Surface Structures of the Tongue, Palate and Buccal Mucosa of the Rat

(Scanning Electron Microscopic Studies on the Oral Mucosa 3)

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Introduction

The tongue of the rat has been observed with scanning electron microscope (SEM) by several investigators (Svejda and Skach, 1971; Mizuhira, 1972; Muto, 1973), and it is thought that the surface structure of the tongue of each animal represents the individual variations under various conditions. On the other hand, on the oral mucosa except tongue, hitherto only the palate has been examined with SEM (Waterman et al., 1973; Yoshioka and Muto, 1975 b). In this paper, some new findings on the surface structure of the rat oral mucosa by SEM will be described.

Materials and Method

Five male Wistar-strain rats (weighing 270, 300, 300, 150 and 310 g) at over 300 days of age were used. They were sacrificed under chloroform anesthesia. The tongue, the palate and the buccal mucosa obtained from these animals were immersed in 2.5% glutaraldehyde solution in 0.1M phosphate buffer (pH 7.3). Dehydration in a graded ethanol series and acetone was followed by iso-amyl acetate, and subsequent drying from liquid CO₂ by the critical point method. The specimens were coated with carbon and gold, and examined with JEOL JSM-U 3 SEM at 8 kV of accelerating voltage.

Observations

1. Tongue

The dorsal surface of the body of the tongue is rough due to the presence of numerous filiform papillae which are divided into 3 types

by Kutuzov and Sicher (1951). The anterior dorsal surface of the tongue contains numerous filiform papillae which were named simple conical papilla by Kutuzov and Sicher. In the spine of this papilla, the epithelial cells overlap each other to antero-posterior direction, and the base of this papilla is circumscribed with the epithelial cells (Fig. 1). The filiform papillae on this part show conical form or lingual form which varied from the conical form. The former which is mostly seen on the tip of the tongue is fewer in number than the latter. In some tongues, transverse furrows are present on the anterior surface of these papillae. Also, in other tongues, the papillae in the apical portion remarkably bend toward the posterior direction in general (Fig. 2), and the interpapillary regions are larger in extent in the posterior sites of the anterior dorsal surface of the tongue than in the rest of the tongue (Fig. 3). On the intermolar eminence, giant conical papillae (Kutuzov and Sicher) are recognized (Figs. 3, 4, 6), and over the posterior region of the body of the tongue, there are the filiform papillae which diverge from 2 to 5 slender secondary papillae like a hand with fingers (true filiform papillae of Kutuzov and Sicher) (Figs. 6, 7). In some cases, transverse furrows are frequently observed on the anterior surface of the filiform papillae on the posterior part of the tongue (Fig. 5).

The fungiform papillae are scattered over the anterior dorsal surface of the body of the tongue. The top of this papilla has one, rarely two taste pores (Figs. 8, 9).

The foliate papillae are located on the marginal regions of the tongue just anterior to its attachment to the sides of the oral cavity. Number of foliate papillae on each side of the tongue ranges from 7 to 8.

A solitary circumvallate papilla in the midline of the tongue and near its base is elongated in form and has the wall on three sides without distinct border in the direction of the tongue tip.

The base of the tongue is rather smooth because of no filiform papilla. Terminal sulcus is not visible on the tongue, although this term is used in rat tongue by many investigators. The filiform papillae, which project from the upper margin of the ridges, decrease in height near the base of the tongue (Fig. 10). The ridges are arc-shape at the both sides of the solitary circumvallate papilla. On the surface of the base of the tongue, many fine folds which decrease in height run parallel to each other, and round or oval pores which may average approximately 30 micra in diameter are scattered (Fig. 11).

2. Palate

The oral surface of the hard palate is smooth and flat except an incisive papilla and several transverse palatine ridges. Also, no fold

and furrow are recognized on its surface, although the exfoliating epithelial cells are often seen here and there. In the anterior tip of the palate, there locates an incisive papilla which is triangular-shape having a blunt anterior point. Each side of this papilla is notched by 4 short grooves arranged in the postero-anterior direction.

The oral surface of the soft palate is uneven for numerous grooves and furrows. Furthermore, round or oval gemmal papillae measuring about 130 to 200 micra in diameter are numerous scattered throughout the oral surface of the soft palate. The gemmal papilla slightly protrudes from the oral surface of the palatal mucosa. One taste pore, rarely two ones are visible on the surface of the central portion of this papilla (Fig. 12).

