The laryngeal saccule

By J. E. DELAHUNTY (Oxford)[1] and J. CHERRY[2]

Introduction

THE first detailed description of the laryngeal saccule was given by Hilton in 1837. Surprisingly little has been written on the saccule since that time, presumably because of its concealed situation and alleged insignificance. The structure of this poorly understood component of the larynx is essentially that of a blind pouch of mucous membrane, columnar ciliated in type. This pouch ascends from the anterior third of the roof of the ventricle, between the false cord and inner surface of the thyroid ala. The saccule is contained within the loose areolar tissue of the pre-epiglottic space and is invested throughout with an abundance of mucous glands, some sixty to seventy in number. This marked glandular element has suggested the only proposed and accepted function of the human saccule—to provide the true vocal cords with lubricating mucous. Pressman (1942) using motion picture studies, observed the ejection of mucous from the saccule, simultaneously with adduction of the vocal cords. Slips of thyroepiglottic and aryepiglottic muscle fibres envelope the summit of the saccule and presumably exert compression during deglutition and phonation, the so called compressor sacculi laryngis of Hilton.

The human saccule appears as an outpouching of the laryngeal cavity towards the end of the second month of intrauterine development. It is relatively larger in early life, but lags behind laryngeal growth from the sixth year. Negus (1949) claims this to be supportive evidence of its one time importance and present lack of use. He suggests that the saccule in man is the vestigial homologue of the ventricular air sac in anthropoids, the function of these sacs being respiratory, directed towards the re-breathing of air.

Investigation

Serial coronal sections of the whole larynx were studied. The processing technique used in the preparation of the laryngeal specimens was that devised by Broyles and Guild and described by Tucker (1961). Serial

[1] William A. Fisher Fellow, Division of Laryngology and Otology, The Johns Hopkins University School of Medicine, Baltimore.

[2] Associate Professor, Laryngology and Otology, Johns Hopkins Hospital, presently, Professor and Chairman of Otolaryngology, Vanderbilt University.

https://doi.org/10.1017/S0022215100070985 Published online by Cambridge University Press

coronal sections were cut at a thickness of 26 microns, a total of approximately 1,600 sections being obtained from each adult larynx. Every fortieth section was stained with haematoxylin and eosin and mounted. The remaining sections were stored, unstained, in 80 per cent alcohol, these being available for histological examination as required. In this way, a three dimensional antero-posterior reconstruction of the larynx was possible.

In infants, the relatively larger dimensions of the saccule were readily apparent, and in most cases, reached to, or above, the superior margin of the thyroid ala. The first interesting feature to be noted was the complexity of the mucosal lining. This varied from an exaggerated rugose pattern, to frank villiform projections (Fig. 1). Infants, more than 3 months of age, exhibited a considerable amount of lymphoid tissue present in the submucosa of the saccule. This tissue was present as (a) lymphocytic infiltration being the simplest form, and (b) discrete lymphoid follicles. The lymphoid element was usually abundant in the mucosal projections (Figs. 2 and 3) and when dense infiltrate or frank follicles existed, the projections were converted into a more spherical configuration.

