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Microscopic study of the submandibular salivary gland of adult African giant pouched rat (*Cricetomys gambianus*, Waterhouse -1840)

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Abstract

The study was carried out to provide the basic histology of submandubular salivary gland in the giant pouched rat, as there is dearth of information of its microscopic architecture in available literature. This becomes more important as the possible use of this species of rodent is considered as a future laboratory animal of choice over the Winster rat because of its bigger size and possibility of the giant pouched rat domestication as a ready source of animal protein. Hence the need to understand the digestive biology to help animal nutritionist in feed formulation. The histology revealed the presence of both serous and mucus secretory acini. Some mucus cell presented serous demilumes. Myoeithelial cells were seen around secretory cells and the intercalated ducts. The serous gland region with more relatively profuse intralobular ducts was larger in size than the mucus gland region. The intralobular ducts of intercalated and striated ducts were lined by simple cuboidal and simple columnar cells respectively. The excretory duct was line by stratified cuboidal cells. The large serous glandular region reflects need for more enzymic action in the oral cavity while the mucus glands will help produce mucin that will lubricate the digestive tract. This study for the first time documents the normal histology of submandibular salivary gland in this species, hence filling the knowledge gap that will help further investigative research especially the role of myoepihelial cells in secretory glands tumours.

Keywords: Submandibular gland; Histology; Myoepithelial cells; African giant rat.
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دراسة مجهرية للغدة اللعابية تحت الفكية في الجرذان الافريقية البالغة العملاقة

إي اكباكيو، يو سي نليديوم، أو ناندوزي و آي أو أكباكيريو

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الخلاصة

أجريت هذه الدراسة لعمل قاعدة معلومات نسيجية للغدة اللعابية تحت الفكية في الجرذان العملاقة ذات الجراب وذلك لعدم وجود معلومات وصفية لهذا التركيب. وهذا أصبح مهماً لاحتمال استخدام هذا النوع من القوارض كحيوان مختبري في المستقبل بدلاً من الجرذ الونستر لأن حجمه كبير ومن المحتمل أن يكون مصدراً جاهزاً للبروتين الحيواني. وان الحاجة لفهم عملية الهضم يساعد أخصائيين تغذية الحيوان في صناعة العليقة. التركيب النسيجي بين وجود وحدات أفرازية مصلية ومخاطية مع وجود بعض الأهلة المصلية. خلايا السلة كانت أيضاً موجودة حول الخلايا الإفرازية والقنوات البينية. القنوات داخل الفصيصات في المنطقة المصلية من الغدة كانت أكبر من تلك الموجودة في المنطقة المخاطية من الغدة. القنوات داخل الفصيصات البينية والمخططة كانت مبطنة بظهارة بسيطة مكعبة وعمودية على التوالي. القناة الإخراجية تبطن بظهارة مطبقة مكعبة. المنطقة الغدية المصلية الكبيرة تعكس الحاجة لمزيد من النشاط الأنزيمي في التجويف الفمي بينما تساعد الغدد المخاطية في إنتاج المخاط لتزيت القناة الهضمية. هذه الدراسة وضحت التركيب النسيجي للغدة اللعابية تحت الفكية لأول مرة في هذا الحيوان وهذا يغطي النقص في المعرفة مما يساعد البحوث الإضافية خاصة في مجال أورام خلايا السلة في الغدد الإفرازية.

Introduction

The major mammalian salivary glands include the mandibular, submandibular, parotid, sublingual and zygomatic glands, while the minor are the buccal, labial, lingual and palatine glands (1-3). These glands usually consist of two sections- the secretory and transport ducts (4,5). The secretions from these glands referred to as saliva moistens the oral cavity mucosa as well as dry foods before swallowing (6), its high bicarbonate content serves as a buffer in the oral cavity. It provides medium for food materials to stimulate the taste buds. It begins the digestion of carbohydrates via the digestive enzyme amylase and also controls bacterial flora by secreting lysozyme (7). There is also reports that it secrets IgA, potassium and resorbs sodium (8,9).