3. Buccal mucosa

The buccal mucosa directly adjoins to the mucous part and transitional part of the lips. The anterior part of the buccal mucosa has many rough or fine folds and furrows. On the posterior part, especially its lower part, papillae projected from the oral surface of the bucca are frequently observed (Figs. 13-16). These papillae are termed "buccal papillae" by the present authors. The buccal papillae on the central part of the posterior buccal mucosa bend toward the posterior direction (Figs. 13, 15), sometimes toward the anterior direction. The surface of the buccal papilla was smooth owing to lack of the fold and the furrow. Generally, on the lower part of the posterior buccal mucosa, the buccal papillae of which tips decline to upper direction are longer than on the upper part (Figs. 14-16). The upper part of the posterior buccal mucosa has not any buccal papilla, only indicating some round or oval areas like the gemmal papilla on the soft palate.

Discussion

1. Tongue

The filiform papillae on the rat tongue are classified into 3 types: simple conical papilla, giant conical papilla and true filiform papilla as described by Kutuzov and Sicher (1951). They concluded that the papillae are entirely different in 3 successive areas. However, their opinion is criticized that these differences should be considered as merely minor variations of simple conical papillae of Kutuzov and Sicher (Sontag, 1925; Livingston, 1956), and that the basic histological structure of the giant conical papillae is the same as those over the rest of the tongue surface (Doran, 1975). The authors recognized 2 types on the anterior part of the body of the tongue, a conical form and a lingual form. "Simple conical papilla" of Kutuzov and Sicher is the exact term for the former, but the majority of the papillae on this part have

a spine of lingual shape, although the difference between these types is not essential. On the one hand, individual variations of these papillae were sometimes seen in some animals: the papillae on the apical portion of the tongue remarkably bend toward the posterior direction (Fig. 2), and these papillae loosely distributed on the posterior sites of the anterior part of the body of the tongue (Fig. 3), and some transverse furrows were observed on the anterior surface of the papillae on the whole tongue surface except the large papillae on the intermolar eminence (Figs. 2, 7). It can not be concluded only from these observations whether these individual variations are caused by aging.

The differences between the rat and mouse tongues were shown in details. Although the filiform papillae in the mouse somewhat differed from the various sites of the tongue in shape, these papillae showed only minor variations that the papillae in the intermolar eminence were not cone-shaped and that the filiform papillae on the posterior part of the body of the tongue are bifid and these secondary papillae are less slender than those on the rat tongue (Yoshioka and Muto, 1975a). Also, the circumvallate papilla in the rat was circumscribed with the wall except the anterior side, while in the mouse except the anterior and the posterior sides.

In the anterior dorsal filiform papillae, the epithelial cells of spine overlapped each other to antero-posterior direction, and a central epithelial cell formed the tip of this papilla. Cane and Spearman (1969) discussed from the histological appearance of the mouse tongue epithelium that the overlapping crescent-shaped cells in mouse papillary spine appeared to be the tip, which would ensure that the sharpness of the spine is constantly maintained. Also, in the rat, it is thought that shedding of the spine cells would be repetition of the tip cell to shed and leave. In the filiform papilla with lingual form spine, because a few anterior epithelial cells of the papillary spine leave or transform, it is possible that the spine became flat and bent to the posterior direction.

On the base of tongue of mammals including human, a few morphological studies have been published. The term, terminal sulcus, was used in many literatures concerning the rat tongue. However, the transitional part between the body and the base of the rat tongue was relatively gradual, and any distinct terminal sulcus could not been recognized.

2. Palate

One of 4 furrows in each side of the incisive papilla is the openings of nasopalatine ducts, because secretion attached itself to the posterior furrows which were deeper than the anterior ones. The nasopalatine ducts are patent in some species of mammals and have been considered

as auxiliary olfactory sense organs.

The gemmal papillae of the soft palate are light microscopically described in human (Hoffmann, 1875; Sakai, 1944), Formosan monkey (Yamamoto et al., 1959), cynomolgous monkey (Yoshioka and Sano, 1966), hedgehog (Ohtomo, 1954) and rabbit (Nomura, 1955). In human and cynomolgous monkey, the gemmal papilla was described in the uvula too. The gemmal papillae in the palate of primates were less in number, and contained numerous secondary papillae and taste buds, but were low in height and slightly prominent from the oral surface as those of mouse, although no soft palate of primates has been observed by SEM. The gemmal papilla on the mouse soft palate was initially reported by Yoshioka (1969), and its surface structure was observed by SEM (Yoshioka and Muto, 1975b), and yet the gemmal papilla on the rat soft palate has not been described in the available literatures. The papilla was almost similar in form to the mouse one, but its oral surface was not so flat as the mouse one (Fig. 12).

