*The Journal of Laryngology & Otology (2007), **121**, 468–471.*

doi:10.1017/S0022215106004415
Printed in the United Kingdom
First published online 20 November 2006

Main Article

Comparative study of palatine tonsil histology in mammals, with special reference to tonsillar salivary glands

Kamal G Effat, Makram Milad*

Abstract

The authors studied the histology of palatine tonsils from various mammals. Special reference was made to tonsillar salivary glands, which are usually rudimentary in humans. Tonsillar salivary glands were a prominent feature in all categories of mammals studied, apart from humans. As far as the authors were aware, no previous study had focussed on tonsillar salivary glands in mammals. The putative physiological implications are discussed.

Key words: Palatine Tonsils; Histology; Salivary Glands; Mammals

Introduction

The palatine tonsils represent a typical mammalian organ, which is absent in rodents only.[1] Under the surface epithelium of human palatine tonsil, the lymphoid tissue contains lymphoid follicles, usually with germinal centres.[2] This lymphoid tissue is part of the mucosa-associated lymphoid tissue which contributes both inductive and effector components to mucosal immunity.[3] Immunohistochemical studies have revealed that different types of antigen-presenting cells are necessary for processing ingested and inhaled antigens.[4] The human tonsil is polycryptic. From electron microscopic studies, it has been estimated that a large area of cryptic epithelium (about 295 cm^2 per tonsil)[5] is composed of specialised reticulated M cells that ensure direct delivery of antigens to the lymphoid cells.[6] Human palatine tonsils, therefore, have no afferent lymphatics.[7]

The tonsils of mammals have been described with reference to crypt number and morphology.[1,8] According to the evolutionary hypothesis, the second branchial pouch gives rise to salivary glands in birds. Over the evolutionary course of mammals, the glands have been progressively shifted aside by lymphoid tissue, so that their ducts finally open outside the organ.[1] The lymphoid tissue architecture in various mammals has also been studied.[9] In humans, minor salivary glands may be found at the superior pole of the tonsil (Weber's glands) and at the tonsillar pillars.[10] As far as the authors are aware, no formal description of the distribution of salivary glands in the palatine tonsils of mammals has been previously reported.

The aim of this work was to dissect palatine tonsils from representative samples of various mammals and to describe the distribution of tonsillar salivary glands. We also aimed to generate a hypothesis regarding relevant physiological implications.

Materials and methods

The mammals studied were taken from the Veterinary College of Cairo University, after approval by the ethical committee. These animals were all young adults aged between one and two years. The animals were sacrificed and the heads bisected in the sagittal plane until the oral cavity and pharynx were exposed. The tonsils were dissected out from behind the palatoglossal folds and immediately placed in a 10 per cent formalin solution. The specimens were embedded, sliced and stained with haematoxylin and eosin. The slides were examined under a light microscope.

The animals studied were a cow, a camel, a sheep, a pig, a dog, a rabbit, a cat and a hamster. In addition, human tonsils from a patient with obstructive sleep apnoea were examined histologically. Special reference was made to salivary glands related to the tonsils. Crypt appearance and lymphoid tissue distribution were also noted.

Results

The hamster tonsil showed no lymphoid tissue organisation behind the palatoglossal folds. This is in accordance with previous reports.[1,8]

The cow tonsil showed a few large crypts. Under the surface epithelium and crypt epithelium, many

From the Department of Otolaryngology, El-Sahel Teaching Hospital, Cairo, and the *Pathology Department, Faculty of Medicine, Cairo University, Egypt.
Accepted for publication: 31 August 2006.

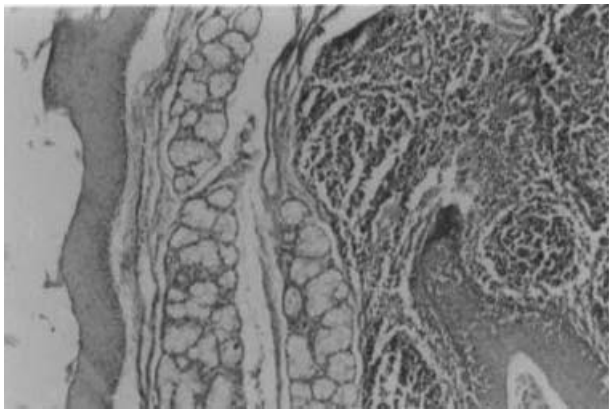

FIG. 1
Tonsil of cow showing salivary tissue deep to surface epithelium (H&E; ×40).

