THE ANATOMY OF CANCER

WITH SPECIAL REFERENCE TO TUMOURS OF THE UPPER AIR AND FOOD PASSAGES*

By M. LEDERMAN

CANCER is fundamentally a disorder of growth: yet an important feature of its natural history as it affects the upper air and food passages is the apparent orderliness of its clinical manifestations. That cancers should occur not indiscriminately throughout the upper aero-digestive tract but at sites of election provides both a basis for their classification and sheds some light on the ætiology of certain of their forms. There are, for example, recognized predisposing causes for cancer in certain sites, such as cancers of the floor of mouth and buccal mucosae occurring in tobacco and betel nut chewers; the tongue cancers associated with syphilitic glossitis and the post-cricoid cancers associated with the Plummer-Vinson Syndrome, etc.

However, only a small proportion of patients suffering from cancers in these regions present with an indisputable ætiological cause; in the vast majority of cases no such cause can be elicited. In these circumstances an attempt to shed light on ætiology by resorting to the study of the morphology and physiology of the region concerned seems not only reasonable, but is in the event rewarding.

A study of this kind can best begin by defining the "upper air and food passages" as being that part of the foregut which extends between the orbicularis oris and the cricopharyngeus muscles. The curved channel so defined is lined by mucous membrane beneath which is a layer of voluntary muscle which in man ceases at the cricopharyngeus, being replaced thereafter by unstriped muscle. The floor of the channel is completely occupied by the tongue and the larynx and the branchial remnants that serve to support or protect these structures, namely the mandible, the hyoid bone and the thyroid cartilage. The roof and posterior wall are osseous excepting for the opening of the respiratory or nasal pharynx, guarded by its sphincter comprising the soft palate, the posterior faucial pillars and Passavant's ridge. The floor of this channel also possesses a respiratory opening, which leads into the larynx and is similarly guarded

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by a sphincteric mechanism—the vestibular sphincter. The two sphincters and their attachments, one situated superiorly guarding the point of entry of air from the nasal fossa into the oropharynx, the other situated inferiorly guarding the point in the pharyngeal floor where air leaves the pharynx to enter the larynx, trachea and lungs, serve by their projection to subdivide the lumen of the foregut into three parts: an upper segment anterior to the nasopharyngeal sphincter, the buccal cavity, which is concerned with the ingestion and mastication of food, both of which acts are under voluntary control: a lower segment behind and below the vestibular sphincter of the larynx, the laryngopharynx, which is concerned solely with the swallowing of food, the act being no longer under voluntary control in this region: and a middle segment between the two sphincters, the oropharynx, where both food and air intermingle before being directed on to their respective exit points.

The oropharynx can be regarded as the carburettor of the body, since it is strategically situated so as to receive and mix "fuel" and air, but, whereas the carburettor of an internal combustion engine permits the onward passage of the mixture so produced, the oropharynx receives the mixture and then separates the "fuel" from the air and thereafter transmits each component in its correct direction.

The projection into the lumen of the foregut of the soft palate and its pillars and the epiglottis and its folds serves to provide in man the upper and lower anatomical limits of the oropharynx. The separation of these two structures does not exist in some animals where the epiglottis comes into intimate contact with the soft palate and may cross it so as to lie in the nasopharynx or intranarially (Fig. 1). In these circumstances

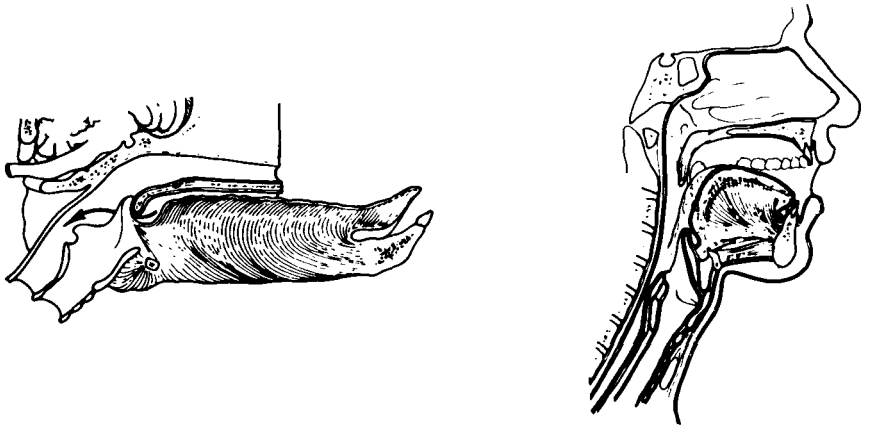


FIG. 1.

(*a*) Sagittal section through the head of a sheep showing a "two-stage" pharynx and an intranarial larynx. (*b*) Saggittal section through a human head showing a "three-stage" pharynx, resulting from the descent of the larynx.

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there is no oropharynx and the pharynx consists of two parts only, an upper nasal or respiratory part, and a lower laryngopharyngeal or alimentary part. Animals possessing this two stage pharynx can breath and swallow simultaneously: the bolus in passing from the buccal cavity to the œsophageal mouth by-passes the intranarial larynx *viâ* channels situated on either side of the larynx, termed the lateral food channels (Negus, 1949) which have their counterpart in man where they are represented by the pharyngolaryngeal grooves or pyriform sinuses. The separation of the larynx from the palate in man and the introduction of an oropharyngeal cavity free of obstruction does mean that a bolus can traverse the midline of the foregut after closure of the airway. By ceasing to breathe whilst swallowing, man has acquired a central pathway for the passage of food in addition to the lateral channels that join the buccal cavity to the œsophageal mouth.

The oropharynx in man has been developed as a result of the descent of the larynx and this in turn is related to the assumption of the erect posture and the greater importance of sight as opposed to olfaction is shown by the development of stereoscopic vision and absence of a snout. Nevertheless evidence is to be found of this erstwhile relationship between the larynx and soft palate, in the fœtus, and structurally in the adult in the presence of similar ciliated columnar epithelium on the dorsum of the soft palate and on the suprahyoid epiglottis and the margins of the laryngeal vestibule. There is also a curious atavistic association between the cancers of these two structures since it is by no means rare to find the disease affecting both simultaneously.

Some light can be thrown on the possible reson for the development of cancers in certain parts of the buccal cavity and pharynx from a study of the so-called lateral food channels. These channels are of greater importance in deglutition in animals possessing an intranarial larynx than in man. In the former they may be directly continuous with the buccal cavity, since the anterior faucial pillars may be absent or negligible and the posterior pillars tend to encircle the intranarial epiglottis.

Sebileau and Truffert (1924), have used the term alimentary grooves or gutters to describe these continuous lateral pathways which extend on either side from the floor of the mouth past the larynx to the œsophageal opening. These pathways are interrupted at two points, namely, at the insertions of the anterior faucial pillars, and the pharyngo-epiglottic folds, so they form a triple tier in their descent and can thus be conveniently sub-divided into three segments: (1) buccal, (2) oropharyngeal and (3) laryngopharyngeal (Fig. 2).