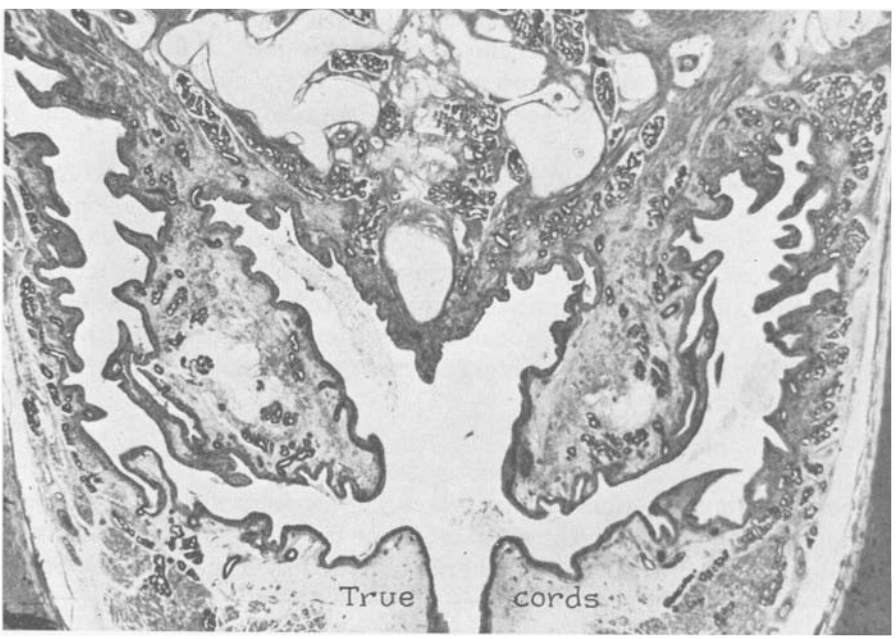


FIG. 1.
Laryngeal saccule of newborn. Note complexity of mucosal lining.

https://doi.org/10.1017/S0022215100070985 Published online by Cambridge University Press

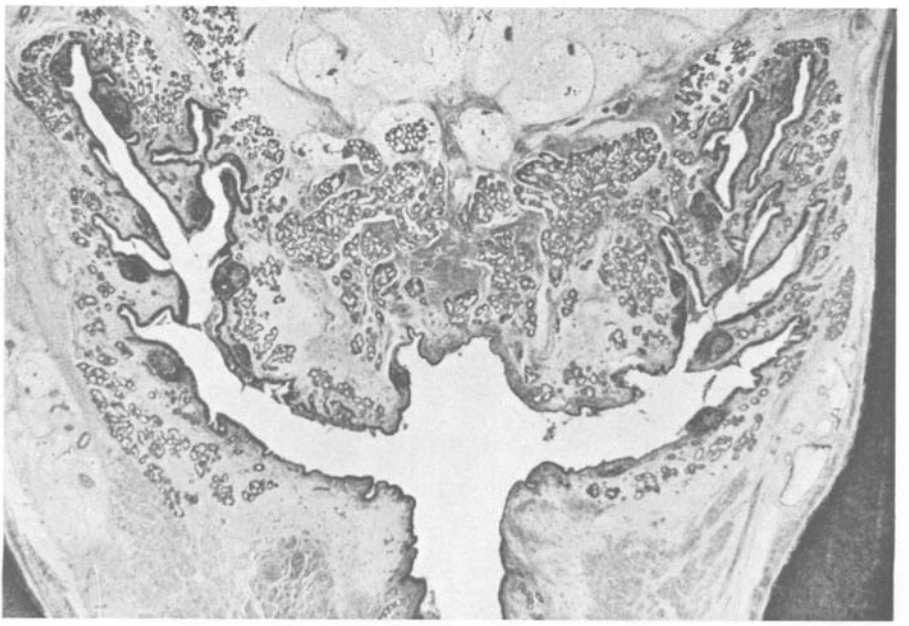


FIG. 2.
Saccule of 9-month infant, showing mucosal projections containing lymphoid follicles.

