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The infant larynx*

by

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Surgery is based upon a knowledge of structure and function and upon how either may be modified by disease. Paediatric surgery adds a further dimension of growth and development, for in our work we have always to consider at what stage of development are we dealing. What? and When? are the two questions at the forefront of our thinking.

An examination of the recent literature on the infant's larynx shows that the preponderance of research is in Embryology, upon the descent of the larynx, upon muscles and innervation and upon epithelial coverings in anatomy. Physiologists have concentrated upon deglutition and phonation.

Two previous Presidents of this Section made important contributions to our knowledge of the Anatomy of the child's larynx. I refer to Sir Victor Negus and to Mr. T. G. Wilson. Their work was published some years ago and since that time there have been significant advances in photographic methods so that it is no longer necessary to rely upon drawings to make a particular point clear. Drawings need not be either unhelpful or inaccurate. They make it possible to demonstrate anatomy by selection of the structures recorded, and in this connection, both S. P. Steward's and Lady Negus's were an outstanding complement to Sir Victor's text.

The material to be demonstrated has all been examined over the past six months, and I wish here to express my deep indebtedness to Dr. Kenneth Backhouse of the Royal College of Surgeons who has helped me to prepare the specimens and to interpret what we have found.

Most surgeons, if pressed, would be able to describe the differences between the child's and the adult's larynx. How many would be able to say what underlies these differences and what purpose they serve? The intention of this paper is therefore to demonstrate the underlying anatomy and to indicate the purpose which I believe is served.

It is now necessary to discuss the comparative anatomy of the larynx. Negus' famous book, which was a condensation of a much larger work was published in 1949, traces the evolution of the larynx, from the moment when animals emerged from the water and substituted lungs for gills as a method of transferring oxygen from the air to the blood (Fig. 1).

The basic requirement was to provide access for air to the respiratory epithelium, while at the same time denying access to food, water and foreign bodies. Some form of valve mechanism was required, and the simplest larynx consisted of a circle of muscles forming a sphincter. The first function of the larynx must therefore always be to protect the lungs. In order to increase respiratory efficiency, it was necessary to have dilator muscles to open the airway more widely and with this development one finds the first appearance of cartilage in the area of the sphincter. Such a single plate of cartilage is found in certain mud fishes and it lies

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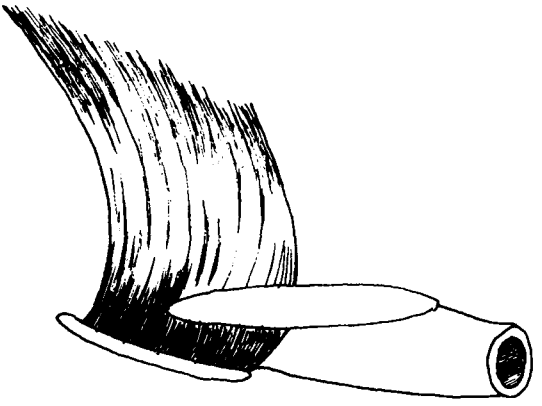


FIG. 1

The arrangement of muscle and cartilage in the larynx of the lung fish (after Negus).

beneath the mucosa of the pharynx. Attached to the cartilage plate are circular muscle fibres which have their origin from septa near to the vertebral column. Contraction of these fibres raises the plate of cartilage nearer to the vertebral column and in so doing admits air to the lung. The next cartilages to appear are laterally placed and are soon found to subdivide into a cricoid and two arytenoid modules. At a still later stage an incomplete cartilaginous ring, which is fused to the cricoid, appears. In higher animals this becomes detached and forms the thyroid cartilage. From this ring, dilator muscles take origin and these are inserted into the arytenoids. By their contraction a triangular airway is produced and we call this the glottis.

Mammalian Larynx

The definitive mammalian larynx consists of thyroid and cricoid cartilages, either fused or articulated, with arytenoid cartilages set on the cricoids and capable of movement on it. Paired dilator muscles arise from the cricoid and are inserted into the muscular processes of the arytenoids and have the function of pulling the arytenoids apart over the surface of the cricoid. A sphincteric girdle therefore surrounds the larynx but is deficient anteriorly. It is divided into three segments: on either side of the glottis are the thyro-arytenoids; below them are the crico-arytenoids; posteriorly lies the inter-arytenoid muscle.

Since the primary function of the larynx is to protect the lungs, the structure may be modified according to the diet the species takes. The modifications may be structural or functional. Snakes (who are of course not mammals) are capable of ingesting whole animals and, presumably, of digesting them too. It is therefore important that, in the process of ingestion, which is slow, the airway is not obstructed. In order to avoid this obstruction the snake has the capacity to protrude the larynx into the mouth. This ensures that breathing will continue while the ingestion takes place.