(1) *The Buccal Segment*

The floor of the mouth and both lower alveololingual sulci together form a horseshoe-shaped channel divided anteriorly into two parts by

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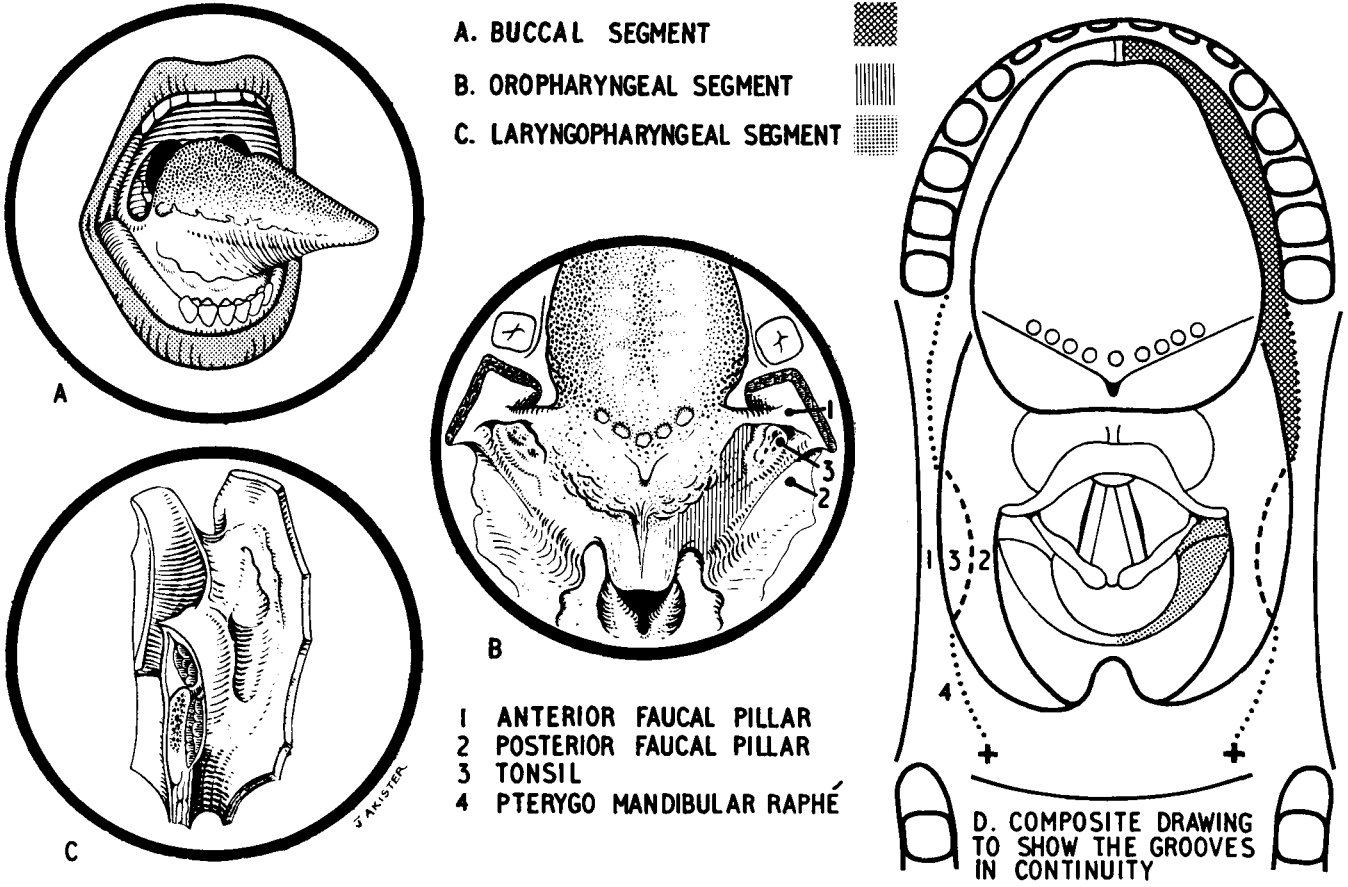


FIG. 2.

the frænum linguae, each part being closed posteriorly by the merging of the lower sulci into the lower partion of the anterior faucial pillars. Although the plane of the groove is largely horizontal, its boundaries may be defined as follows:

Anterior:	frænum linguae.
Posterior:	junction of anterior faucial pillar with the posterior end of the lower alveololingual sulcus.
Medial:	lateral margin and infralingual aspect of tongue.
Lateral:	inner aspect of lower alveolus.
Floor:	this is formed by the floor of the mouth and its posterior prolongations, the alveololingual sulci.

(2) *The Oropharyngeal Segment*

The second or oropharyngeal segment of the alimentary groove lies between the base of the tongue and the lower pole of the tonsil and can be termed the "linguotonsillar groove or sulcus". Its plane is vertical and its boundaries are:

Antero-superior:	The insertion of the anterior faucial pillar.
Postero-inferior:	the pharyngo-epiglottic fold.
Medial:	lateral margin of the base of tongue and the lateral glosso-epiglottic fold.
Lateral:	the lateral pharyngeal wall between the two faucial pillars below the lower pole of the tonsil down to the pharyngeal insertion of the pharyngo-epiglottic fold.

(3) *The Laryngopharyngeal Segment*

The third part of the alimentary groove is formed by the pharyngo-laryngeal grooves and represents the lateral food channels found in other mammals.

The term "pyriform sinus" can be most conveniently applied to this region (3), which extends from the pharyngo-epiglottic fold above to the œsophageal opening at the level of the lower border of the cricoid cartilage below and is roughly triangular in cross-section, being closed anteriorly and open posteriorly towards the posterior pharyngeal wall; it varies in depth from above downwards being relatively shallow in its upper part, deepest and broadest in its mid-part, the shallowest and least well defined in its lowest part. It can be divided into two parts:

(1) An upper part, extending from the upper margin of the pharyngo-epiglottic fold above to the level of the mucosal fold formed by the internal

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laryngeal nerve below as it crosses the floor of the groove to reach the larynx. This part of the groove is thus roughly constituted by the pharyngo-epiglottic fold and has been very figuratively termed the "vestibule of the sinus pyriformis" by Sebileau and Truffert (1924).

(2) A lower part, which can be further subdivided into two portions:

(*a*) extending from the fold of the internal laryngeal nerve above to the lower border of the thyroid ala below, being related laterally to that ala and medially to the posterior surface of arytenoid cartilage. This region is really the true anatomical sinus pyriformis and corresponds to the broad deep part of the groove.

(*b*) extending from the lower border of the thyroid ala to the level of the lower border of the cricoid cartilage. The lateral wall contains the inferior cornu of the thyroid cartilage and part of the cricopharyngeus muscle, the medial wall being formed by the lateral aspect of the posterior lamina of the cricoid with its covering muscles.

Cancer of the Alimentary Grooves

Fig. 3 shows the site distribution and frequency of buccal cavity

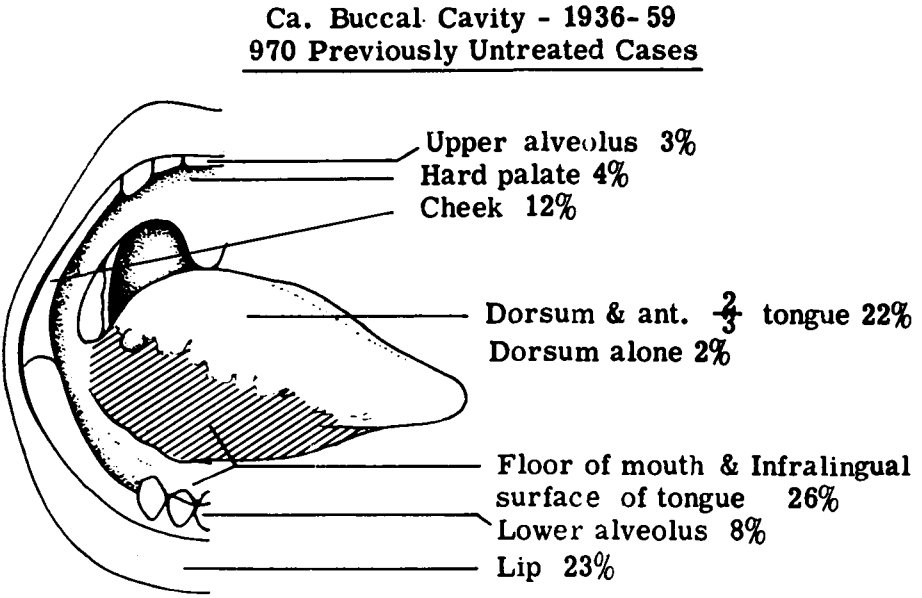


FIG. 3.
The Site Distribution of Cancers of the Buccal Cavity.

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cancer in a series of cases seen at the Royal Marsden Hospital (Bhansali, 1961). The commonest site affected is the infralingual surface of the tongue, followed thereafter by its lateral margin. If the buccal segment of the groove and its boundaries, namely the alveolus and the lateral margin of the tongue are considered, then some 50 per cent. of cancers occurring in the buccal cavity, arise in relation to this groove. The dorsum of the tongue and the hard palate, both of which are concerned with the prehension of food and the formation of a bolus are rarely the seat of cancer, and even when they become cancerous, the prognosis is good since these primary sites are rarely associated with lymph node metastases, because there is no sub-mucosa present in either of these regions.