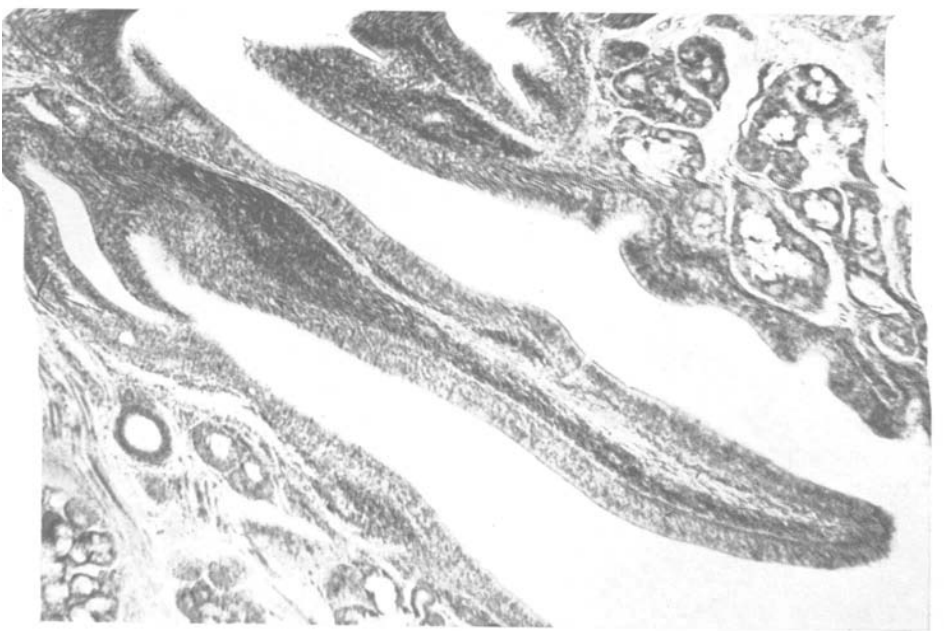


FIG. 3.
Mucosal projection in saccule of 10-month infant. Note lymphocytic content of submucosa.

https://doi.org/10.1017/S0022215100070985 Published online by Cambridge University Press

In the adult larynx, the saccule varied considerably in size and shape. Certain contrasts were apparent between the infant and adult saccule. In the adult, the mucosal lining was usually much less complex, although in some instances the infantile configuration persisted (Fig. 4). Moreover, the normal adult saccule was virtually devoid of lymphoid tissue. Malignant larynges, however, frequently showed a saccular lymphoid hyperplasia, similar to that present in infants. The hyperplasia was sometimes more marked on the side opposite the carcinoma (Fig. 5). Lymphoid reaction of the saccule was almost inevitably accompanied by a similar response of the ventricular submucosa, but this was usually much less prolific.



FIG. 4.
Saccule of malignant adult larynx. The central core of villiform-like projections is packed with lymphocytes.

https://doi.org/10.1017/S0022215100070985 Published online by Cambridge University Press

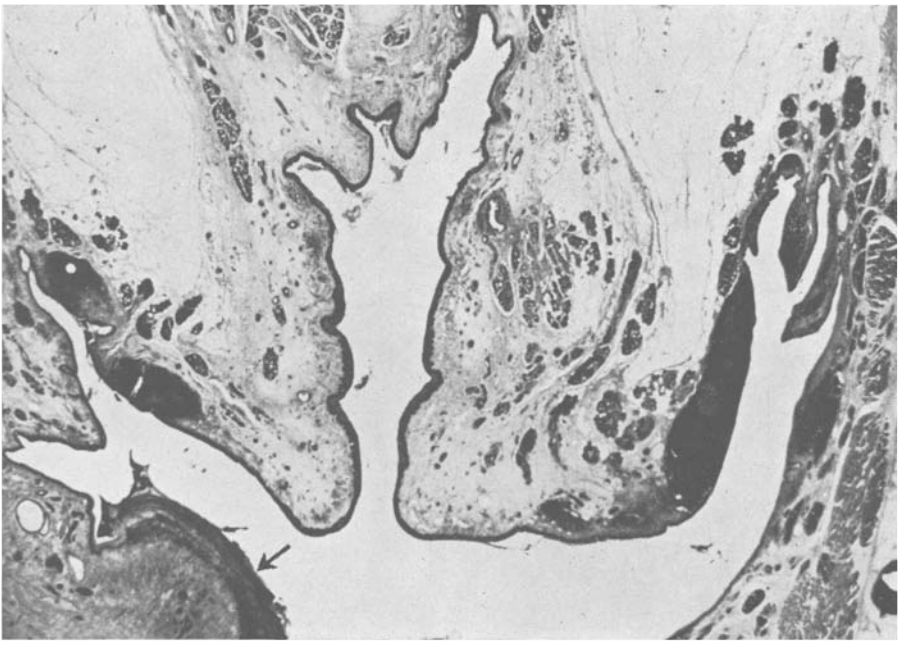


FIG. 5.
Carcinoma of true cord (arrow). Note marked lymphoid reactive hyperplasia in both saccules.