Modifications in structure include the development of the epiglottis which is thought to have evolved in order to close the gap between the nasal cavities and the larynx in order to make olfaction more efficient. On the whole mammals are very dependent upon

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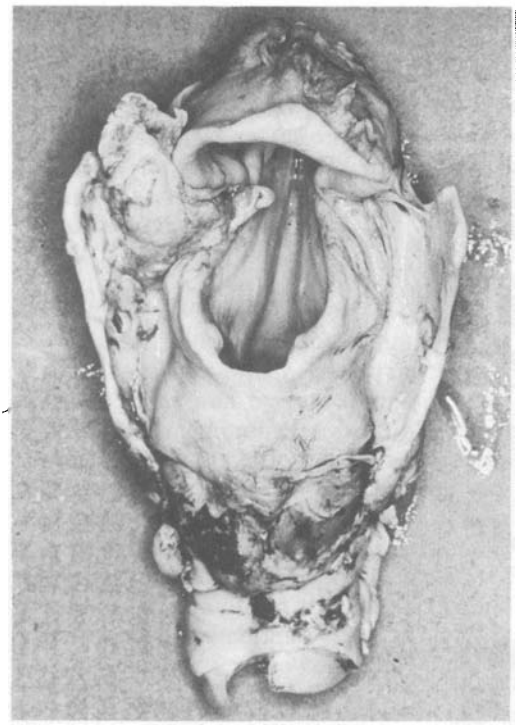


FIG. 2
The larynx of the lion viewed from the postero-superior aspect.

olfaction for the detection of food and, in them, the epiglottis lies in close relationship with the nasopharynx, tends to be relatively large and is upright.

Deglutition in carnivores

Mammals who hunt for their meat and live on meat alone, tear that meat from the carcase and swallow it whole without mastication. In the second stage of deglutition the larynx and pharynx rise over the bolus of food and the larynx is drawn up towards the hyoid at the base of the tongue. The glottis is closed and the epiglottis is displaced from the nasopharynx and compressed over the larynx (Fig. 2).

Deglutition in herbivores

In animals who feed on greenstuff alone a large amount of food is ingested in a semi-liquid state over a long period of time. In order therefore to protect the larynx it would be necessary to interrupt respiration for an unacceptably long period or to run the risk of undernourishment. Modifications in structure have been necessary to allow both respiration and deglutition to take place simultaneously. In these species food travels in lateral food channels placed on either side of the larynx and the sides of the larynx are raised to make overspill less likely. As the stream of liquid reaches the epiglottis it is parted into two portions, and half travels distally on the left side and half on the right side of the larynx. The lateral wall of the larynx may be raised in one of two ways (Fig. 3):

(a) By means of lateral epiglottic folds, and
(b) By means of aryteno-epiglottic folds.

Both are in effect upward extensions of the margins of the glottis and are raised up above the floor of the pharynx. The aryteno-epiglottic fold is continuous with the thyro-arytenoid fold, but the attachment extends upwards to the epiglottis, as distinct from the epiglottic folds, in which there is no arytenoid involvement. The purpose of each is identical but the aryteno-epiglottic fold is the more efficient. Some animals have both lateral epiglottic folds and aryteno-epiglottic folds. In those animals in which the larynx lies in the nasopharyngeal sphincter, additional protection is afforded by the contraction of the sphincter during deglutition which has the effect of sealing off the airway while the semi-liquid food passes down the lateral food channels. Further protection for the glottis is obtained posteriorly by an increase in the height of the arytenoids and it may become relatively much larger in some animals than in others. Even further height may be gained by the crowning of the arytenoids with the corniculate cartilages of Santorini.

The raising of the aryepiglottic fold as a defence mechanism may pose problems. When the arytenoid is large, as it is in deer and rodents, there is only a very short distance between it and the epiglottis. However, when the arytenoid is relatively

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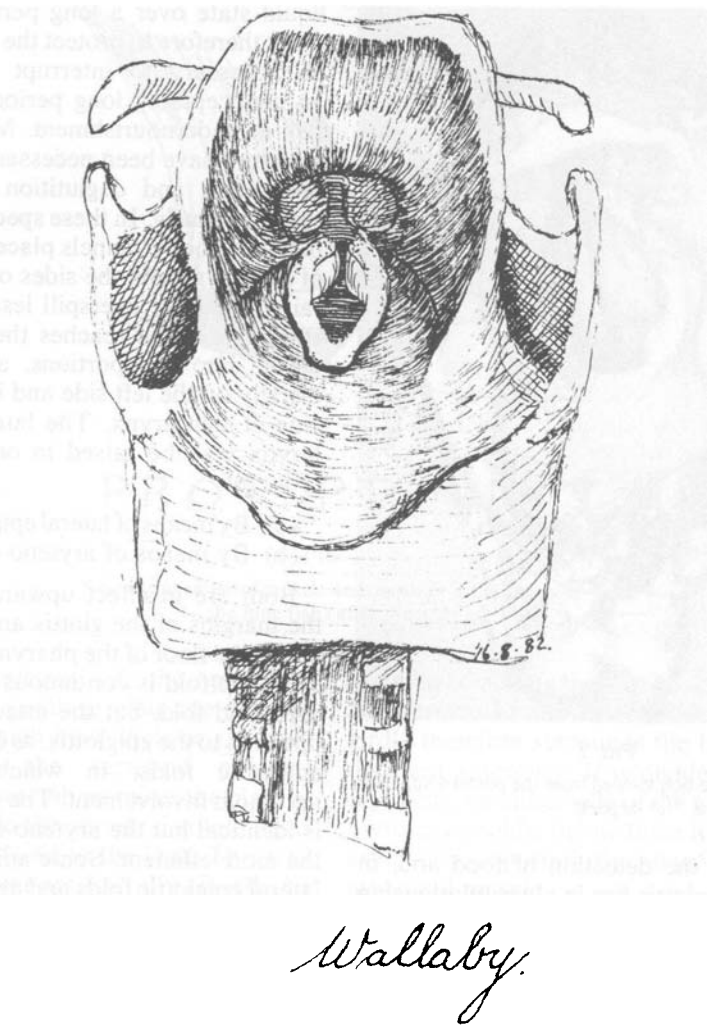


FIG. 3

Drawing of the larynx of the wallaby, showing the lateral epiglottic folds.

small, the gap may be relatively large and in some species this is closed in part by the cuneiform cartilage of Wrisberg which has the added advantage of strengthening the aryepiglottic fold. This cartilage is said to be a derivative of the median process of the epiglottic cartilage.