Structurally, the morphology of the submandibular gland has been described as a tubuloalveolar gland, surrounded by a capsule of connective tissue septa, whose septa divide the glands into lobes and lobules. The morphology of the salivary glands has been documented in many animals like the Ferret (1), rats (10), free-tailed bat, *Tadarida thersites* (11), chicken (12), Wallabies species (13), domestic cat (14), pigs (15), even normal rabbit and miniature pig scintialographic evaluation of their salivary glands (16,17), but there is dearth of information on the submandibular salivary gland anatomy in the African Giant Pouched Rat (AGR) from available literature except for its weight –length morphometry (18). The AGR is becoming an animal of importance because of its use in land mines and tuberculosis detection (19-21). Also the AGR is an important source of animal protein in several rural communities, hence the possibility of its domestication for commercial production (22). There is report in available literature of the ambition to use the AGR as a research model to replace Winster rat because of its bigger size (23,24), hence the need to provide the baseline data on this organ in AGR for further investigative researches especially the pathogenesis of the submandibular gland tumours (25), and the use of salivary gland adiposity to correlate the level of liver cirrhosis in alcoholic patients (26).

Materials and methods

Ten adult African giant rat of both sexes captured in the wild from Olokoro Umuahia in Abia state, Nigeria from March to November 2012 using metal cage traps were used for the study. Olokoro umuahia is in the rainforest vegetation of southern Nigeria characterized by heavy rains and thick well grown mangrove forest trees. They were immediately transferred to the veterinary anatomy laboratory of Michael Okpara University of Agriculture, Umudike, for acclimatization. During this period, the animals were fed with grasses, oil palm fruit and water ad libitum.

The rat on the day of sacrifice was sedated with inhalated chloroform. The weight of the animal was taken with Mettler balance (Model Ohaus scout PRO-200) with a sensitivity of 0.1 gm. Each rat was sacrificed according to Adeyemo and Oke (27), and placed on dorsal recumbency. The animal was cut open through mid ventral incision from the inguinal region to the mandibular symphysis. The submandibular salivary gland was dissected out and fixed in 10% neutral buffered formalin. The tissues were passed through graded ethanol, cleared in xylene, impregnated and embedded in paraffin wax. Sections 5 µm thick were obtained with Leitz microtome model 1512. They were stained with haematoxylin and eosin for light microscopy examination (28). The slides were examined and photomicrographs taken with – Motican 2001 camera (Motican UK) attached to Olympus microscope.

Results

At low magnification, the gland was covered by a dense regular connective tissue capsule (Fig. 1). Beneath this capsule, two distinct regions separated by thin connective tissue fibres were clearly seen. One region contained mostly serous cells while the other contained mostly mucus cells (Fig. 2). The cells of the mucus acini were triangular, rounded to wedge shaped with flattened basal nuclei, some mucus cells presented serous demilumes or cresents (Fig. 1). The serous cells were mostly light pinkish with rounded basal nucleus (Fig. 3).

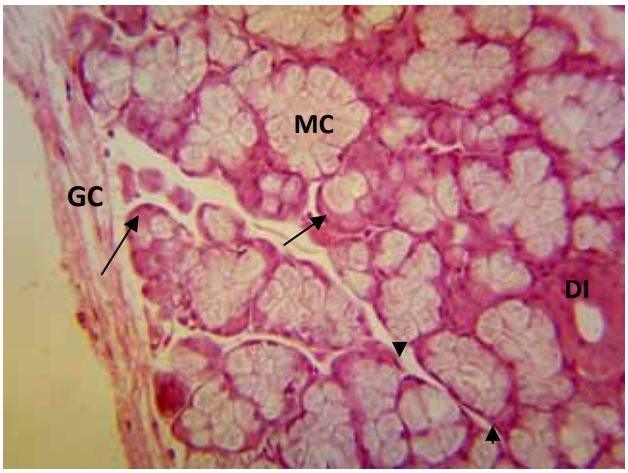

Fig. 1. submandibular salivary gland mucus region, mucus cells MC, gland capsule GC, serous demilume (black arrow), and myoepithelial cells (arrow head) surrounding the acini cells. Note the intercalated duct DI. H&E x400.

Myoepithelial cells were seen surrounding the secretory acini cells and intercalated ducts (Fig. 1 and 3). Intercalated ducts of simple cuboidal cells were sandwitched between the secretory acini cells (Fig. 1, 3 and 4). Larger striated or secretory ducts of simple columnar cells were observed in the lobules (Fig. 4). Interlobular duct of stratified cuboidal cells were seen as the excretory duct (Fig. 5). Generally more intralobular ducts and large gland veins were observed in the serous region (Fig. 4 and 5).