Fig. 4 shows some typical lesions of the tongue and floor of mouth. Cancers of the alimentary groove possess a characteristic macroscopic appearance, showing a cleft-like ulcer in the floor of the groove with infiltration of the medial boundary (the tongue in this case) and proliferation as the tumour advances towards the lateral boundary (the alveolus). (Fig. 4*a*). This pattern is repeated in all three divisions of the groove.

Fig. 5 shows the site incidence and frequency of cancer affecting the oropharynx. The commonest tumours seen are those affecting the glosso-epiglottic region, followed by those of the tonsil. The posterior faucial pillar, unlike the anterior faucial pillar, is rarely the site of cancer, but if the posterior pillar is linked with the uvula and the soft palate, as is physiologically the case, then the incidence resembles that of the anterior pillar.

Fig. 6 shows a typical linguo-tonsillar lesion, sitting astride the groove, involving the base of tongue and the tonsil: gross infiltration and enlargement of the tongue can be seen and the tongue can be separated from the fauces only with difficulty. When this is achieved a linear ulcer with medial infiltration and lateral proliferation characteristic of an alimentary groove lesion can be seen. Mirror examination in this type of case is often impossible, but on resolution following radiation treatment, destruction of the anterior pillar with an intact tonsil can often be seen. A lateral X-ray is always of considerable value in showing the full extent of such a lesion.

Fig. 7 shows that in the laryngopharynx there is a similar tumour incidence, the commonest site for carcinoma is the sinus pyriformis, which represents the laryngopharyngeal segment of the alimentary groove, followed by the post-cricoid region and then the epilaryngeal region.

For the purposes of classification, description and study of cancers of the upper alimentary tract, the concept of a buccopharyngeal tubular structure containing in its floor the tongue and larynx with the alimentary grooves providing by-pass channels from the orbicularis oris to the cricopharyngeus has much to commend it; but to complete the anatomical and physiological picture, two further ancillary mechanisms which serve to

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(*a*)



(*b*)

FIG. 4.

(*a*) Cancer of the infralingual surface of the tongue and floor of mouth showing the cleft-like ulcer in the floor of mouth infiltrating postero-medially into the tongue and proliferating antero-laterally towards the alveolus. (*b*) Cancer of the lateral margin of the tongue after radiotherapy. Note the linear ulcer situated at the junction of the dorsum and the infralingual surface of tongue. This region is almost certainly the point of origin of the tumour.

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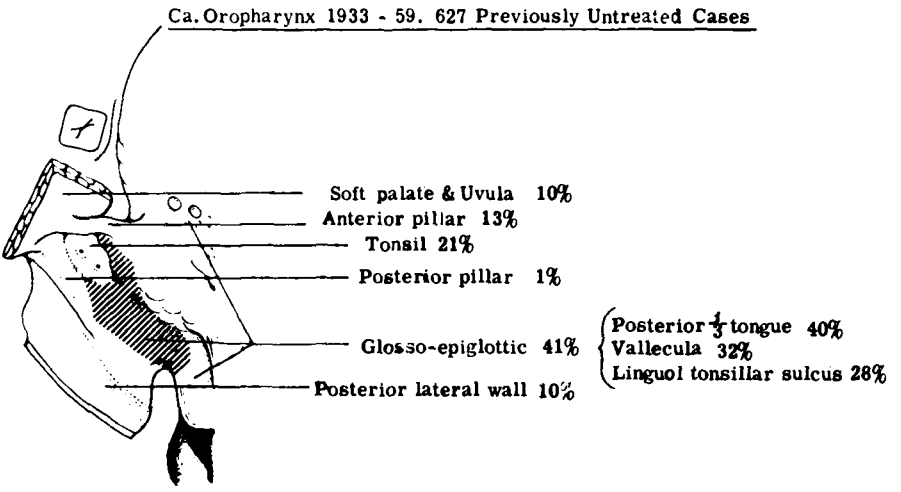


FIG. 5.
Site Distribution of Cancers of the Oropharynx. (The Linguo-tonsillar sulcus is shown shaded.)

control the direction and speed of food and fluid in the buccopharyngeal tube require mention. These are:

(1) The sphincteric mechanisms.

(2) The "Reservoir" Systems related to the floor of the alimentary grooves.

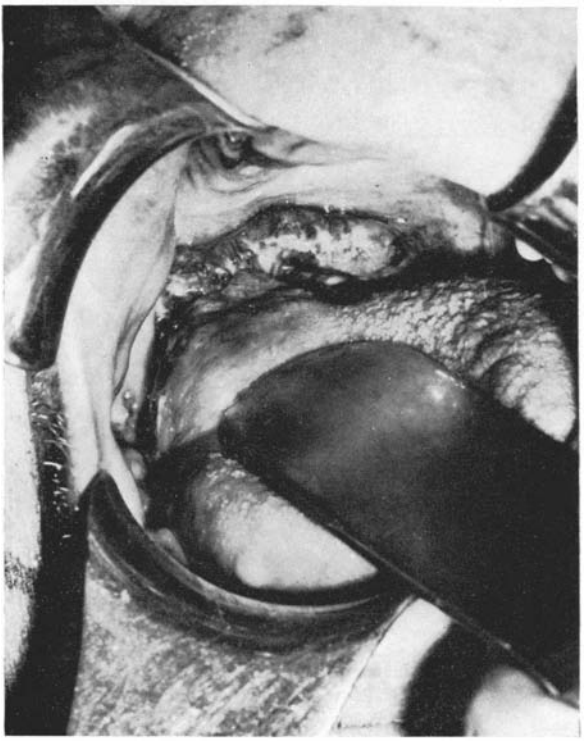
(1) *The Sphincteric Mechanisms and their Cancers*

It is the custom in nature to ensure that the contents of tubular structures pass in one direction. With the exception of the blood vessels this directional control is achieved by strategically situated and accurately co-ordinated sphincters. The propelling forces may, as in the case of the gut, be provided by involuntary peristaltic movement of the wall of the tube: in the case of the buccal cavity and pharynx, where the wall musculature is under voluntary control both co-ordinated voluntary muscular contraction and peristalsis play their part in the onward propulsion of food. The sphincteric arrangements in the upper air and food passages comprise a sphincter guarding the entry to the buccal cavity (the orbicularis oris) and a sphincter at the exit of the pharynx (the cricopharyngeus): between these two guarding sphincters, are the special sphincters related to the nasopharyngeal and laryngeal openings.

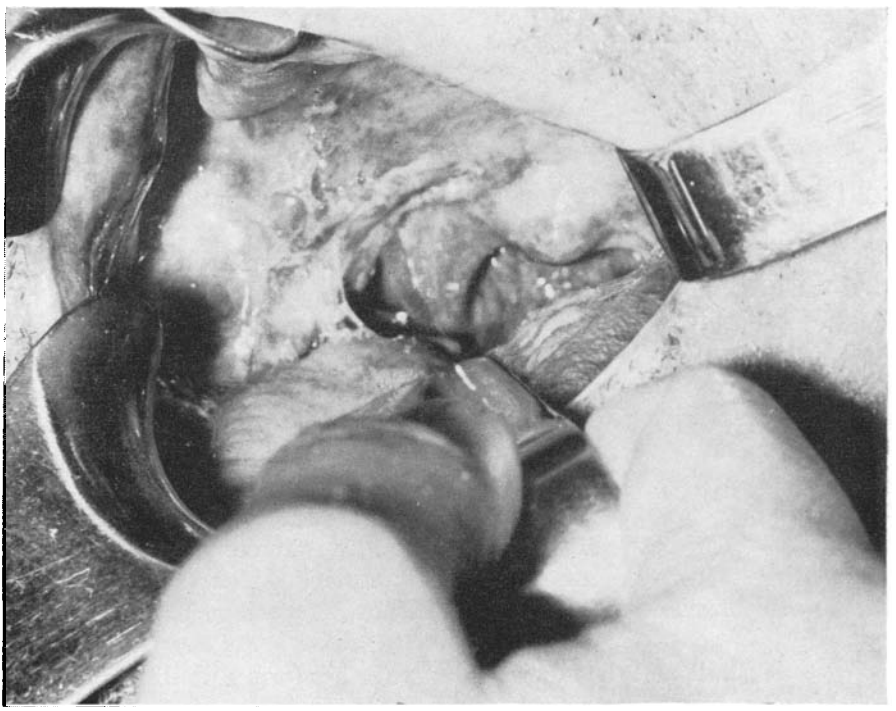
The orbicularis oris and the lips will not be specially commented on here.