Most of what I have said has been obtained from Negus' book. I do not think that a more concise or authoritative account exists. What I have said so far has considerable bearing on what is to come.

I must now turn to the standard account of the normal human larynx. There are certain points to be discussed in the adult anatomy before embarking on the child.

The larynx opens above into the pharynx. Below, its cavity is continuous with the trachea. In its natural position it is situated anterior to the borders of the fourth, fifth and sixth cervical vertebrae. The lower border of the cricoid extends to the lower border of the sixth cervical vertebra. The larynx lies below the hyoid bone in the mid-line of the neck

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between the great vessels and below the tongue. Its position is affected by movements of the head and neck. Thus it is elevated when the head moves backwards and depressed when the chin is lowered. However, its relationship to the vertebral column is scarcely altered. It moves upward on deglutition.

The construction of the larynx

The underlying skeleton is composed of several cartilages which are connected by synovial joints and by elastic membranes. Two of these membranes stretching between the arytenoids to the thyroid cartilage form the groundwork for the vocal fold. There are many muscles which act upon the cartilages to effect changes in the relative positions of the vocal folds and which vary the tension of the folds. The cavity of the larynx is lined with mucous membrane under which, in certain localities, are collected mucous glands.

The Cartilages

Consist of

Three single	*Three paired*
Epiglottis	Arytenoid
Thyroid	Corniculate
Cricoid	Cuneiform

It is unnecessary to go over again the descriptions of the three single cartilages or the first two of the paired cartilages. However, what is said about the cuneiform cartilage?

'The cuneiform cartilages which may be very large are not always present. They are a pair of rod-shaped pieces of elastic fibrocartilage, each of which occupies a place in the aryepiglottic fold immediately anterior to the arytenoid and corniculate cartilages. On the laryngeal surface of each cartilage a collection of mucous glands stands out in relief under the mucous membrane'.

Grant (1943) states quite positively that the larynx of the neonate is relatively larger than it is in the adult and that the trachea is relatively smaller. He also states that, by the time the child reaches six years of age, the calibre of the trachea equals that of the larynx.

Grant is not unique in believing that the infant's larynx is relatively larger than the adults'. It may be that he had not given the matter any detailed consideration and decided that previous authors had authenticated the facts.

In examining a relatively small number of infant larynges it was decided to approach the available material with an open and, we hope, an objective mind, to record what was found if possible so that it could be demonstrated to others, and to postulate reasons for the findings.

Measurements were made in order to provide the foundation for a series of 'norms' which could be assessed with increasing accuracy as the amount of material increased. The validity of Grant's assertion that the infant's larynx is relatively larger than that of the adult must be tested.

Immediately one is confronted with the problem of the basis on which such an assessment should be made. It would be interesting to hear the basis for previous assessments.

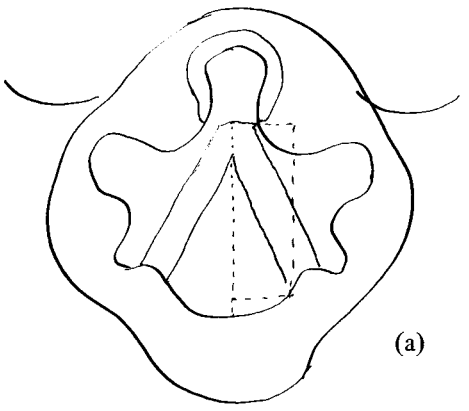
It was decided to relate the square area of the glottic opening to the surface area of the body. The reason for this was that the oxygen requirements for the body surface have to be taken in past the laryngeal choke or the glottis.

The oxygen requirements per square metre of infant surface are certainly equal, if not greater, than the oxygen requirements of the adult surface. Therefore by comparing square area of the glottis to surface area of skin we can derive an index of the area of skin each square millimetre of glottis has to supply. This figure will show which is relatively the larger organ.

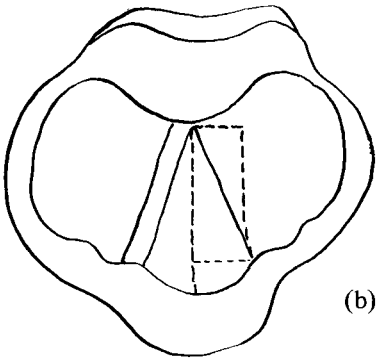
The adult larynx has been measured frequently and, as far as I have been able to ascertain, the figures are accurate. I have measured the infant vocal cord and the width of the posterior commissure.

