGY.

In considering the subject of the spread of pus, there are certain questions of a pathological nature to which we must give attention. When pus is present within the sheath of a muscle, it may become—

- (a) Shut off as a localised abscess; or
- (b) It may spread throughout the sheath of the muscle.

With respect to (a), if the abscess is not absorbed or drained surgically (depending on the degree of pressure within the abscess, and the reaction of

surrounding tissues), it may extend, and thus enter one or more of the fascial spaces of the neck; under more fortunate circumstances it may reach the surface of the body.

With regard to (*b*), a collection of pus may spread, extending throughout the fascial sheath. The further course of the spread will depend on similar factors to those described in (*a*).

CLINICAL.

In regard to any particular collection of pus it is most important to obtain a history of how the condition arose. For correct treatment it is important to know in which space the collection of pus was first present. The factors of importance with regard to its appearance may be considered under the following heads:—

- (1) Whether the condition was subsequent to trauma, with or without breach of continuity of surface (the surface may be internal or external).
- (2) Was it a complication of pyaemia and septicaemia, or in association with septic embolism and thrombosis?
- (3) A direct infection from bone, the abscess bursting into the fascial space delimited by the attachment of the fascia to the bone?
- (4) Suppuration caused by spread of infection occurring in the lymphatic system?
- (5) Suppuration in association with chronic infection such as tuberculosis?

The more common infections are those following injury of the skin or mucous membrane, and those in association with pyogenic diseases of bone, particularly, in the case of the present study, the mandible.

The spread of suppuration following spread of dental abscess into the bony tissue of the mandible will be largely determined according to the site of the abscess in the bone, and the position of the fascial attachments. It may extend into the tissues immediately subjacent to the mucous membrane or beneath the skin and cutaneous muscles of the face. In this case the problem of treatment is simple.

It may, however, spread to the region of the muscles of the floor of the mouth above the mylohyoid muscle. Accumulation of pus may lead to the elevation of the tongue and swelling of the tissues of the floor of the mouth. In order to drain collections of pus here it is necessary to drain through the neck—in order to reach the infected area the sinus forceps must pass through the mylohyoid muscle. In this way drainage may be established successfully.

Should pus escape into the tissues below the mylohyoid muscle, it may do so outside the sheath of the submaxillary gland, or within that area. In the latter case infection may spread directly into the parotid space through the weak area already indicated.

As a complication of certain of the exanthamata and suppurative processes, an abscess may develop within the sheath of any muscle. It may for example develop within the sheath of the sternohyoid or sternothyroid muscles. Usually, the suppurative process is stopped by the attachment of the fascia covering the muscle to the sternum. In some cases, however, the abscess may burst these boundaries and may spread into the anterior mediastinum (Fig. 7).

SUPPURATION IN THE NECK FOLLOWING INFECTION IN THE TONSIL.

The so-called tonsillar gland, situated in the angle of the confluence of the internal jugular vein and the common facial vein, is commonly the site of pyogenic conditions secondary to infection of the tonsil. From the focus in this gland we may get a spread of suppuration as described previously. If conditions of this sort are not relieved, we may have set up in the tissues of the neck a condition of oedema, and adhesion of the tissues known as "woody neck"; these frequently are seen as a more chronic type of infection. They may terminate fatally through disease process leading to invasion of the walls of the large vessels, with resulting secondary haemorrhage.

In regard to abscess of the tonsil, it is very rarely that infection spreads directly into the other spaces of the neck. The reason for this is the very strong fascia that is present between the tonsil and superior constrictor muscle (Fig. 8). It is part of (or, perhaps more correctly, connected with) the pharyngobasilar fascia.

As is well known, most tonsillar abscesses are evacuated after treatment by Hilton's method through the mouth. The success of the treatment of the tonsillar abscess by enucleation is probably also due to the presence of this strong layer of fascia, separating the tonsil from contiguous structures.

Again, the reason why the results of radium treatment in this region are not so good as elsewhere is that this fibrous layer does not provide the sort of "tissue bed" in which we may implant radium with success.

RETROVISCERAL SPACE.

The greatest difficulties are met with in the drainage of pus in the lateral pharyngeal and retrovisceral spaces.

One of the commonest types of suppuration in the former region is that following abscesses of the last molar tooth. In some instances the swelling reaches a very large size, the patient is unable to open the mouth, and swallowing is difficult, often causing great distress.