The soft palate and the faucial pillars together form a double sphincter, the anterior pillars with the palatal muscle below the palatal aponeurosis

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(*a*)



(*b*)

FIG. 6.

(*a*) Tumour of linguotonsillar sulcus—before treatment. (*b*) After treatment showing the destruction of the anterior pillar with the tonsil and posterior faucial pillar intact.

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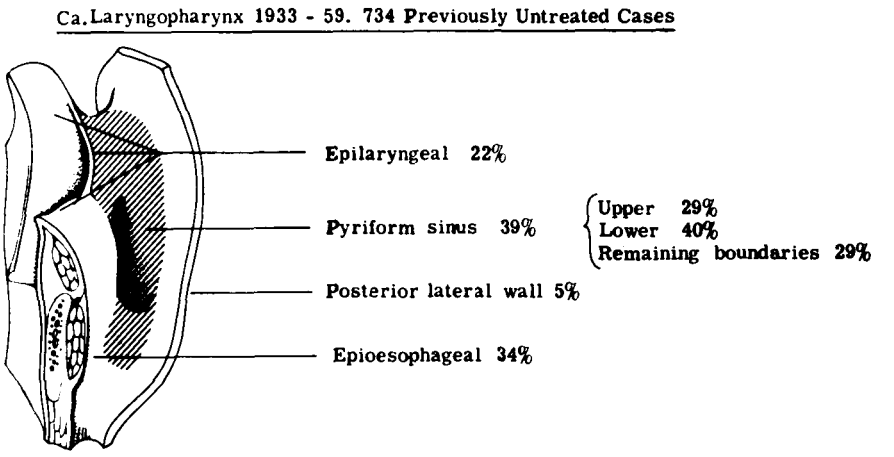


FIG. 7.
Site Distribution of Cancers of the Laryngopharynx.

forming the buccopharyngeal sphincter and the posterior pillars together with the palatal muscles above the aponeurosis forming the pharyngonasal sphincter. The latter sphincter is much the more important, since it effectively closes off the nasopharynx during the act of swallowing: the buccopharyngeal sphincter may play some part in assisting the base of tongue in closing off the buccal cavity from the pharynx, but this function, as will be shown later, must be relatively unimportant.

Fig. 8 shows the faucial compartment of the oropharynx which normally receives the bolus. The bolus is formed in the mouth between the palate and tongue and is under voluntary control as long as its head is anterior to the anterior faucial pillar; once past this point this control is lost. The faucial compartment is made up of the anterior and posterior faucial pillars, and the latter on contraction approximate towards the midline in the direction of their origin but diverge away from each other inferiorly towards their insertion leaving a gap through which the posterior pharyngeal wall can be seen. The head of a bolus enters this compartment and is, thereafter, projected into the oropharynx between the diverging pillars and passes on over the closed larynx or sometimes *viâ* the lateral food channels into the œsophageal mouth. The area of mucous membrane on the posterior pharyngeal wall exposed between the diverging posterior pillars lies approximately over the bodies of the third and fourth cervical vertebrae, and is important for the following reasons:

(1) It is the seat of election for a posterior oropharyngeal wall carcinoma and may be the seat of leukoplakic or atrophic changes independently of the formation of a carcinoma (Fig. 9).

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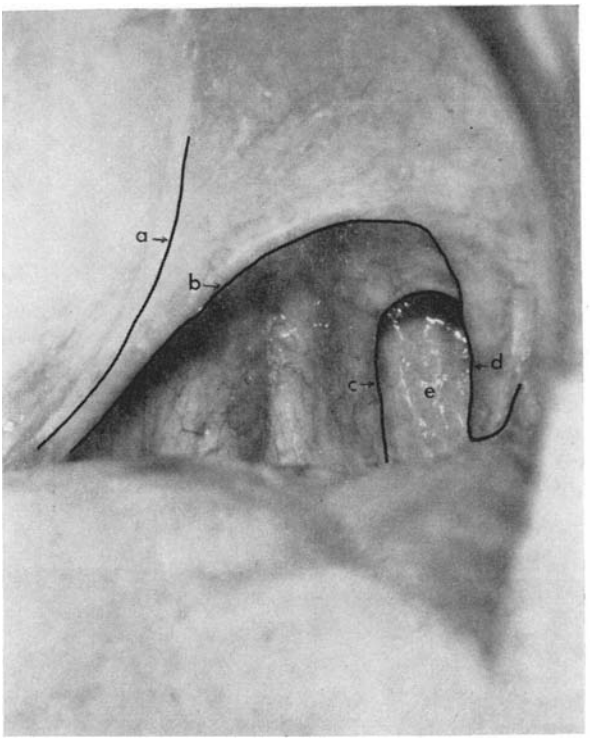


FIG. 8.

The Faucial Compartment seen in preparation for reception of the head of the bolus.
A. Pterygomandibular raphe. B. Anterior Faucial Pillar. C. Posterior Faucial Pillar.
D. Uvula. E. Posterior Oropharyngeal Wall.



FIG. 9.

Cancer of the Posterior Oropharyngeal Wall. Note situation in relation to the faucial compartment illustrated in Fig. 8.

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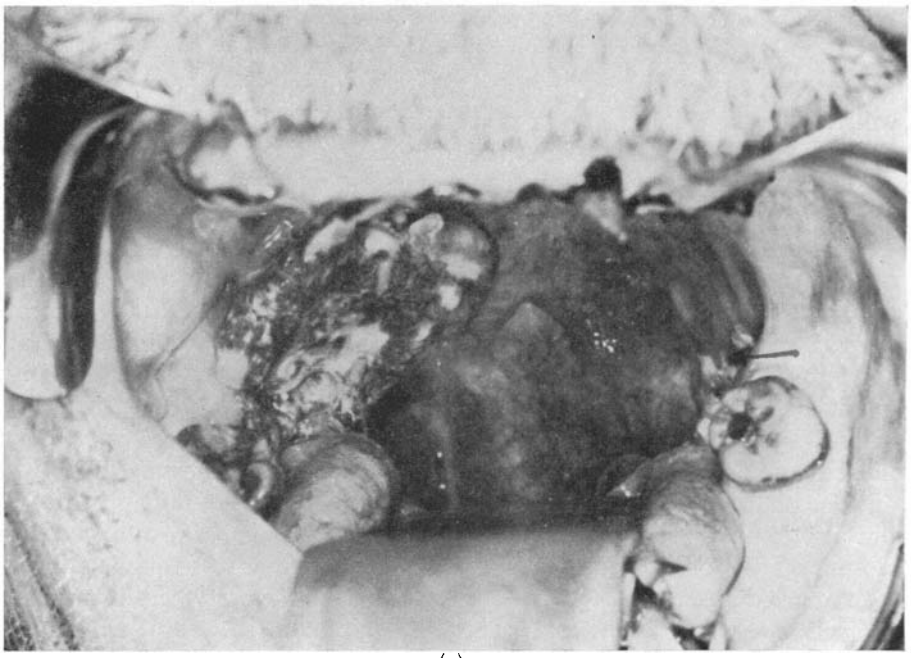
(2) It is the site of formation of the "oropharyngeal bar", which, as will be described later, serves in association with the base of tongue to close off the buccal cavity from the oropharynx.

Figs. 10 and 11 illustrate the types of cancer which affect the sphincters in relation to this region of the pharynx and larynx.