The average vocal cord length in the neonate (Fig. 4a) is 4.75 mm. The maximum width of the posterior commissure I have

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Av. vocal cord length = 4.75 mm.
Posterior commissure width = 6 mm.
Surface area of 3.5 kg. infant = 0.2 sq. m.
Square area of glottis = 15 sq. mm.
∴ Each sq. mm. of glottis supplies 0.013 sq. m. of body surface.



Av. vocal card length = 23 mm.
Posterior commissure width = 19 mm.
Surface area of 75 kg. man = 1.97 sq. m.
Square area of glottis = 218.5 sq. mm.
∴ Each sq. mm. of glottis supplies 0.009 sq. m. of body surface.

FIG. 4

Diagrams to show the methods used to calculate the square area of the glottis.

measured is 6 mm. Therefore it is fair to say that the maximum glottic area is 3×5 mm. = 15 mm. The surface area of the body of a neonate weighing 3.5 kg. is 0.2 sq. m. Therefore each square millimetre of glottis passes oxygen to supply 0.013 sq. m. of body surface.

The average vocal cord length in the 6 ft. adult man (Fig. 4b) is 23 mm.

The posterior width of the glottic chink in full abduction is 19 mm.

The area of the glottis is therefore 218.5 sq. mm. The surface area of the body of a 6 ft. 75 kg. man is 1.97 sq. m. This means that each square millimetre of adult glottis admits oxygen to supply 0.009016 sq. m. of surface area of the body.

From this it is clear that the infant's larynx is relatively smaller than the adult. However, that does not mean that individual parts of the larynx are relatively smaller in the child than they are in the adult. The problem about making these sorts of measurements can be resolved by the use of photography. By photographing the supero-inferior length of the larynx on a graticule it is possible to produce pictures of the infant larynx on which the image is the same size as that of the adult larynx and by comparing these pictures the proportional differences will become clearer.

Taking the anterior aspect first, it is clear that the angle of the thyroid cartilage is very different. The infant's cartilage (Fig. 6a) subtends an obtuse angle of 110° which leads to a spreading of the thyroid ala. The adult cartilage (Fig. 6b) subtends an acute angle which adds prominence to the pomum adami.

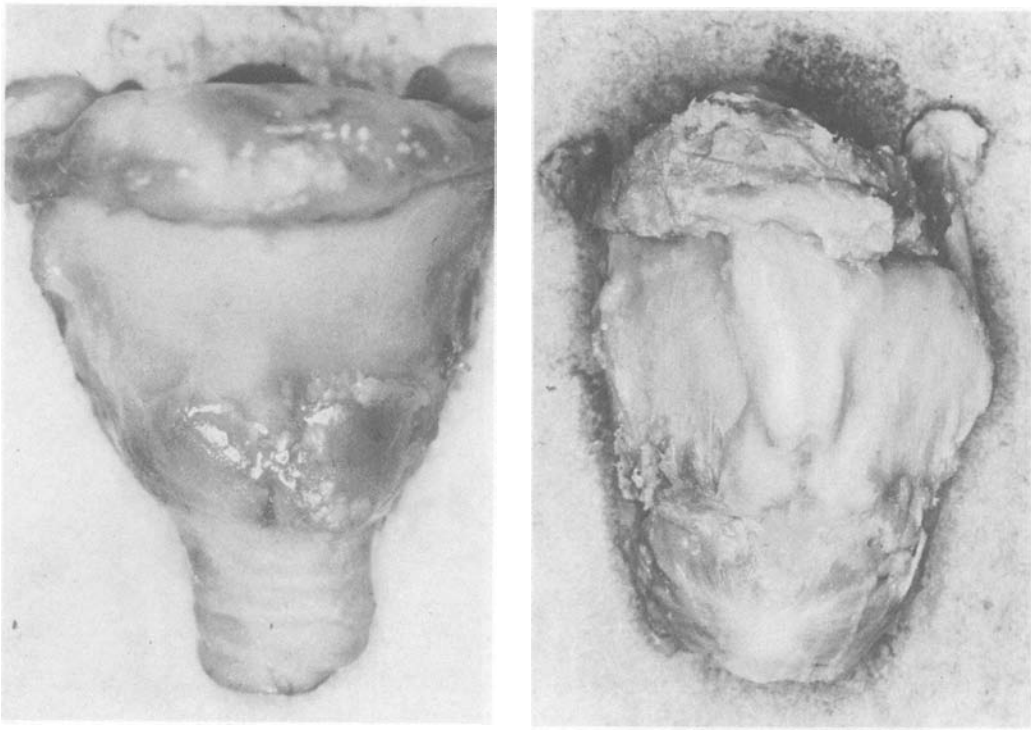
When the larynx is divided in the mid-line in the sagittal plane, it is clear that the vocal cord length of the infant is relatively smaller than the adult in the ratio of 0.76 : 1.

At the level of the lower border of the cricoid the ratio is 0.69 : 1. Again the infant's larynx is smaller.

The epiglottis of the infant (Fig. 7a) is taller than the adult (Fig. 7b) relatively in the ratio of 1.38 : 1. In the posterior aspect, in order to derive accurate measurements, the inter-arytenoid muscles have been removed and measurements made from the upper border of the cricoid lamina to the tip of the arytenoid cartilage. Here the ratio is 1 : 1. In other words the heights are relatively the same.