Five malignant larynges that had undergone pre-operative radiotherapy showed little in the way of lymphoid tissue, illustrating the susceptibility of this tissue to irradiation. A specimen that exhibited diffuse bilateral leukoplakia with atypia and one small focus of invasive carcinoma, had considerable lymphoid hyperplasia in both saccules (Fig. 6). A similar lymphoid reaction was apparent in another specimen of bilateral leukoplakia with atypia, without evidence of an invasive lesion (Fig. 7). In these latter sections, there was evidence of submucosal non-specific inflammatory infiltrate, which appeared distinct from, and unrelated to, the lymphoid follicles.

A specimen containing bilateral laryngocoeles and supraglottic carcinoma showed invasion of one of the enlarged saccules. This saccule had undergone a generalized intense submucosal lymphoid hyperplasia and carcinomatous cells were seen permeating the channels of the obviously rich lymphatic plexus of the saccular submucosa (Fig. 8). Such invasion in this instance had resulted in the neoplasm escaping from the endolaryngeal confines.

In an attempt to map the submucosal lymphatic channels of the ventricle and saccule, 0·1 c.c. of indian ink was injected into the anterior third of the true cord in two dogs. The animals were sacrificed 4 days later

https://doi.org/10.1017/S0022215100070985 Published online by Cambridge University Press

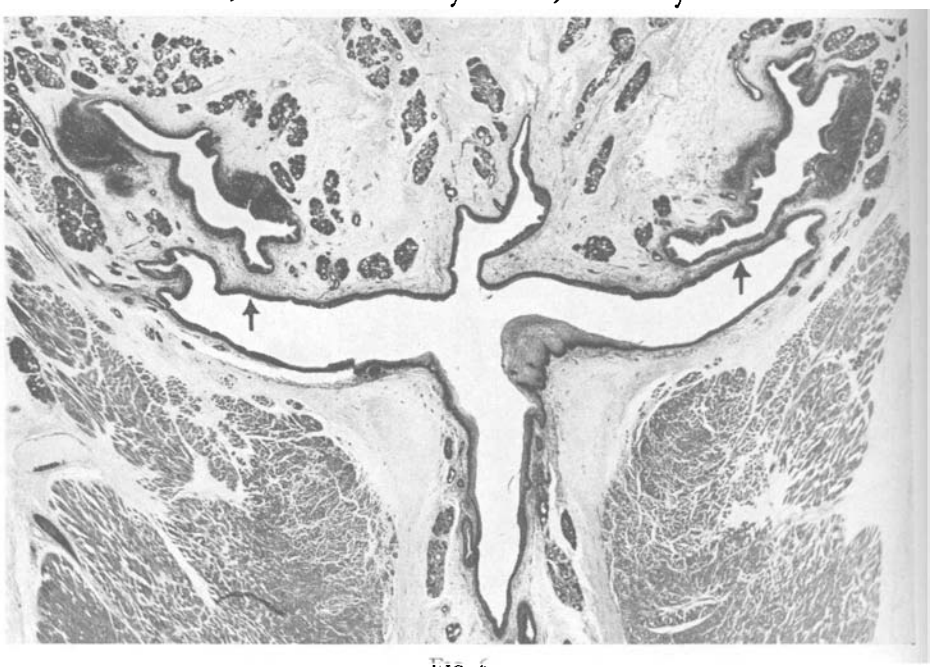


FIG. 6.

Leukoplakia with small focus of invasive carcinoma (not seen here). Note lymphoid follicle formation and ventriculo-saccular folds (arrows).