When the abscess bursts through the periosteum of the mandible, it accumulates, and makes its way through the weak barrier on the inferior and medial aspect of the lateral pharyngeal space, and rapidly fills up the space, giving rise to the symptoms described. The way to the exterior is barred by the strong fascial attachment connecting the deep surface of the sternomastoid to the angle of the mandible.

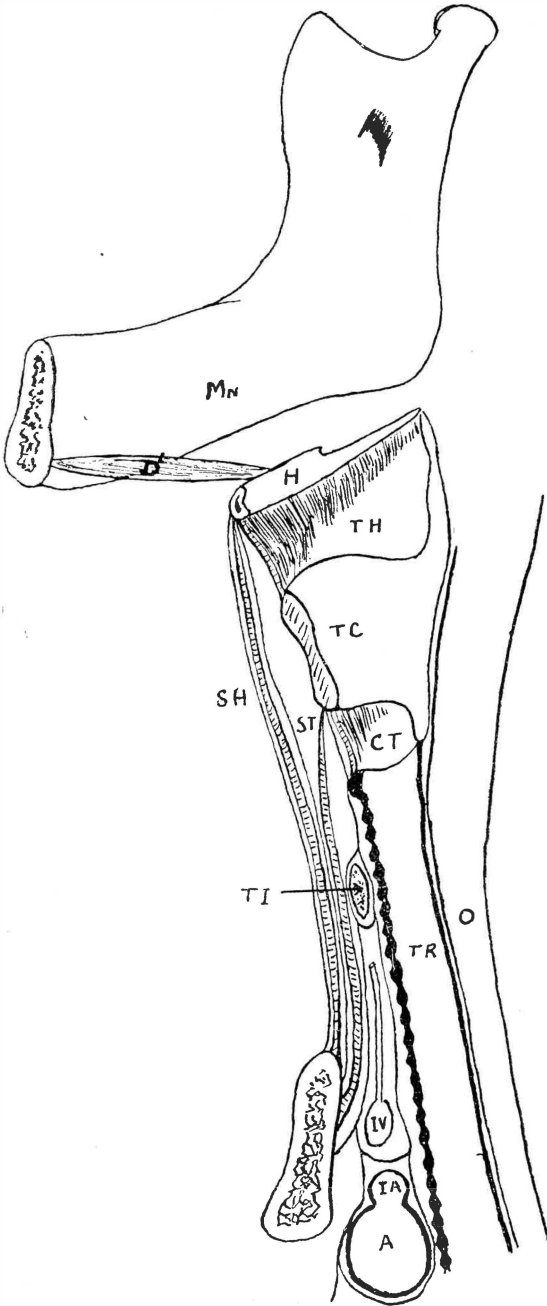


Fig. 7.

MEDIAL SAGGITAL SECTION OF MID-PLANE—MEDIAL ASPECT.

A—arch of the aorta; CT—cricothyroid; D'—anterior belly of the digastric; H—hyoid; IA—innominate artery; IV—innominate vein; Mn—mandible; O—oesophagus; SH—sternohyoid; ST—sternothyroid; TC—thyroid cartilage; TH—thyrohyoid; TI—thyroid isthmus; TR—trachea.