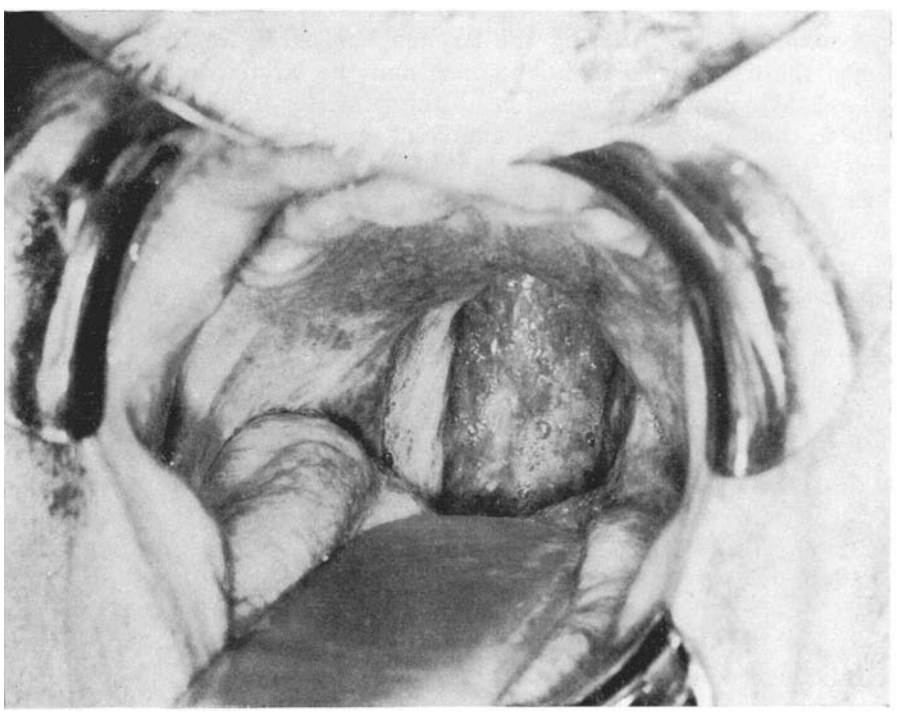
It is a surprising fact that although the existence of a sphincter at the upper and lower end of the pharynx has for long been known, the mechanism of closure of the large hiatus existing between the buccal cavity and the pharynx has never been clearly defined. It would seem that the anterior faucial pillars are ineffective as a sphincter, since in many animals they are absent, and their loss in man occasions neither discomfort, nor physiological disability. The base of tongue itself, obviously, must play some part in closing off the space between the buccal cavity and the pharynx, and its functions would appear to be not only gustatory, but also to act as a propellant for the bolus, and to act as a sphincter for closing off the oropharynx. Thus, in Fig. 12, the base of tongue can be seen approximating to the posterior wall of the pharynx where it meets a projection at the level of the third and fourth cervical vertebrae not unlike the projection of Passavant's ridge in the nasopharynx and the cricopharyngeal bar at the œsophageal mouth. This projection is often, but not invariably, seen during the laryngopharyngeal stage of swallowing when the œsophageal mouth is open and the larynx and nasopharynx closed. Whether this projection at the posterior oropharyngeal wall is due to contraction of a special bundle of muscle fibres or to a peristaltic wave is uncertain, but radiological evidence would suggest the latter. The base of tongue and projecting bar on the post-pharyngeal wall together form an effective oropharyngeal sphincter preventing reflux of the bolus into the buccal cavity. The writer suggests (Lederman) that the term "oropharyngeal bar" be applied to this projection on the posterior wall of the oropharynx because of its radiological and physiological (if not anatomical) similarity with Passavant's ridge and the cricopharyngeal bar. Not only is each of these sphincters the seat of a carcinoma, but one of the characteristics of these "sphincteric" cancers is the tendency to "cancerization" or neoplastic involvement of the whole of the physiological sphincteric mechanism (Figs. 10, 11).

The position of the vallecula fossa during contraction of the oropharyngeal sphincter is also of significance as at this phase of swallowing it can be seen to be almost non-existent (Fig. 12), a small pool of barium alone lying in its situation between the base of tongue, the oropharyngeal bar, and the downturned epiglottis. The vallecula in these circumstances has no depth and lies a considerable distance away from the hyoid body, whereas under normal breathing and resting conditions the floor of the vallecula is almost immediately behind the body of the hyoid. The vallecula appears to follow the base of tongue as it contracts and approaches

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(*a*)



(*b*)

FIG. 10.

(*a*) Extensive lesion of the right anterior faucial pillar with small lesion (⇐) on the left pillar (buccopharyngeal sphincter). (*b*) Destructive lesion of the uvula, soft palate and posterior pillars (pharyngonasal sphincter).

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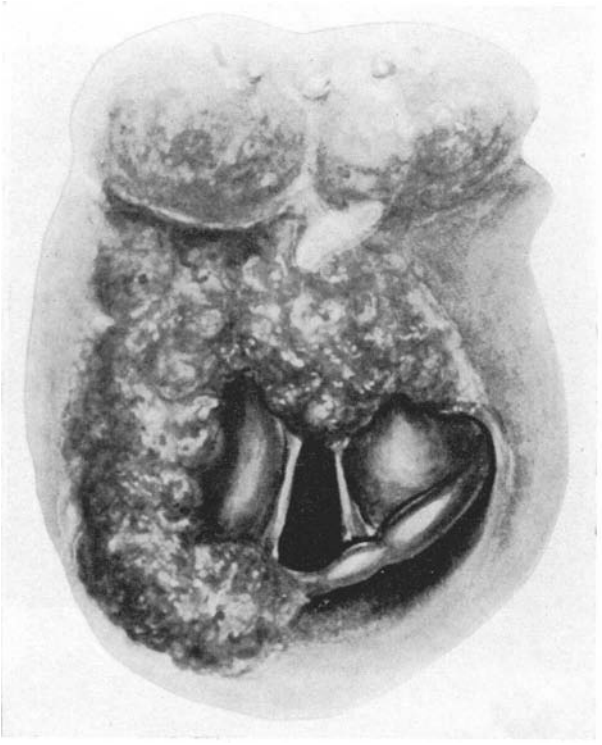


FIG. 11.
Shows an annular carcinoma of the laryngeal inlet (involving the epilaryngeal sphincter).

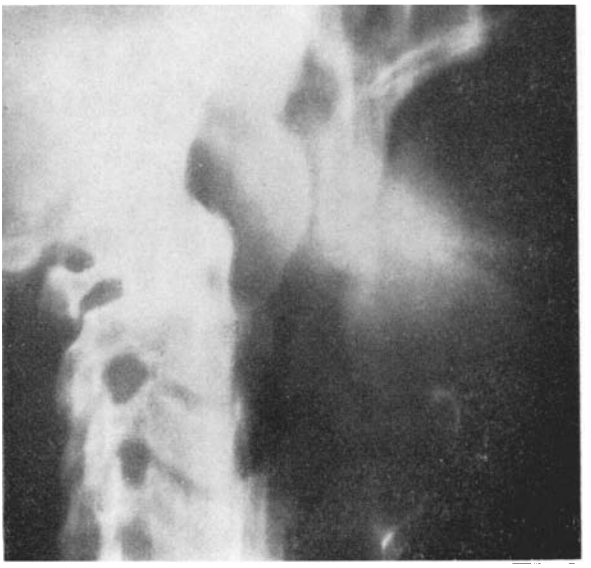
the posterior pharyngeal wall, becoming during this process downturned and so emptied rather in the fashion of a bucket.

This backward movement of the base of the tongue and the emptying of the vallecula fossa also means that in the absence of the epiglottis the closed elevated larynx will automatically come to lie under the protective projection of the base of tongue, hence the facility with which the suprahyoid epiglottis can be dispensed with as a protection for the laryngeal opening (Fig. 13).