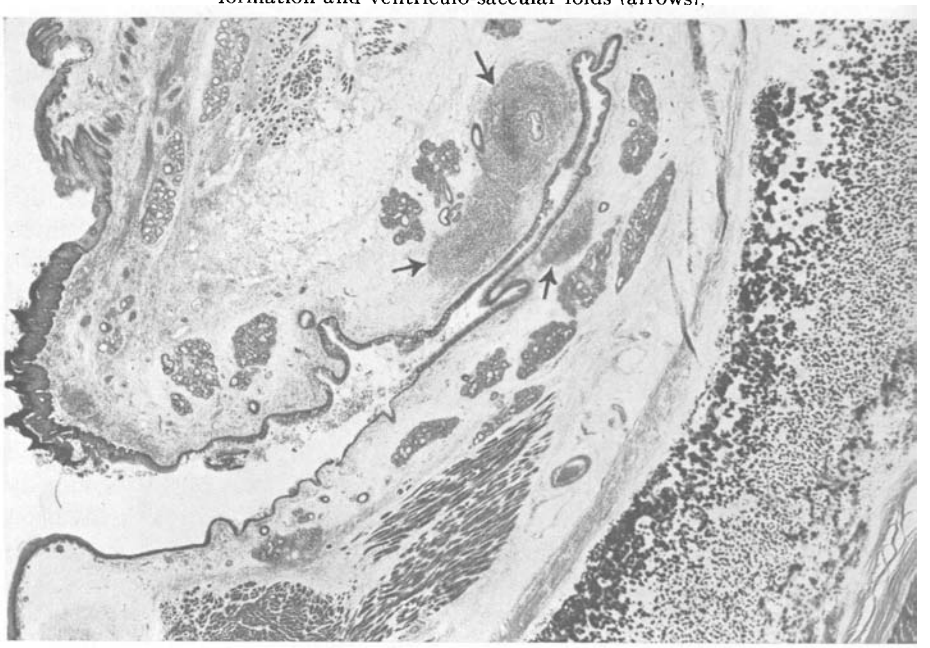


FIG. 7.

Leukoplakia. Note lymphoid reaction in saccule (arrows).

https://doi.org/10.1017/S0022215100070985 Published online by Cambridge University Press



FIG. 8.
Carcinoma involving saccule. Note submucosal lymphatic permeation with intense lymphoid reaction.

and the larynges coronally sectioned. The majority of the indian ink was seen to have drained inferiorly, through the cricothyroid membrane. Some, however, had been absorbed into the lymphatics of the ventricular submucosa and was draining up and into the saccular plexus (Fig. 9).

Sections of infant and malignant adult larynges, at the plane of the anterior commissure, frequently showed an unbroken, circumferential, submucosal, lymphocytic infiltration with periodic aggregation into foci.

This extended from the anterior commissure inferiorly, to the fused false cords, superiorly (Fig. 10). In those larynges which exhibited saccular lymphoid hyperplasia, this submucosal infiltrate was almost invariable and was usually richest in the fused false cords, being less evident in the exact midline of the anterior commissure.

The presence of this submucosal lymphoid tissue raises the question of contralateral lymphatic communication. Pressman *et al.* (1960) described the larynx as being a highly compartmentalized organ, the submucosal lymphatics of each hemilarynx forming an independent network with little or no intercommunication between the two sides. Welsh *et al.* (1962 and 1963) did not support the concept of a midline barrier against endolaryngeal lymphatic spread and presented findings to the contrary. The anterior commissure, in their opinion, comprised the only barrier to contralateral submucosal spread.

https://doi.org/10.1017/S0022215100070985 Published online by Cambridge University Press



FIG. 9.
Dog saccule (note squamous epithelial lining). Indian ink (arrow) has tracked superiorly in submucosal lymphatics from ventricle into saccule. Lymphoid follicle present.

The middle third of one vocal cord of a dog, was injected with 0·8 c.c. of teflon-glycerine paste, particle size 50–100 microns. Two years later, the animal was sacrificed and the larynx coronally sectioned. The sections were studied microscopically through crossed polarizers, the teflon particles being birefringent. At the plane of the anterior commissure, particles were seen to have undergone contralateral lymphatic migration. This was clearly evident in the subepithelial lymphatics of the fused false cords (Fig. 11). Less frequently, particles were identified in the deeper lymphatics of the anterior commissure, on both sides of the midline.

https://doi.org/10.1017/S0022215100070985 Published online by Cambridge University Press