On examining the gross morphology of the larynx from the posterior aspect it soon

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(a) (b)

FIG. 5

Photographs of the anterior aspect of the infant (a) and adult (b) larynx taken on a graticule to give equal image height.

became clear that what was assumed to be the tip of the corniculate cartilage of Santorini was in fact anterior and lateral to that structure. Dr. Backhouse postulated that these swellings could be the cuneiform cartilages of Wrisberg. Material was therefore taken and sectioned and examined histologically in order to identify the cuneiform cartilage and the results were difficult to interpret because there did not appear to be sufficient cartilage mass to produce such a swelling on the surface. However, undeterred by lack of success, it was decided to explore this mass and to extract the cartilage by dissection under magnification and then to have this sectioned histologically. I dissected out what appeared to be a piece of cartilage under ×6 magnification. Professor Michaels reported that there was no cartilage and that the specimen consisted only of hypertrophic glandular tissue.

I decided to dissect out an adult larynx to demonstrate the cuneiform cartilage and its relationship to the surrounding structures. As Grant had described it as a rod-shaped structure, I proceeded with circumspection and had almost convinced myself that this was one of the percentage of cases in which the cartilage was absent when I came across the cartilage lying on the anterior surface of the arytenoid (Fig. 8).

Viewed from the medial and the lateral aspect, it can be seen that the cartilage is not in fact 'rod-shaped' but wedge-shaped; as it should be with such a name. This dissection was repeated by Dr. Backhouse and confirmed in both a fixed and a fresh

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(a)



(b)

FIG. 6

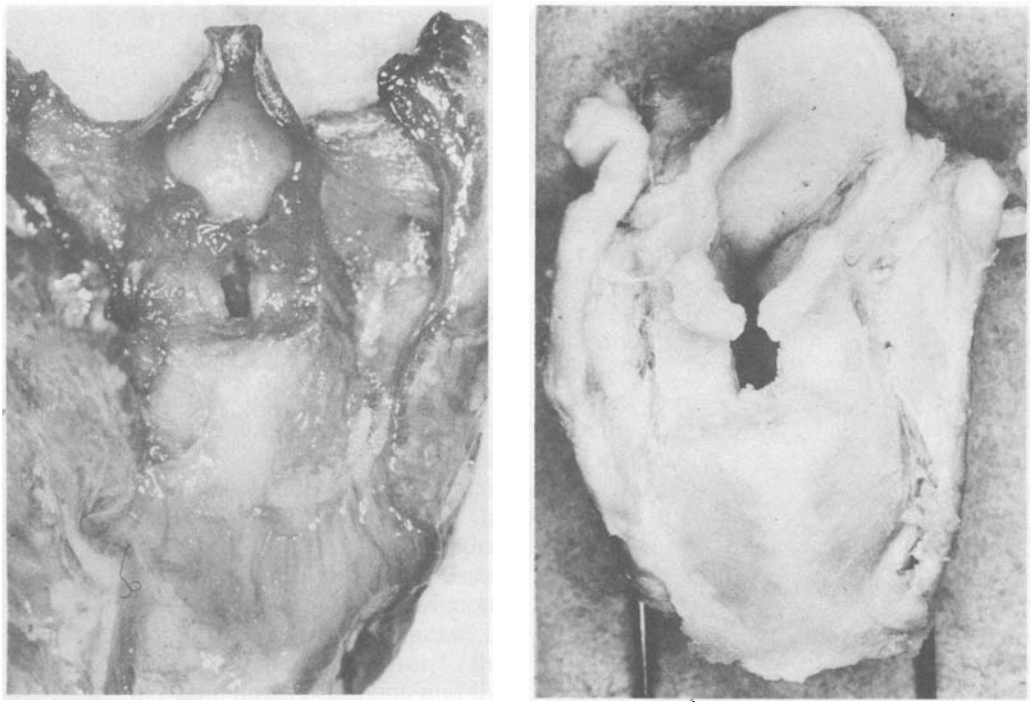
Photographs of sagittal sections of the infant (a) and adult (b) larynx taken on a graticule to give equal image height.

specimen. The question now arose as to when the cuneiform cartilage appeared and what part it played in the anatomy of the infant larynx. Sections of a 160 mm. foetus show no evidence of distinct cartilage. Sections of a fresh neonatal larynx do show a cartilage in the same relationship to the arytenoid which is found in the adult. Armed with this knowledge, I attempted to perform a better micro-dissection of the area of the anterior surface of the arytenoid in a neonate and I uncovered the cuneiform cartilage. It was different in shape and relatively larger in size than in the adult.

It was decided to attempt to produce a set of 'norms' for the various important structural distances. Eight were chosen. These were:

(a) The distance between the curled tips of the epiglottis.
(b) The distance between the cuneiform swellings.
(c) The height from the interarytenoid muscle to the tip of the epiglottis.
(d) The diameter of the lumen of the trachea in coronal section.
(e) The diameter of the trachea in sagittal section.
(f) The distance from the anterior surface of the larynx to the tip of the epiglottis.
(g) The distance from the anterior

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(a) (b)

FIG. 7

Photographs of the posterior aspect of the infant (a) and adult (b) larynx taken on a graticule to give equal image height.

surface of the larynx to the cuneiform swelling.

(h) The distance from the tip of the corniculate cartilage to the interarytenoid muscle.