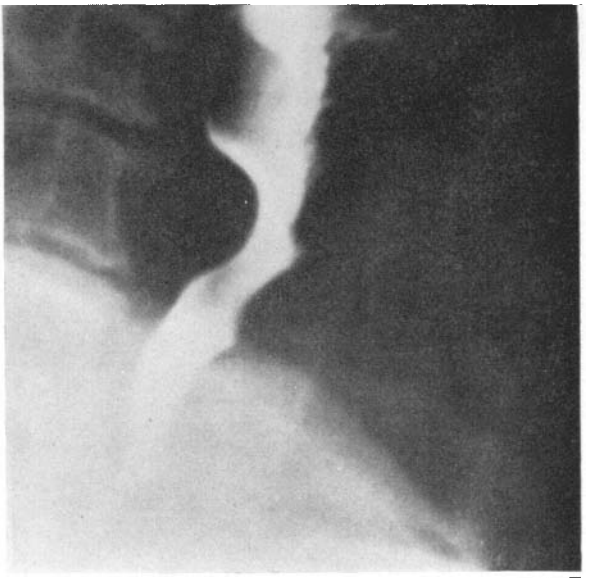
(2) *The Reservoir System* (Lederman, 1956)

So far the carcinomas arising both in the food channels and on the sphincters controlling the volume and the direction of the food passing through these channels have been discussed. Unfortunately by siting the opening of the airway in the floor of the buccopharyngeal tube Nature has committed a fundamental error in construction, and in order to overcome this, not only has a system of by-passes and sphincteric controls had to be developed, but special provision has also had to be made to

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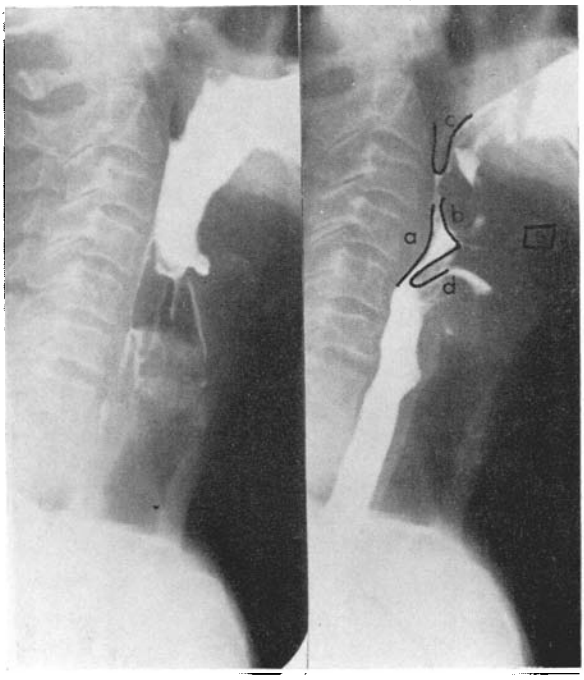


(*a*)



(*b*)

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(i) (ii)

(*c*)

A. Oropharyngeal Bar.
B. Base of Tongue.
C. Uvula.
D. Epiglottis.
E. Body of Hyoid.

FIG. 12.

(*a*) Tomograph showing Passavant's Ridge and Soft Palate. (*b*) Radiograph showing the Cricopharyngeal Bar. (*c*) Oropharyngeal Bar. (i) The oropharyngeal phase of swallowing. (ii) The laryngopharyngeal phase of swallowing. Note closure of oropharynx and sealing off of buccal cavity by apposition of base of tongue and the oropharyngeal bar which is visible as a projection in front of the bodies of the 3rd and 4th cervical vertebrae. Note also the "emptying" of the "vallecula fossa" and the distance between its floor and the body of the hyoid bone.

prevent inundation of the airway in the presence of an excess of fluid or food. One obvious method of coping with possible inundation is to divert any excess fluid into side channels or reservoirs where it is taken out of the main circulation and temporarily stored. As a result of such a diversion the volume and speed of the fluid passing through the main channel is reduced and any fluid so retained or stored can subsequently be poured back into the main circulation as necessary.

A reservoir system of this kind exists in the buccopharyngeal tube where, in relation to each segment of the alimentary grooves, a small "reservoir", is interposed for the temporary accommodation of excess

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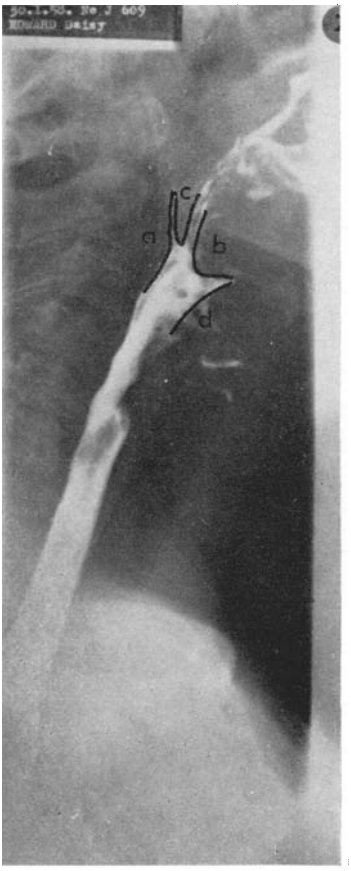


FIG. 13.

Closure of the buccal cavity and protection of the larynx by the base of the tongue in the absence of the epiglottis. Note entry of barium into the larynx in front of the cartilage of Santorini.

A. Oropharyngeal Bar.
B. Base of Tongue.
C. Uvula.
D. Laryngeal Inlet.

fluid or bolus. These reservoirs are situated at strategic points as follows (Fig. 14):

(1) At the posterior ends of the lower alveololingual sulci (Palatoglossal sulci (Lederman).

(2) In the Valleculae Fossae

(3) In the Pyriform Fossae.

Each reservoir is an actual or potential depression situated at the termination of a segment of the alimentary grooves, in the upper two

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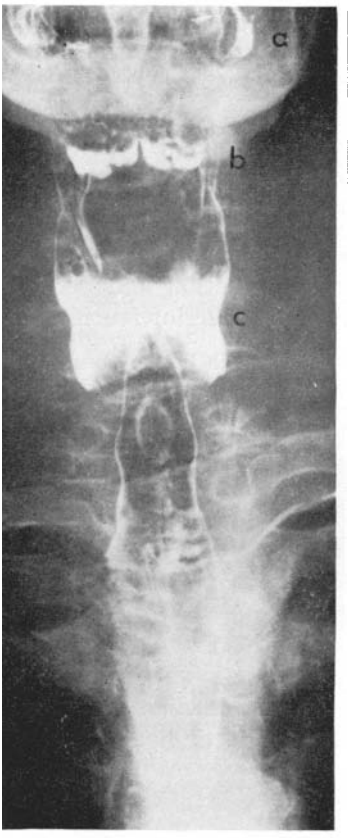


FIG. 14.

The Reservoir System. Radiograph showing barium in (*a*) the palatoglossal sulci, (*b*) the valleculae, and (*c*) the Pyriform fossae.

coinciding with the junction of two consecutive segments of this groove.

(1) The palatoglossal sulcus is situated at the junction of the buccal and oropharyngeal segments of the alimentary groove just anterior to the anterior faucial pillar.

(2) The vallecula fossa is situated at the junction of the oropharyngeal and laryngopharyngeal segments supero-medial to the pharyngo-epiglottic fold.

(3) The pyriform fossa acts as a double reservoir as will be shown later.

With the exception of the lower part of the pyriform fossa, there is also a structural similarity between the reservoirs in that the floor of each possesses little muscle, having instead either fascial or ligamentous structures, which permit temporary distension.

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The anatomical structure of these reservoirs is as follows:

(1) *Palatoglossal Sulcus*

The palatoglossal sulcus or recess may be defined as the most posterior part of the lower alveololingual sulcus. It forms the lingual pouch (Fish, 1952) or retro-mylohyoid space (Edwards and Boucher, 1942) of the dentists, and its boundaries are formed as follows:

Floor: The region where the mucous membrane of the lower alveololingual sulcus changes direction and becomes continuous with the mucous membrane of the anterior faucial pillar.

Medial: Lateral margin of the tongue in the region of the papilla foliatum and the insertion of the anterior faucial pillar behind this.

Lateral: The mucous membrane over the medial aspect of the last lower molar tooth socket and the immediately adjacent lower jaw.

Postero-superior: The sulcus is continuous with the anterior faucial pillar.

Antero-inferior: The sulcus is continuous with the lower alveololingual sulcus.

(2) *Vallecula Fossa*

This is a mucosal depression situated between the epiglottis and base of tongue on either side of the median glosso-epiglottic fold. Its floor is formed chiefly by the hyo-epiglottic ligament.