3. Buccal mucosa

The morphological studies on the mammalian buccal mucosa have been published in small number. According to the studies of Luschka (1863), Ram (1905) and Schumacher (1924), the human buccal mucosa was composed of 2 parts, the one is the maxillar and mandibular mucosal part directly adjoining the mucous part of the upper and lower lips and the other is the marginal zone (Saumregion der Wange) (Schumacher, 1924) being equal to the transitional part of the lips. The marginal zone in the human newborn could be obviously distinguished from the other part of the buccal mucosa, because of the presence of the villi which followed the zona villosa of the newborn lips (Yamazaki et al., 1948). After the loss of villi with maturity, this part was readily distinguishable from the other buccal mucosa by the large thickness of epithelium and the large size of papillae (Watt, 1911). In contrast, in the surface structure of the rat buccal mucosa, the marginal zone could not be distinguished. As a characteristic feature of the rat buccal mucosa, the buccal papillae which were prominent from the oral surface of the bucca were recognized on the posterior part of the buccal mucosa (Figs. 13-16). Hitherto, these findings have not been described by any other investigators. The buccal papillae were a few on the upper part of the posterior bucca but relatively abundant on the lower part of it. Namely, the buccal papillae were numerous on the part where directly adjoined to the posterior part of the body of the tongue, and with being distant from the posterior part of the body of the tongue, the buccal papillae became to decrease in number. A buccal papilla in the lower part often seemed in form to be the filiform papilla of the tongue (Fig. 16). In the light

microscopic observations of the dog cheek (Suenaga, 1960), buccal papilla was not described. For the future, we expect to obtain some new findings on the cheek of various animals using SEM. .

Summary

The tongue, the palate and the buccal mucosa were excised from 5 male rats aged over 300 days, and were observed by scanning electron microscope. The results obtained were as follows:

1. In the anterior dorsal filiform papillae of the tongue, the epithelial cells of papillary spine overlapped each other to antero-posterior direction. The filiform papillae on the anterior part of the body of the tongue showed conical form or lingual form which varied from the conical form. The former which was mostly seen on the tip of the tongue was fewer in number than the latter. The posterior part of the body of the tongue was characterized by the presence of the filiform papillae, from the base of which rose 2 to 5 secondary papillae.

2. In some individuals, the spine of the filiform papillae was generally marked owing to numerous transverse furrows, but the furrows were not visible on the surface of the large filiform papillae on the intermolar eminence. In some animals, it was observed that the tip of these papillae remarkably bent toward the posterior direction in general.

3. Distinct terminal sulcus was not recognized. The base of the tongue was even and the duct of lingual glands opened on its surface.

4. The gemmal papillae on the soft palate were described. This papilla was round or oval in shape and was not flat in the surface with one taste pore.

5. The papillae projected from the oral surface were seen on the buccal mucosa. These papillae which were named buccal papillae by the authors were initially described in this paper.

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Explanation of Figures

Plate I

- Fig. 1. A filiform papilla of anterior dorsal surface of a rat tongue. $\times 1000$
- Fig. 2. Filiform papillae of anterior dorsal surface of a rat tongue. These apical portions often bend toward the posterior direction, and transverse furrows are observed on the anterior surface of the papillae. $\times 1000$
- Fig. 3. Filiform papillae on the middle part of a rat tongue. $\times 100$
- Fig. 4. Large filiform papillae on the intermolar eminence of a rat tongue. $\times 100$

Plate II

- Fig. 5. A secondary papilla of a filiform papilla on the posterior part of a rat tongue. $\times 3000$
- Fig. 6. Filiform papillae on the posterior part of a rat tongue. $\times 100$
- Fig. 7. The secondary papillae of the filiform papillae on the posterior part of the tongue (Fig. 6). Furrows are not so obvious. $\times 1000$
- Fig. 8. A fungiform papilla of the anterior part of a rat tongue. $\times 300$

Plate III

- Fig. 9. Two taste pores of the fungiform papilla (Fig. 8). Many needle-like crystals of CuSO_4 are seen. $\times 2000$
- Fig. 10. Filiform papillae just anterior to the root of a rat tongue. $\times 300$
- Fig. 11. Surface of the root of a rat tongue. Several openings of lingual glands are observed. $\times 100$
- Fig. 12. Two gemmal papillae on a rat soft palate. $\times 300$

Plate IV

- Fig. 13. "Buccal papillae" on the posterior part of left buccal mucosa of a rat.
×300
- Fig. 14. "Buccal papillae" (Fig. 13). ×600
- Fig. 15. Several "buccal papillae" on the lower posterior part of left buccal mucosa
of a rat. ×300
- Fig. 16. Several "buccal papillae" on the lower posterior part of left buccal mucosa
of the rat (same individual as Fig. 15). ×430