The variations were small but then so were the number of larynges measured. The most constant findings were the dimensions of the trachea, and it is remarkable that there appears to be little increase in the dimensions of the trachea in the first year of life (Table I).

In the neonate the length of the vocal cord was measured and was found to be on average 4.75 mm. No attempt was made to measure the cricoid lumen because this had been done already by Toochung and Green (1974).

One very obvious difference in the infant was the size of the laryngeal saccule. The internal opening is relatively enormous and on horizontal section it is seen to be lined by secreting mucus glands which are many in number. Professor Harrison reports that glandular tissue above the glottis is a common finding in other animals. It is difficult to marry function to structure in this case.

Throughout the period of the examination of the gross anatomy, material was taken for histological examination. There is no guarantee that what is shown is normal histology, because these children have all died, and in many the terminal stages were complicated by respiratory inflammation. However, one must also weigh in the balance the length of life and therefore the length of time which has been available for pathological changes to have taken place.

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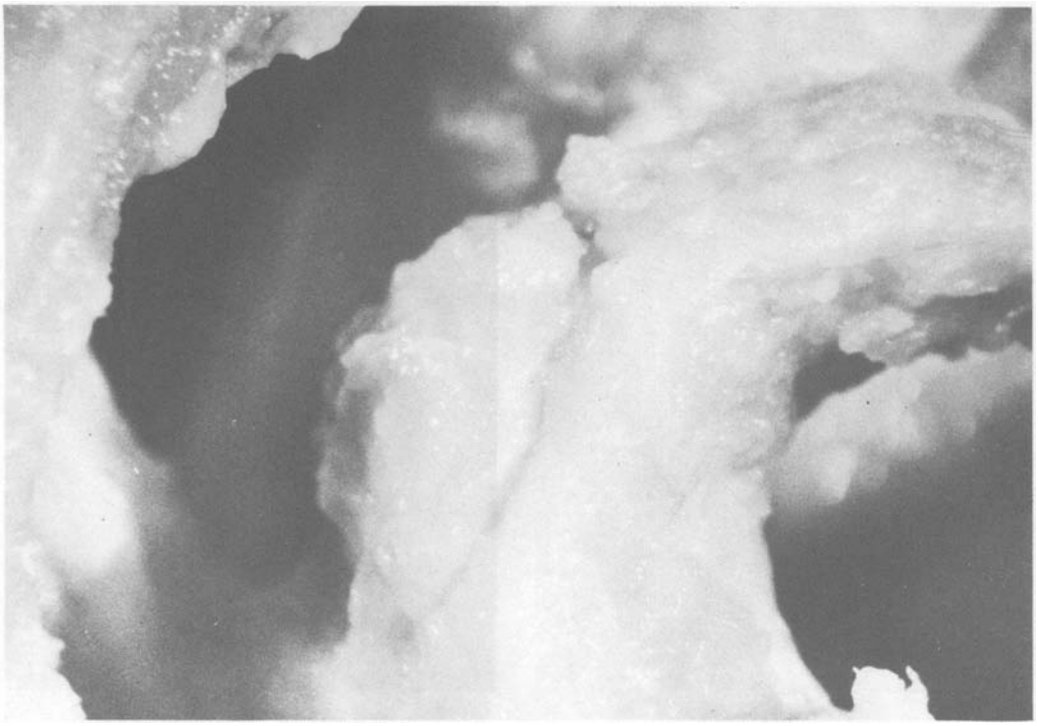


FIG. 8

Macrophotograph (×6) of a dissection of the adult cuneiform cartilage to demonstrate the relationship with the arytenoid cartilage (left side).

Some of the gross changes which we have seen have had little accompanying evidence of microscopic changes such as one would expect to see in association with trauma due to intubation or of inflammatory infiltration, and there would appear to have been too little time for the development of new histological patterns.

Much has been made of the musculature to be found in the region of the aryepiglottic folds and the vestibular bands. However, the overwhelming impression gained from magnifying glass inspection of the sections is of their glandular content. Adult larynges too show evidence of glandular tissue in the vestibular bands, but they are not nearly as

TABLE I

COLLATED MEASUREMENTS OF NINE SUBJECTS IN MILLIMETRES

Sex	♀	♀	♂	♀	♂	♀	♂	♀	♂
Age in days	1	8	180	320	42	35	49	16	16
A	2.0	2.5	4.8	3.9	3.6	4.4	4.3	3.7	3.7
B	3.8	0	2.5	2.5	2.7	1.8	2.1	0.5	3.2
C	7.7	9.3	13.6	12.1	13.5	10	9	9.3	12.3
D	5.4	4.8	6.0	5	6.1	5.2	4.0	6.3	3.9*
E	5	3.9	4.6	4.2	4.6	4	3.8	3.6	3.6
F	14	10	12.2	11	13.5	9	11.5	13.0	13.0
G	11	9	12.2	9.3	11.5	6.9	9.5	11	12.8
H					4.7	2.5	3.5	3.7	4.4

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active as they are in the child.