(3) *The Pyriform Fossa*

The pyriform fossa is the most important of the segments of the alimentary grooves, as the safety of the laryngeal airway depends on its proper functioning both as a "reservoir" or well and as a laryngeal by-pass. This can be demonstrated as follows:

During the act of swallowing when the larynx rises and is closed off the pyriform fossa widens to receive the oncoming bolus. In this phase the upper half of the fossa is distensible, since it is related to the thyrohyoid membrane and the aryepiglottic fold, whereas the lower half is rigid and unyielding because of its relationship to the cricoarytenoid region and the thyroid lamina. Should the bolus prove excessive then the upper part can indergo distension so as to accommodate this excess up to a point, but over-distension will result in a breach of the walls of the fossa at its weakest point, which is the medial wall formed by the aryepiglottic fold. When this occurs the vestibular sphincter of the larynx is overcome and food may enter into the larynx over the rampart formed by the aryepiglottic fold. The breach always occurs at one particular point, which is just in front of the cartilage of Santorini. The upper half of the pyriform fossa appears to act as a distensible receiver (or

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reservoir) whilst the larynx is closed during swallowing. After swallowing when the larynx has descended and breathing is resumed, the lower part of each pyriform fossa and the retro-cricoid region between them together act as a reservoir for any residual bolus or fluid remaining at the end of the pharyngeal phase of swallowing. In this situation this residue can be retained below the level of the aperture of the larynx so that breathing can continue safely until such time as the œsophageal mouth opens to receive this residuum. It is precisely in this particular situation that the pooling of mucus so typically associated with cancer in this region is observed on indirect laryngoscopy.

To summarize, the functions of the pyriform fossa would appear to be as follows:

1. To provide a by-pass to the larynx.

2. Its distensible upper part is used as a reservoir for retaining excess fluid or bolus whilst the larynx is closed and the œsophageal mouth open.

3. The rigid lower part of the pyriform fossa, in conjunction with its fellow of the opposite side, also acts as a reservoir by storing fluid or bolus after re-aeration of the larynx, in which position it is kept safely below the opening of the airway until such time as the cricopharyngeus next relaxes.

Cancer of the Reservoir Systems

Cancers arising in the region of the reservoirs as described possess two important features in common:

(1) They occur frequently.

(2) Because of their situation and anatomy these reservoirs form a feeble barrier to cancerous invasion. They act in fact as weak links in the anatomical defences of the head and neck and provide escape points for cancer.

The Palatoglossal Sulcus

The anatomical limits of the sulcus have already been described. There are four tumours which may arise primarily from the boundaries of this sulcus, the two commonest occurring in relation to the medial boundary, namely the lateral margin of the tongue in the region of the foliate papilla and the lingual insertion of the anterior faucial pillar. The remaining two sites are less commonly affected, namely its floor, which is the posterior end of the lower alveololingual sulcus and the lateral boundary formed by the mucous membrane over the last lower molar tooth socket and the jaw below.

Whatever the primary origin of the cancer, be it pharyngeal or buccal cavity, once the floor of the palatoglossal sulcus is involved the lesion automatically becomes a tumour of the neck. The reason for this is found in the

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anatomy of the floor of the sulcus, where it lies below the last molar tooth and behind the posterior border of the mylohyoid muscle (Fig. 15); in this region the muscular and fascial floor of the oral cavity is absent, the mucous membrane alone forming the barrier between the oral cavity and tissue spaces of the neck (Sicher, 1948). A neoplasm affecting the floor of the palatoglossal sulcus has, therefore, direct access to the neck, and as the structures immediately deep to the floor of the sulcus are the lingual nerve and the deep portion of the submaxillary gland, direct extension is heralded by pain, and followed by invasion of the submaxillary gland. This invasion gives rise to a palpable swelling in front of the angle of the jaw associated with a rigid bar-like thickening of the stylo-mandibular ligament, which normally separates the submaxillary from the parotid gland (Fig. 16).

Because of this peculiarity in behaviour, a carcinoma affecting the floor of the pataloglossal sulcus should never be regarded purely as an intra-oral carcinoma and any treatment method restricting itself to the intra-oral part of the disease alone is usually doomed to failure.

The Vallecula Fossae

The vallecula fossae and base of tongue together forming the glosso-epiglottic region are frequently the seat of cancer. The mucosal floor of the fossa offers no resistance to the spread of cancer so that deep extension of neoplasm through this floor inevitably results in invasion of the pre-epiglottic space. Fig. 17 shows the clinical and radiological results of this extension and its seriousness as a prognostic and therapeutic factor requires little comment.

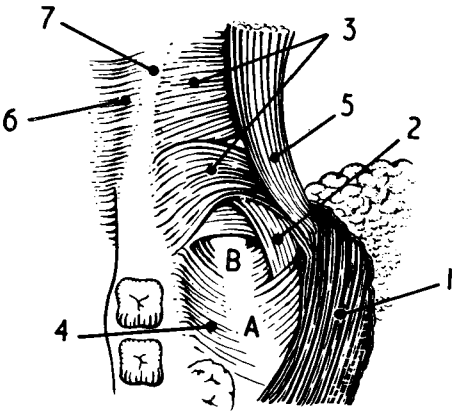
The Pyriform Fossa

An account of the anatomy of the pyriform fossa and its cancers has been published elsewhere (Lederman, 1953). The division of this segment of the alimentary groove into an upper and lower part is not only of physiological importance, but of prognostic and therapeutic importance as far as its cancers are concerned.

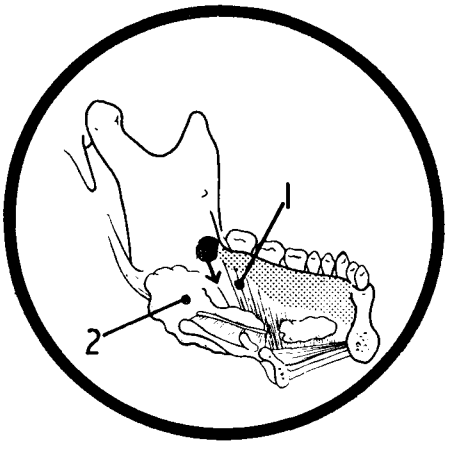
As a rule the freedom of the boundaries of the upper part of the fossa from cartilage means that this region is less able to resist the spread of cancer: but as a compensation the response to radiotherapy and the prognosis with this form of treatment is better than for a comparable tumour arising in the lower part of the fossa; in which latter region the cartilaginous wall may longer resist the cancer, but radiotherapy is less likely to be successful and the need for surgery correspondingly greater.

Fig. 18 shows the clinical appearance of extension through the lateral boundaries of the fossa. These extensions are frequently interpreted as lymph node metastases, a mistake that can be avoided by asking the

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(*a*)



(*b*)

FIG. 15.

(*a*) Anatomy of the floor of the palatoglossal sulcus (after Fish). A. Area in relation to the great cornu of the hyoid bone. B. Area in relation to the deep part of the submaxillary gland. (*b*) The pathway of spread from the floor of the palatoglossal sulcus directly into the tissues of the neck.

(*a*)

1. Tongue musculature.
2. Stylo-glossus muscle.
3. Superior constrictor muscle.
4. Mylo-hyoid muscle.
5. Palatoglossus muscle
6. Buccinator muscle.
7. Pterygo-mandubular raphe.

(*b*)

1. The posterior border of the hylo-hyoid muscle.
2. The submaxillary gland (deep part)

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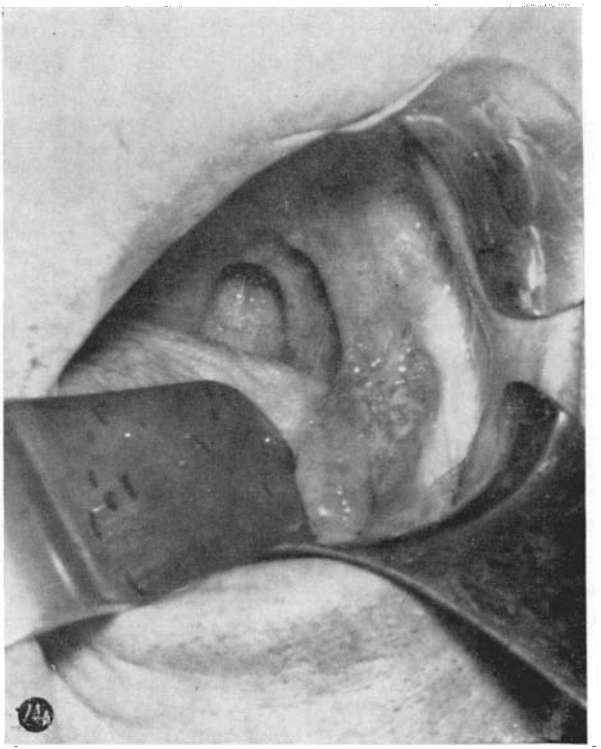
patient to swallow: when a direct extension from the pyriform fossa will move with the larynx, whereas a cervical lymph node metastasis will not.