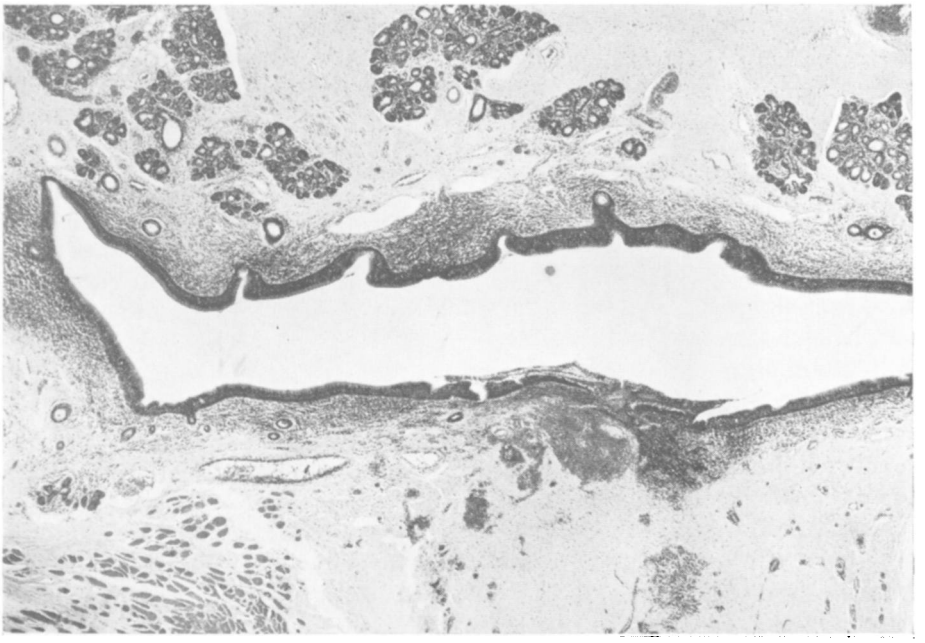


FIG. 10.

Anterior commissure inferiorly (note biopsy site) and fused false cords superiorly, showing circumferential, submucosal, lymphocytic infiltrate.

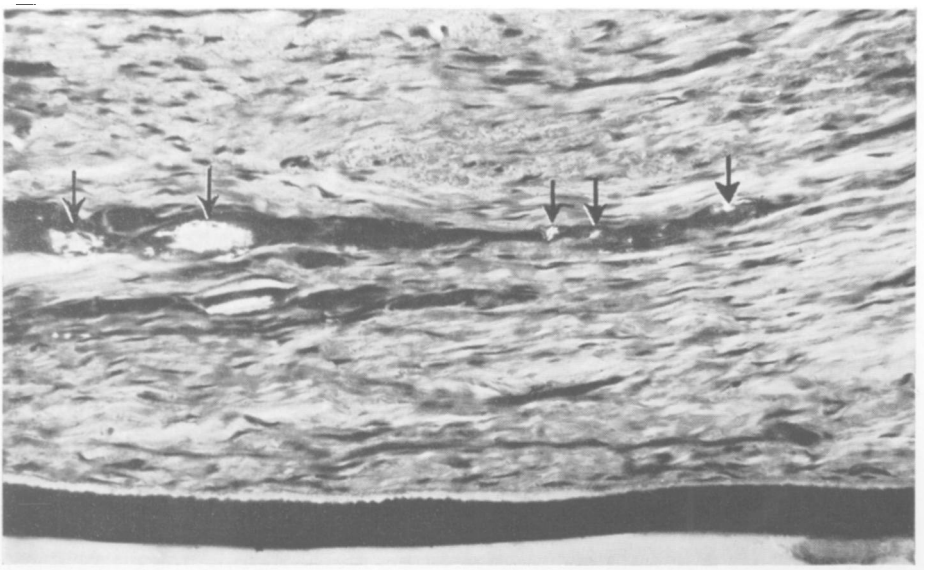


FIG. 11.