One very interesting aspect of the glandular drainage, is that a series of ducts pass at regular intervals under the mucosa and appear to keep the mucosa moist. Special staining for mucus confirms that these are neutral mucus-secreting glands and the secretion must therefore be somewhat glary. Such a mass of glandular tissue requires support and it is interesting to find that, in areas close to cartilage, tissue like protocartilage is thrown out in strands. Not all laryngeal mucosal glands drain on to the surface, of course. There is great activity to be seen in the glands draining into the saccule. Finally it is intriguing to note that the prominent 'rod-like' swelling, taken by many anatomists to be overlying the cuneiform cartilage, appears on section to be largely composed of glandular tissue similar to that described already. Mucous glands are, of course, always abundant in respiratory epithelium. However, the arrangement of the ducts is striking and the functional arrangement is obscure—more particularly when one remembers that the function of the larynx is primarily to protect the lower airway. The epithelium covering the larynx is of the respiratory type on the vestibular bands and the aryepiglottic folds. The anterior or upper side of the epiglottis is covered with squamous stratified epithelium, whereas the posterior or underside is covered by non-stratified respiratory epithelium. Further work is required in this area using the techniques described by Stell, Gregory and Watt (1972) in order to map the overall distribution.

It is now necessary to try to draw together the threads of this investigation and to indicate how the findings are interpreted.

Clearly the general morphology of the infant larynx differs from the adult. In addition we know that the site is different in that it lies higher in the neck and is tucked away underneath the tongue. Only after the first two years of extra-uterine life does the larynx assume its adult relationship to the cervical spine. Can any explanation be offered for this finding? On looking at the larynx from the anterior aspect it is obvious that the epiglottis is upright and curled. There are troughs anteriorly on either side of it down which fluid could travel. In addition, in the very young infant, a swelling of the soft tissue was present in the mid-line below the glottis on the lamina of the cricoid. This is certainly not present in the older child or the adult. It seems therefore that the function of this swelling is to ensure that the central part of the lumen of the hypopharynx is occluded during deglutition and in this way it ensures that the milk travels in the lateral food channels.

What can be said about the cuneiform swelling or rather the glandular tissue in the cuneiform area? In some species in which the distance between the arytenoid and the epiglottis is large the cartilage of Wrisberg (the cuneiform cartilage) is well developed. In adult man as we have shown the cuneiform cartilage is small, and although we have always managed to find it in dissection eventually, it does not contribute to the essential strengthening of the aryepiglottic fold. In the infant, however, it is relatively larger and somewhat fan-shaped and although thin it does go some way towards supporting the aryepiglottic folds. However, the area of the cuneiform glandular swelling is distended and does have the effect of increasing the height of the lateral wall of the larynx above the glottis. Since the tip of the epiglottis is curled the effect is to bring the aryepiglottic folds nearer to the mid-line and thus to widen the lateral food channels. This makes it more likely that the food will pass laterally and not spill over into the glottis. One has to concede that as yet no satisfactory explanation for the need of so much glandular tissue in this site exists and much more work is required both in human and comparative anatomy. The fact that this swelling continues into adult life means that this is something which has a definite function at all phases of existence.

This has still not answered the basic question as to why the larynx descends in early life. We know that mammals have an acute sense of smell and I have indicated already that the development of the epiglottis in mammals enhanced the efficiency of the

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olfactory apparatus by allowing the epiglottis to lie in the nasopharynx. In this way the animal could feed, breathe and smell at the same time. If, therefore, the infant's epiglottis lay in the nasopharynx one could argue that this was to assist the infant's sense of smell. If that is so, then how can it be reconciled with the frequently repeated statement that man is a 'microsomatic' animal?

Several people have interested themselves in the development of the base of the skull and in the descent of the larynx, notably Symington (1885), Negus (1949) and Roche and Bzrkla (1965). From them we learn that in amphibians and reptiles the larynx opens directly into the oral cavity below the pharynx which is merely a posterior extension of the oral cavity. In certain mammals and in the human infant the larynx can be elevated so that its epiglottis slides up behind the soft palate to lie locked in the nasopharynx. Thus with the posterior edge of the soft palate embracing the epiglottis and aryepiglottic folds a tight seal is made between the oro- and naso-pharynx and this enables respiration to continue while suckling takes place. Crelin (1973, 1976) shows a picture of the epiglottis tucked up behind the velum palati. This possibility had occurred to Ardran and his colleagues (1958, 1966, 1967, 1968) in Oxford some years earlier. In 1958 they published a study of bottle feeding in infants in which they showed that respiration was interrupted by deglutition but that even so the airway could remain open while the food passed down the lateral food channels. In a second study on the mechanisms of the larynx published in 1967, they reviewed the previous work on deglutition and breathing, and in this paper they point out that distinguished laryngologists, such as Pressman of Los Angeles, have not challenged Negus's view that the epiglottis was an organ designed to assist olfaction and that it was vestigial in man. Ardran and his co-worker Kemp (1968) noted too that in quiet respiration the vestibular bands did not obtrude on to the glottic pathway and that the vocal folds were turned upwards and outwards.

During swallowing the arytenoids tilt forwards, downwards and inwards, and this approximated the vestibular bands and the vocal folds. By this time (Ardran and Kemp, 1966–1967) the 'safety regulations' with regard to irradiation had become more stringent and children were not included in the study.

The question of whether breathing could continue during deglutition in infants was being pursued in the United States and in 1981 Wilson and others investigated the possibility of recording 'swallow breaths' in order to carry Crelin's hypothesis further. However, in all the infants they examined they found an interruption of the respiratory flow associated with 'non-feeding' swallows, and they state that the pattern in infants differs in no way from the pattern seen in adult man swallowing a bolus.