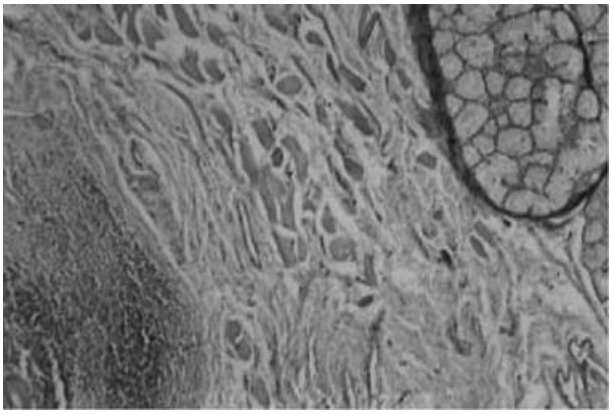

FIG. 3
Tonsil of camel showing salivary tissue deep to muscle (H&E; ×40).

lobules of salivary glands were present. Deeper to the salivary glands, this tonsil contained many large, back-to-back lymphoid follicles (Figure 1).

The sheep tonsil showed a few short crypts. The underlying lymphoid tissue contained few lymphoid follicles. An excess of salivary tissue was found under the epithelium and deep to the lymphoid tissue (Figure 2).

The camel tonsil showed a few short, wide crypts. The lymphoid tissue was composed of large lymphoid follicles. Salivary glands were present deep to the pharyngeal muscle (Figure 3).

The pig tonsil had a thin covering of mucosa with no crypts. Under the mucosa, there was a thick layer of lymphoid tissue composed of numerous lymphoid follicles. Excess salivary tissue was found deep to the lymphoid tissue and in between groups of muscle fibres (Figure 4).

The rabbit tonsil showed only one deep crypt lined by a few layers of epithelial cells and surrounded by a cuff of lymphocytes containing a few lymphoid follicles. A thick layer of salivary glands was found deep to the lymphoid tissue (Figure 5).

The dog tonsil showed many deep crypts. The epithelial lining of these crypts showed focal infiltration by lymphocytes. Many lobules of salivary glands were found at the surface and in the middle of the tonsil (Figure 6).

The cat tonsil revealed only one deep crypt surrounded by lymphoid tissue containing few lymphoid follicles. Salivary tissue was found deep to the lymphoid tissue (Figure 7).

The human tonsil showed a chronic inflammatory cell infiltrate, but there were no salivary glands related to the tonsil.

Discussion

Saliva is involved in a number of important bodily functions, including digestion of food by enzymatic cleavage, lubrication of the oral cavity and mediation of taste. Saliva also acts as an acid buffer, mechanical debriding agent, immunoglobulin secreter and oral cavity cleanser.[11] In mammals other than humans, sweat glands are not abundant; in these animals, thermal panting increases evaporative cooling when the animal is faced with a high ambient temperature. In addition, some mammals exposed to high temperatures salivate copiously and spread the saliva over themselves.[12] Thus, the tonsillar salivary

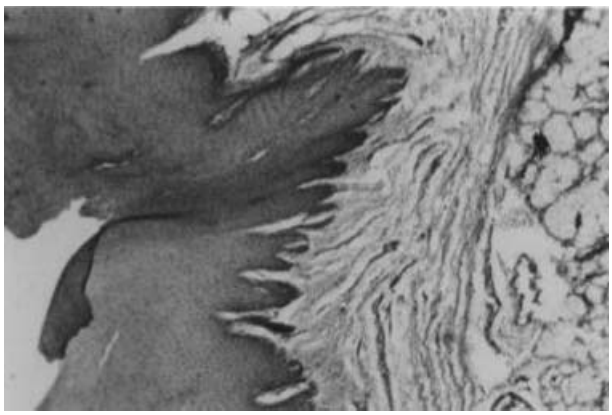

FIG. 2
Tonsil of sheep showing salivary tissue deep to surface epithelium (H&E; ×40).