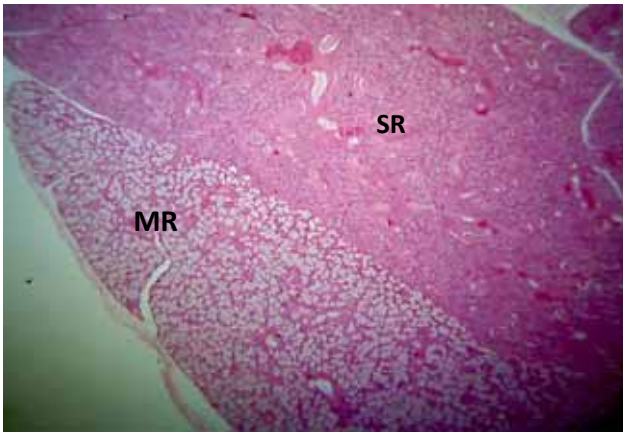

Fig. 2. submandibular salivary gland with the larger pinkish serous region SR, and the smaller light staining mucus region. H&E x40.

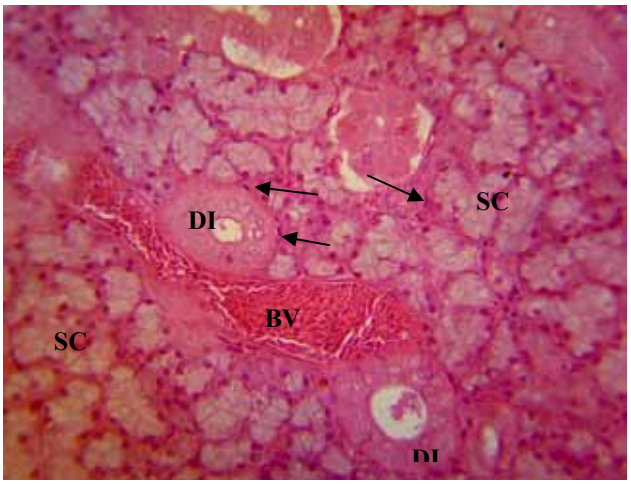

Fig. 3. Section of the submandibular salivary gland serous region, serous cells SC, mandibular vein BV, and myoepithelial cells (black arrow) surrounding the serous acini cells. Note the intercalated duct DI. H&E x400.

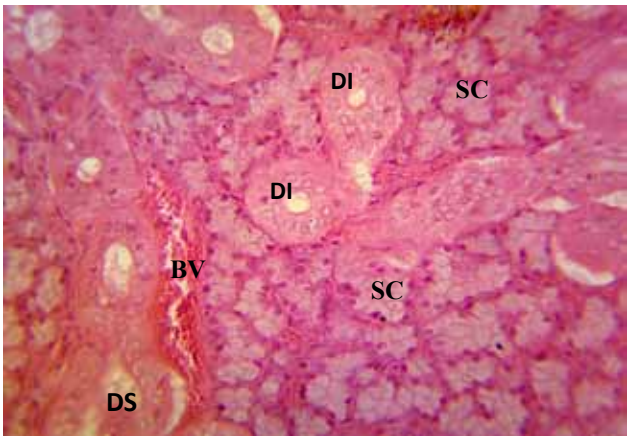

Fig. 4. submandibular salivary gland serous region serous cells SC, intercalated ducts DI, and striated duct DS, and gland vein BV. H&E x400.