The larynx at this stage therefore is adapted in form to correspond to the requirements for the herbivore where there is a continual stream of fluid and solids down the lateral food channels.

Is there any evidence from the study of the infant larynx that the epiglottis does have a more important function that it does in the adult? In this connection it is perhaps pertinent to repeat the observation that the epiglottis is proportionately larger in the infant, in the ratio of 1.38 : 1. Furthermore it stands upright and it is curled, so that it could fit well into the lower part of the nasopharynx. If it was possible to demonstrate that in the infant the sense of smell was more important than it is in the adult this would certainly support the need for the larynx to lie higher in the neck and for the epiglottis to be longer than it is in the mature animal.

In 1975 McFarlane, working in the Department of Experimental Psychology at Oxford, investigated olfactory perception in the human neonate. He reported that in the first two days of life the neonate was unable to locate a food source by using his sense of smell. By five days a statistically significant number of babies spent more time turning to their mother's breast pad than to a clean unused pad. By six days the baby could

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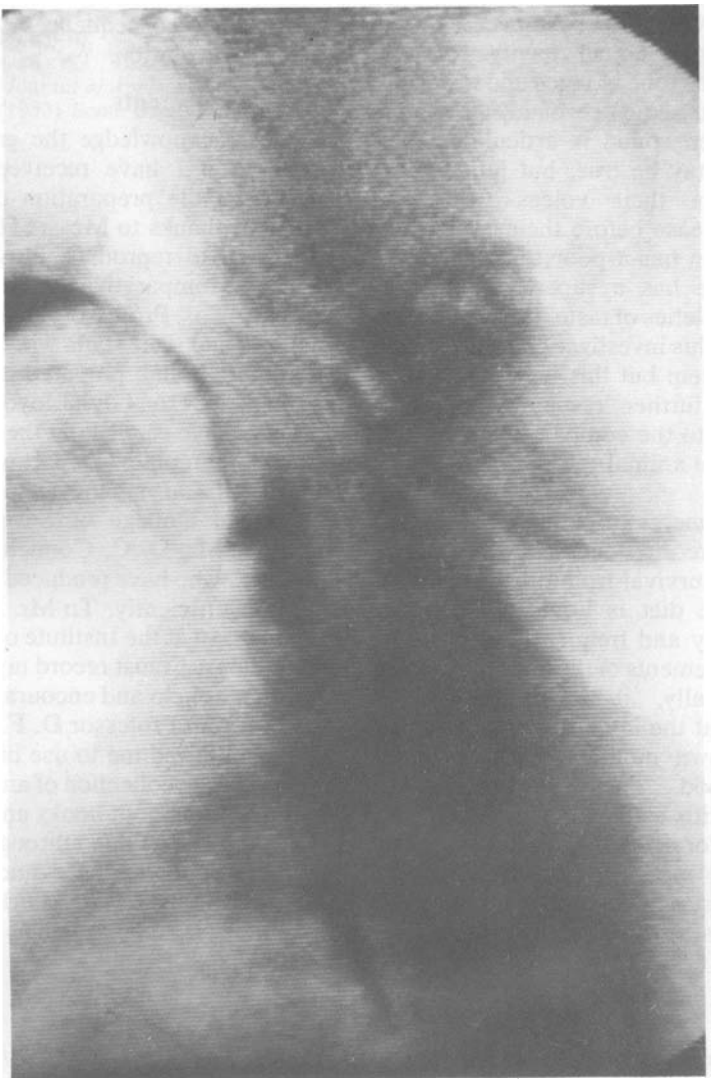


FIG. 9

Frame from a cineradiograph of a swallow in the neonate showing that the epiglottis is lying in the naso-pharynx.

distinguish between its own mother's breast pad and that of another nursing mother by the use of the sense of smell. Adults were unable to distinguish by the use of the sense of smell even between a clean and a used pad.

There seem to be conflicting opinions as to whether the epiglottis does or does not lie temporarily in the nasopharynx in infancy (Fig. 9) shows that it does. There appears to be clear evidence that the infant does rely upon the sense of smell to locate its food source.

The question which remains to be answered is: why is it necessary for the larynx to descend? Laryngeal descent is at its greatest in man. It would certainly appear to be better protected if it were to remain tucked away under the base of the tongue.

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One view is that descent is necessary to provide a large enough cavity for the modulation of the tone of voice and to permit the complicated sequence of events which take place when sound is articulated into speech. This may be true, but infants can often modulate their voices well and articulate with ease before their larynx has descended. Man has a poor sense of smell but perhaps he has a superior ability to distinguish subtleties of taste. It has not been the purpose of this investigation to shed light upon this problem but this is a field which would repay further research alongside further work into the comparative anatomy of the immature animal.

What does emerge from this investigation is that immature man does not differ in the design for his survival from other immature mammals. The diet is liquid. It must be ingested rapidly and frequently in order to meet the requirements of the basal metabolic rate. Biologically, it is of paramount importance that the immature mammal can identify it's own mother as it's essential source of food. The sophistication of modern life with artificial baby foods and chemical deodorants tends to obfuscate our perceptions in more ways than one. It is therefore reassuring to find that, after all, we have not escaped and indeed we cannot escape the consequences of our own biological evolution.

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