Teflon particles (arrows) in submucosal lymphatics of fused false cords.

https://doi.org/10.1017/S0022215100070985 Published online by Cambridge University Press

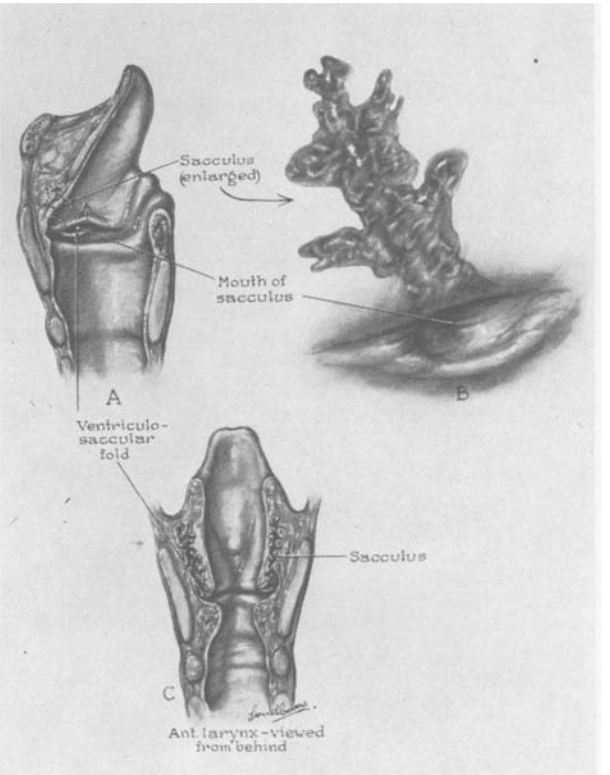


FIG. 12.
Diagrammatic representation of infant saccule.

Discussion

The histological appearance of the laryngeal saccule, as seen in coronal section, would demonstrate two features of possible significance. Firstly, the almost villiform mucosal pattern, which obviously increases the mucosal surface area, and secondly, the marked lymphatic potential of the saccule which declares itself in normal infancy and some forms of laryngeal pathology. Shattock (1919) referred to the conspicuous amount of lymphatic tissue present in the submucosa of the ventricle and queried the pathological significance. Freedman (1938) commented on the rich endowment of the ventricle and saccule with lymphoid tissue, and seemed to imply this might be due to these recesses being 'blind and stagnant'.

Evidence of saccular lymphoid hyperplasia in the infant of more than 3 months of age and, therefore, no longer protected by maternal antibodies, would suggest a normal immune response mechanism. As age increases, the lymphoid element of the saccule would appear to regress, so that in the normal adult larynx, it is practically non-existent. Laryngeal disease,

https://doi.org/10.1017/S0022215100070985 Published online by Cambridge University Press

such as malignancy, promotes a renewed activity of the lymphoid potential, the mechanism involved, presumably, being that of reactive hyperplasia with possible immunological significance (Crile, 1965). Leukoplakia, with its premalignant implication, would appear to induce a similar lymphoid hyperplasia, seemingly unrelated to the round cell infiltrate of non-specific inflammatory response. The role of this lymphoid tissue as a laryngeal defence mechanism is, no doubt, a point of controversy. Should this submucosal area become invaded by cancer, it constitutes a ready pathway for dissemination. Tucker (1961) comments on a laryngeal specimen in which the region normally occupied by the saccule had been replaced by carcinoma. The saccular outline in this case still existed and it seems highly probable a perisaccular submucosal lymphatic infiltration occurred.

It would, therefore, seem apparent that larynges possessing large saccules would predispose to rapid submucosal spread from endolaryngeal to extralaryngeal areas, namely, the pyriform fossa and vallecula. The saccule, as it is contained within the pre-epiglottic space, affords a ready path of access to this space, with its sinister potential for bilateral metastases. Indeed, it may be the richly endowed lymphatic system of the saccules that comprises the lymphatic abundance attributed to the pre-epiglottic space. As the submucosal lymphatics of the ventricle and saccule are obviously part of the same network, the possibility of invasion of the pre-epiglottic space by a carcinoma which has involved the ventricle, would seem apparent.

The saccular lymphoid tissue can doubtlessly be involved in laryngitis and conceivably become chronically and irreversibly infected in the same manner as may the pharyngeal tonsils. This could then contribute to a persistence or recurrence of laryngitis, the saccule acting as a hidden source of re-infection, the possibility of which has been suggested by Broyles (1959). The villiform-like projections of the saccular mucosa, with their capacity for intense lymphatic response, may become enlarged and even pedunculated through lymphocytic infiltrate or follicle formation. The saccular compression caused by deglutition and phonation may then conceivably initiate a process of eversion.