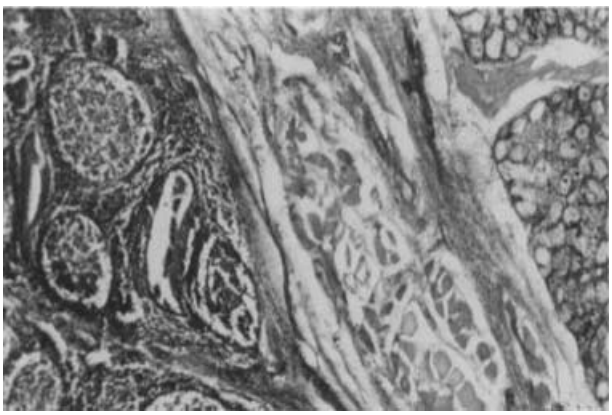

FIG. 4
Tonsil of pig showing salivary tissue in between muscle groups (H&E; ×40).

https://doi.org/10.1017/S0022215106004415 Published online by Cambridge University Press

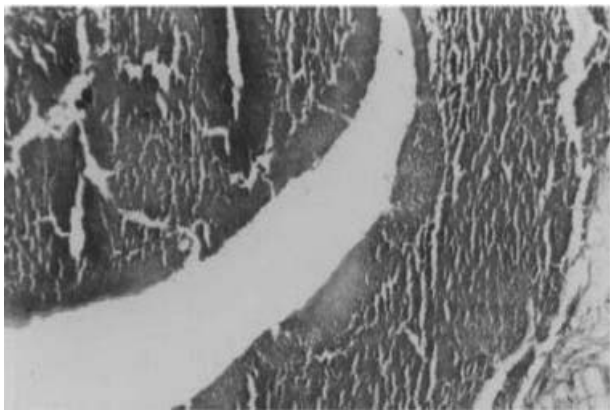

FIG. 5
Tonsil of rabbit showing one deep crypt and salivary tissue deep to lymphoid tissue (H&E; ×40).

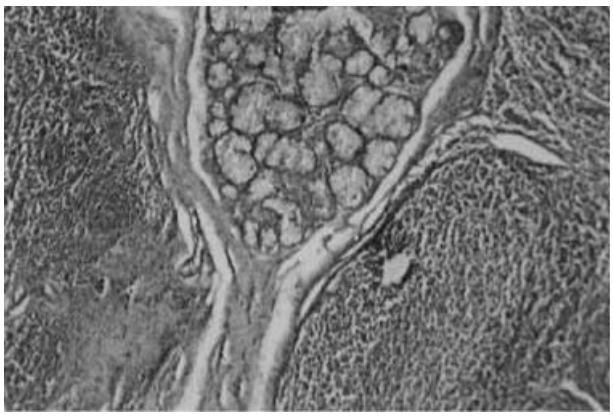

FIG. 6
Tonsil of dog showing salivary tissue in the middle of the tonsil (H&E; ×40).

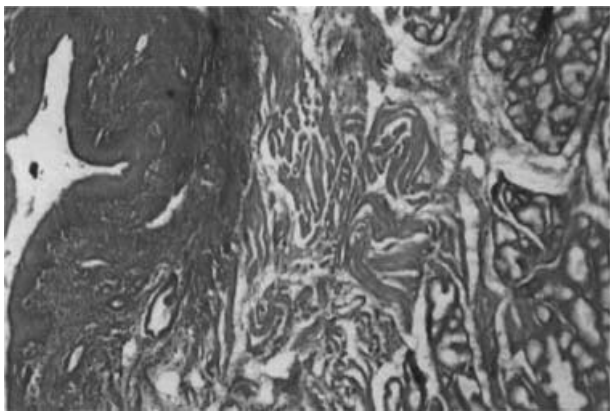

FIG. 7
Tonsil of cat showing one deep crypt and salivary tissue deep to lymphoid tissue (H&E; ×40).

glands in various mammals may augment the production of saliva necessary for relevant physiological functions. On the other hand, the tonsil in humans has evolved as an essential part of Waldeyer's ring. This ring plays an important role in protecting the upper respiratory and alimentary tract regions against incoming antigens, through a highly sophisticated mucosal immune system.[13]

- **This study investigated the histology of palatine tonsils from various mammals. A special reference was made to tonsillar salivary glands, which are usually rudimentary in humans**
- **In the mammals studied, tonsillar salivary tissue was a very conspicuous feature**
- **The implications are that, in various mammals with limited sweat gland distribution, tonsillar salivary tissue augments salivary secretion, necessary for evaporative cooling by panting and salivation**

In the comparative studies of palatine tonsils available in the literature,[1,8,9,14,15] only the crypt morphology and immune cell distribution were mentioned. As far as the authors are aware, no comparative study of tonsillar salivary glands in mammals has previously been reported. In their discussion of the histology of palatine tonsils in animals, three veterinary histology textbooks did not mention the tonsillar salivary glands.[16–18] The present work serves to highlight the distribution of tonsillar salivary glands in various animals, which is quite different from the histology of human tonsils.