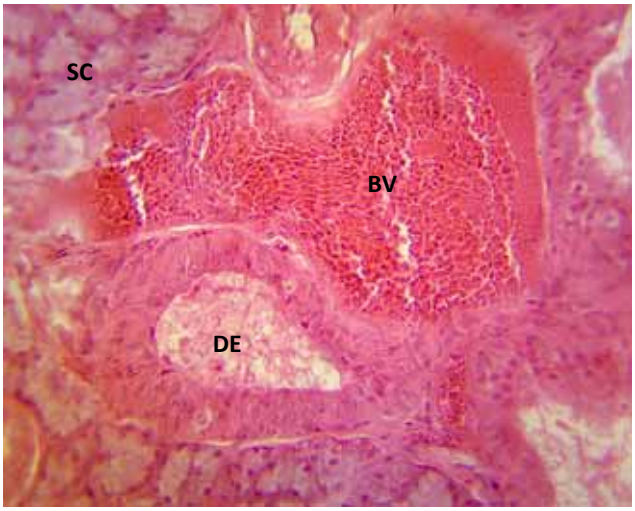

Fig. 5. submandibular salivary gland serous region, serous cells SC, excretory duct DE. Note the large gland vein BV. H&E x400.

Discussion

The covering dense regular connective tissue capsule is for protection of the secretory acini cells. A fibrous capsule of dense connective tissue has been reported in European hamster -*Cricetus cricetus* (29). The presence of both serous and mucus cells indicates a mixed gland and this has also been reported in European Hamster (29). A seromucous parotid gland has been reported in carnivores dog and cat, but an entirely mucus submandibular salivary gland has been reported in Ferrets (177), however in *Jaculus blanfordi* it contains only serous acini (30). The

report of two regions of gland acini of serous and mucus with serous demilumes as seen in this study has also been reported in submandibular salivary gland of armadillo *Zaedyus pichiy* (31). The seromucus gland seen in this study will readily provide enzymes for digestive process and mucus for lubrication of the digestive tract. The presence of more serous cells may be an adaptation for increased digestive enzyme action in the oral cavity especially the pouch, hence this pouch may not only be serving as a temporary storage sac, but also be a site for prolonged enzyme activity to aid digestion of carbohydrates by amylase. It may also be a need for increased production of anti bacterial agents to reduce rate of infection establishment in the wild (32).

The intercalated duct of simple cuboidal epithelium functions to transport secretions from the acini cells to the striated duct. This simple cuboidal epithelium in the intercalated duct has been reported in other rodents (33). The striated duct of simple columnar epithelium transports secretions from the intercalated duct to the excretory duct. A tall cuboidal epithelium in the striated duct has been reported in the submandibular gland of gerbil -*Meriones unguiculatus* (34). The intercalated and striated ducts are referred to as intralobular duct, and in this study, they were more in the serous region than in the mucus region. This may be a functional morphological specialization for increased transport of digestive enzymes into the oral cavity, thus increasing the rate digestion by these enzymes as more serous fluid is transported per unit time unlike the mucin from the mucus region. The less developed intralobular duct of the mucus region may reflect less need for mucin lubrication in the wild of rainforest region of Nigeria as the animals have ready access to water, fresh succulent fruits and grasses. The excretory duct of stratified cuboidal epithelium in the interlobular duct finally delivers the products of the gland into the oral cavity. The presence of stratified epithelium in the excretory duct may reflect need for protection of underlying basement membrane for occasion action of activated serous fluid enzymes.

The myoepithelial cells surrounding the secretory acini cells and intercalated ducts provides contractile force to help expel this secretion from the acini cells and push them through the intercalated duct (4,35), through autonomic nervous stimulation (36). There is a report on the ability of the myoepithelial cells to store glycogen (25), but was not demonstrated in this study. The absence of myoepithelial cells in rat parotid salivary gland and their occasional presence in human salivary gland have been reported (36). These myoepithelial cells in man have been incriminated in the pathogenesis of salivary gland tumours (4,25). The presence of well developed veins could serve as the basis to use the AGR for studies on age related changes especially histopathologies due to ischaemia instead of waiting to use human necropsy specimen (37,38).

Conclusion

The micromorphology of the African giant rat submandibular salivary gland from this study is a mixed gland producing both serous fluid and mucin. The larger serous acini cells may be a functional adaptation for increased rate digestion by salivary gland enzymes in the oral cavity especially the storage pouch of the cavity. The well developed submandibular salivary gland from this study can serve as a model for other biomedical researches like the myoepithelial cells may make the African giant rat the animal of choice in investigative research on the role of these cells in the pathogenesis of salivary gland carcinoma. Also the well developed serous region can be used as a template for studies in digestive zymogen activities. From available literature, this is the first time submandibular salivary gland normanl in the African giant pouched rat is described.

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