Observations made in the coronal plane of the anterior commissure would suggest this region may be a critical focus for the contralateral lymphatic dissemination of cancer. In larynges exhibiting lymphoid reactive hyperplasia, the presence of a circumferential ring of submucosal, lymphocytic infiltrate which involves the fused false cords superiorly, and the anterior commissure inferiorly, would imply a continuous, submucosal, lymphatic plexus. The impressions of Rüedi (1959) that the anterior commissure region possessed a poor lymphatic element, are not supported by the above findings. Coronal sections of the dog larynx containing a unilateral true cord depot of teflon showed evidence of contralateral

https://doi.org/10.1017/S0022215100070985 Published online by Cambridge University Press

lymphatic dissemination of small particles at the plane of the anterior commissure. The pathway of predilection was the subepithelial lymphatic channels of the fused false cords.

The orifice of the saccule was described by Hilton as guarded by two crescentic folds of mucous membrane, placed anteriorly and posteriorly, the presumed purpose being that of breaking the stream of mucus, giving it a general diffusion over the true cord surface. Moore (1922) felt the description of these folds did not consistently apply and that variation in development existed. In this current study, the orifice of the saccule was invariably found to be guarded by an anterior crescentic fold of mucous membrane, passing from the false cord to the lateral wall of the saccule (Figs. 6 and 12). Evidence of a posterior fold was lacking. The ventriculo-saccular fold probably serves to help store the mucus and direct it posteromedially.

Conclusion

1. Coronal total organ sections of the larynx have illustrated the rich submucosal lymphatic system of the laryngeal saccule. The pathological and possible immunological implications of this are emphasized.

2. At the anterior extent of the larynx, it would appear the site of fusion of both true cords inferiorly and both false cords superiorly, comprises an area that is circumferentially enveloped by submucosal lymphatics. This area may constitute a focus for the contralateral lymphatic spread of cancer, the pathway of predilection being superiorly across the fused false cords.

Acknowledgements

We wish to thank Dr. T. H. Burrows, Division of Otolaryngology, Johns Hopkins Hospital, for his assistance in providing the teflon injected dog larynx.

REFERENCES AND BIBLIOGRAPHY

Broyles, E. N. (1959) *Ann. Otol. (St. Louis)*, **68,** 461.
Crile, G. Jr. (1965) *Surg. Gynec. Obstet.*, **120,** 975.
Freedman, A. O. (1938) *Arch. Otolaryng.*, **28,** 329.
Hilton, J. (1837) *Guy's Hosp. Rep.*, **2,** 519.
Moore, I. (1922) *J. Laryng.*, **37,** 265, 333 and 381.
Negus, V. E. (1949) *The comparative anatomy and physiology of the larynx*. London.
Pressman, J. J. (1942) *Arch. Otolaryng.*, **35,** 355.
———, Simon, M. B., and Monell, C. (1960) *Trans. Amer. Acad. Ophthal. Otolaryng.*, **64,** 628.
Rüedi, L. (1959) *J. Laryng.*, **73,** 1.
Shattock, S. G. (1919) *Proc. roy. Soc. Med. (Sect. Laryng.)*, **12,** 201.
Tucker, G. F., Jr. (1961) *Ann. Otol. (St. Louis)*, **70,** 910.

https://doi.org/10.1017/S0022215100070985 Published online by Cambridge University Press

The laryngeal saccule

WELSH, L. W., and WELSH, J. J. (1963) *Trans. Amer. Acad. Ophthal. Otolaryng.*, **67**, 524.
———, ———, and BEHLKE, F. M. (1962) *Ann. Otol. (St. Louis)*, **71**, 913.

Department of Otolaryngology,
The Radcliffe Infirmary,
Oxford.

https://doi.org/10.1017/S0022215100070985 Published online by Cambridge University Press

https://doi.org/10.1017/S0022215100070985 Published online by Cambridge University Press