References

1 Slipka J, Slipka J. The palatine tonsil as an evolutionary novelty. *Acta Otolaryngol (Stockh)* 1996;**116**(suppl 523): 8–11
2 Junqueira LC, Carneiro J. The immune system and lymphoid organs. In: Junqueira LC, Carneiro J. *Basic Histology*, 10th edn. Beirut: Lange Medical Books/ McGraw-Hill, 2003;265–90
3 Brandtzaeg P, Jahnsen FL, Farstad IN. Immune functions and immunopathology of the mucosa of the upper respiratory pathways. *Acta Otolaryngol (Stockh)* 1996;**116**:149–59
4 Gorfien JL, Noble B, Brodsky L. Comparison of the microanatomical distributions of macrophages and dendritic cells in normal and diseased tonsils. *Ann Otol Rhinol Laryngol* 2001;**110**:173–82
5 Berkovitz BKB. Pharynx. In: Standring S, ed. *Gray's Anatomy*, 39th edn. Edinburgh: Elsevier Churchill Livingstone, 2005;619–31
6 Choi G, Suh Y, Lee HM, Jung KY, Hwang SJ. Prenatal and postnatal changes of human tonsillar crypt epithelium. *Acta Otolaryngol (Stockh)* 1996;**116**(suppl 523):28–33
7 Werner JA, Dunne AA, Myers JN. Functional anatomy of the lymphatic drainage system of the upper aerodigestive tract and its role in metastasis of squamous cell carcinoma. *Head Neck* 2003;**25**:322–32
8 Slipka J. Palatine tonsils: their evolution and ontogeny. *Acta Otolaryngol (Stockh)* 1988;**108**(suppl 454):18–22
9 Nishikawa K, Takagi T. Comparative immunobiology of the palatine tonsil. *Acta Otolaryngol (Stockh)* 1988; **108**(suppl 454):43–7
10 Johns ME. The salivary glands: anatomy and embryology. *Otolaryngol Clin N Am* 1977;**10**:261–71
11 Cunning DM, Lipke N, Wax MK. Significance of unilateral submandibular gland excision on salivary flow in non-cancer patients. *Laryngoscope* 1998;**108**:812–15
12 Bartholomew GA. Body temperature and energy metabolism. In: Gordon MS, ed. *Animal Physiology: Principles and Adaptations*, 4th edn. New York: McMillan, 1982; 382–6

https://doi.org/10.1017/S0022215106004415 Published online by Cambridge University Press

13 Plzak J, Holikova Z, Smetana K, Riedel F, Betka J. The role of dendritic cells in the pharynx. *Eur Arch Otorhinolaryngol* 2003;**260**:266–72
14 Olah I, Takacs L, Toro I. Formation of lymphoepithelial tissue in the sheep's palatine tonsil. *Acta Otolaryngol (Stockh)* 1988;**108**(suppl 454):7–17
15 Tohya K, Kimura M. Preference of lymphocyte-homing to high endothelial venules in palatine tonsils of musk shrew (*Suncus murinus*). *Acta Otolaryngol (Stockh)* 1996; **116**(suppl 523):25–7
16 Banks WJ. Lymphatic system and immunity. In: Banks WJ. *Applied Veterinary Histology*, 3rd edn. St Louis: Mosby Year Book, 1993;277–97
17 Brown EM, Dellmann H. Lymphatic system. In: Dellmann H, Brown EM, eds. *Textbook of Veterinary Histology*. Philadelphia: Lea & Febiger, 1976;161–84
18 Andrew W, Hickman CP. Digestive System. In: Andrew W, Hickman CP. *Histology of the Vertebrates: a Comparative Text*. Saint Louis: CV Mosby, 1974;243–96

Address for correspondence:
Dr Kamal G Effat,
51A El-Madina El-Menawara St,
Medinet El-Mohandeseen, Giza, Egypt.

E-mail: kamaleffat@hotmail.com

Dr K G Effat takes responsibility for the integrity of the content of the paper.
Competing interests: None declared