The concept of the alimentary grooves with its sphincters and reservoirs all providing starting points for cancer may on the surface seem logical, but in conclusion it is both necessary and prudent to remark that any observations derived from this attempt to relate the cancers arising from a particular part of the body to its anatomical structure and physiological functions must be regarded as speculative, since proof in a scientifically acceptable sense can never be provided.

Nevertheless, in view of the magnitude of the cancer problem and its unlikely solution in the forseeable future, any basis for observed clinical findings, even a speculative one, is better than none at all, since at least the correlation and classification of such findings can be undertaken so that some foundation is provided for further progress in the clinical study and possible detection of ætiological causes of these diseases.

Summary

The upper air and food passages are defined as being that part of the



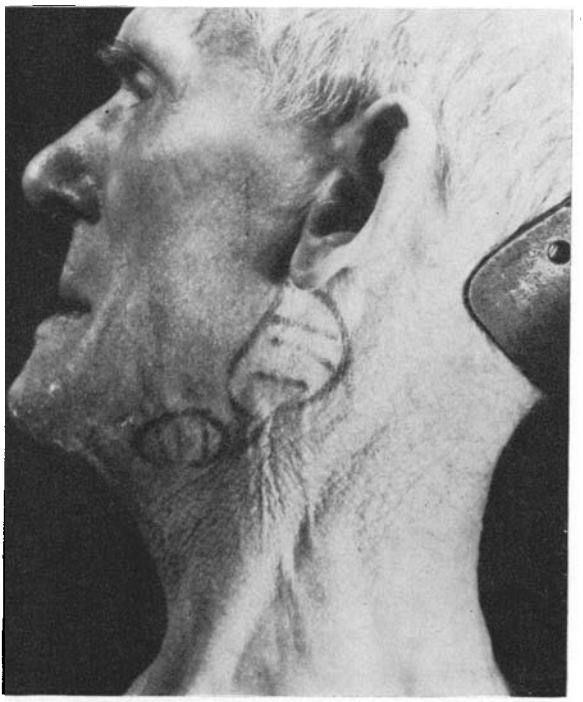
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foregut extending between the orbicular oris and the cricopharyngeus. Some light can be thrown on the possible reason for development of cancers in certain parts of the buccal cavity and pharynx from a study of the alimentary grooves which extend from the floor of the mouth to the œsophageal opening past the tongue and larynx. The grooves are in three segments, (i) buccal, (ii) oropharyngeal, and (iii) laryngopharyngeal, and each of them is a frequent site for cancer. The direction taken by fluid and bolus through the buccopharyngeal tube is also controlled by a series of sphincters: innundation of these channels is prevented by a series of strategically situated reservoirs, whose purpose is to accommodate temporarily any excess of fluid or bolus. The sphincteric mechanisms and the reservoirs are also frequently affected by cancer. A detailed account is given of the anatomy of these alimentary grooves and their sphincters and reservoirs.

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I wish to express my indebtedness to Dr. Stevenson, the Director of the Radiodiagnostic Department of the Royal Marsden Hospital, for the



(*b*)

FIG. 16.

(*a*) An apparently limited lesion of the floor of the palatoglossal sulcus. (*b*) Showing direct extension into the submaxillary salivary gland and metastases in the adjacent upper deep cervical region.

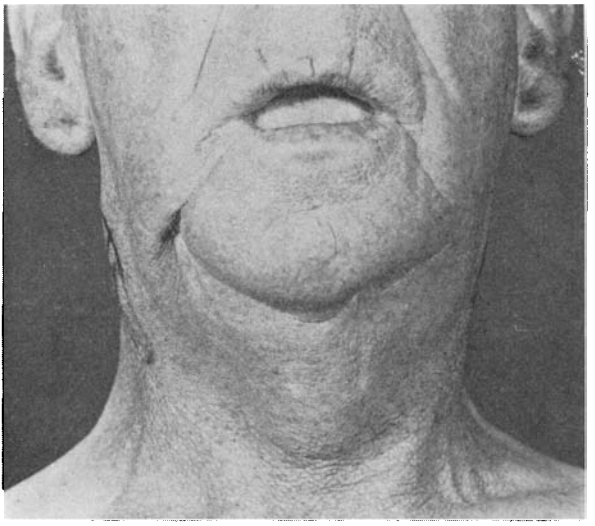
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radiographs and his invaluable assistance and guidance in many of the problems encountered in the course of this work.

I wish to thank the Hon. Editor of the British Journal of Radiology for permission to reproduce Figs. 2, 15(*a*) and (*b*), 16 (*a*) and (*b*).

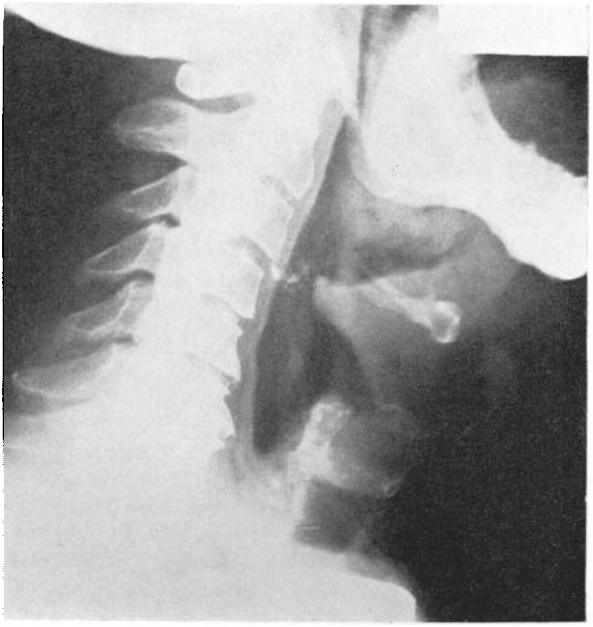


(*a*)



(*b*)

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(*c*)

FIG. 17.

(*a*) Cancer of the base of tongue with gross œdema of the floor of the mouth and anterior ⅔rds of the tongue. (*b*) Fullness of the prelaryngeal region. (*c*) Radiograph showing extensive destruction of the base of the tongue and invasion of the pre-epiglottic space.

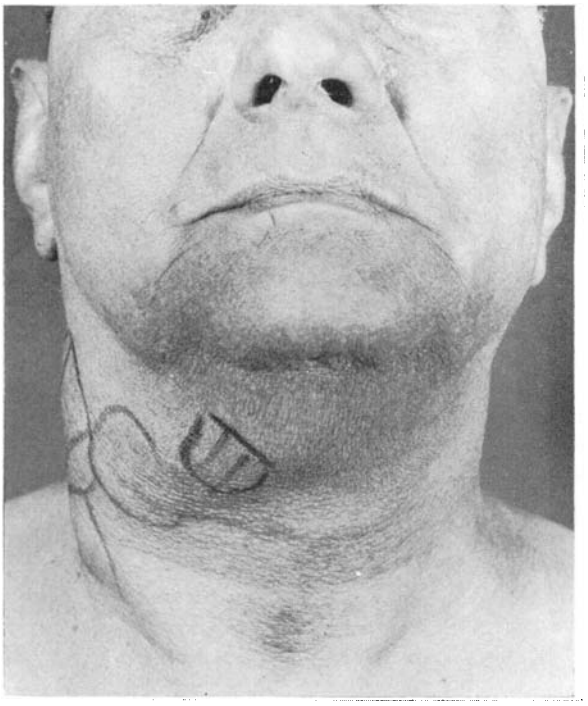


FIG. 18.

Cancer of the sinus pyriformis showing direct extension through the posterior part of the thyrohyoid membrane and adjacent lymph node metastases.

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