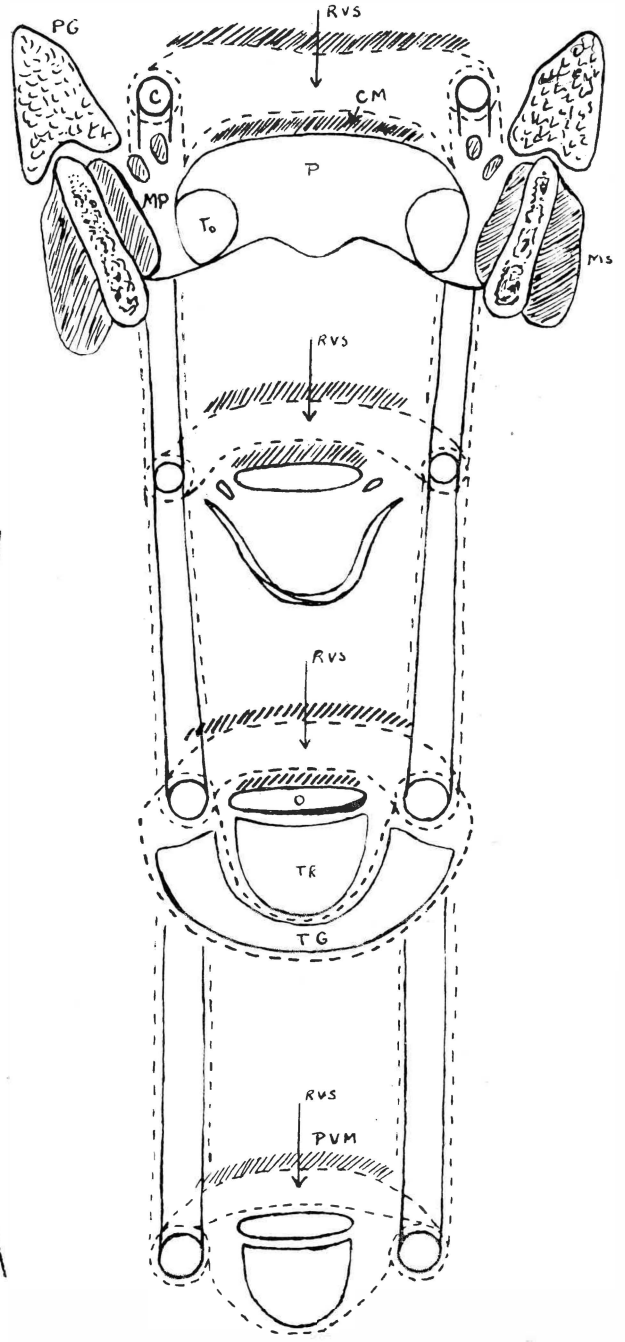


Fig. 8.

SCHEMATIC VIEW OF THE RETROVISCERAL SPACE AT VARIOUS LEVELS.

C—common carotid; CM—constrictor muscles; Ms—masseter; MP—medial pterygoid; O—oesophagus; P—pharynx; PG—parotid gland; PVM—prevertebral muscles; RVS—retrovisceral space; To—tonsil; TG—thyroid gland; TR—trachea.

This should be remembered in treating these cases by Hilton's method. The sinus forceps should be directed to a point slightly posterior to the angle of the mandible, and the operator should experience the feeling of going through this important layer. It is not until this is done that pus will be evacuated.

Suppuration in the retrovisceral space may give rise to very great difficulties in treatment. The acute abscesses in young children in this space usually follow infection from the retropharyngeal glands. They may be treated by incision through the mouth—the child being held in the inverted position, always taking care to make use of good lighting and suction apparatus.

It will be realised from Fig. 8 that retrovisceral abscesses may be situated at any level in the neck. Furthermore, having formed, the abscess may spread in any direction. In its spread it may displace structures with which it is in contiguity. Such structures may offer considerable resistance to the extension of the abscess owing to their firm fascial connections; then, owing to the formation of adhesions, the direction of the spread may change; the abscess may approach the surface and in favourable cases “point.”

A retropharyngeal abscess may displace the great vessels of the neck and their fascial coverings. In such cases a careful examination should be made as to their exact position. Then, should it be necessary to drain in their neighbourhood, no harm will be done.

If a retropharyngeal abscess is tending to “point” posterior to the great vessels it may be necessary to use a retractor and draw them forwards, much in the same way as must sometimes be done if one desires to divide the fascia over the anterior scalene muscle in operations on the phrenic nerve. The posterior border of the sternomastoid muscle must, of course, first be drawn forward.

Instead of being displaced anteriorly the carotid vessels may be displaced posteriorly, and pus may come to the surface from beneath the anterior border of the sternomastoid muscle.

The sternomastoid serves as a covering that may successfully conceal many a pathological process. When one feels sure that pus is present beneath this covering there should be no hesitation in proceeding to turn it back, and even to remove it partly or completely, should such a procedure be necessary to secure adequate drainage.

Among the most serious of the retropharyngeal abscesses are those that spread down to the posterior mediastinum. Such abscesses usually follow injury to or perforation of the food passages. The best way of reducing mortality here is by prophylaxis. Injuries in these areas should be treated with the greatest care, and when possible by an expert.

In the days when the radiation treatment of diseases of the pharynx was an unusual event, suppurative mediastinitis was not uncommon as a sequel to pharyngotomy. In this operation, and also following wounds in this area, the use of “quarantine packing” is a practice that will lessen the incidence of unfortunate sequelæ of mediastinitis.

CONCLUSION.

This paper is based upon the personal experience of the author in departments of Anatomy and Surgery and in private practice. Its main purpose is to make easier of comprehension a region of the body that students and less experienced practitioners consider one of great complexity.

NOTE.—The relation of the parathyroids to the deep cervical fascia has not been considered in this paper. Hugh. R. G. Poate, of Sydney, has dealt very ably and exhaustively with this question in two articles, one of which was published (4) and the other made available to the writer by the courtesy of its author.

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