Oral Physiology

Change in Distribution of Taste Buds in Aging Rats

Shutaro Harada*, Norikazu Kanemaru* and Yasuo Kasahara*

Taste bud distribution on the soft palate (SP) and within three types of tongue papillae (fungiform, FF, foliate, FL; and circumvallate, CV) were examined histologically in the rat at different postnatal ages until the end of life. Serial paraffin sections (10μm) were made and stained by HE, and digitized images of each section were examined. At birth, the number of matured SP taste buds exceeded that of FF taste buds. One week after birth, 90% of SP taste buds and 80% of FF taste buds contained taste pores. The number of SP and FF taste buds similarly increased and reached a steady level (SP: 203.7 ± 8.0; FF: 184.3 ± 26.3) at one week, and were not changed hardly at all even at 28–31 months. In contrast, no taste buds with a pore were observed at birth within FL and CV, and the number of FL taste buds continuously increased until 8 weeks of age (247.0 ± 77.2 at one side) and reached a steady level, while that of CV taste buds continuously increased even at 28–31 months of age (751.7 ± 72.7). It can be concluded that there are species differences in both taste bud morphology and distribution during aging in mammals.

Key words: Taste bud — Papilla — Soft palate — Rat — Aging

INTRODUCTION

The number and maturation of taste buds in the oral cavity may essentially cause changes in gustatory function. The maturation of taste buds within the soft palate (SP) of rat (Harada et al.13), hamster (Beleczky and Smith14) and marmoset (Yamaguchi et al.15) precedes that within the three types of tongue papillae (fungiform, FF; foliate, FL; and circumvallate, CV).

However, taste bud distribution was not fully investigated among the different taste bud subpopulations through the life-span of mammals. The present investigation was therefore designed to elucidate age-related developmental changes of taste bud distribution within the SP, FF, CV and FL papillae through the life of the rat.

METHODS

Pregnant female rats (Sprague Dawley) were kept in separate cages, and the day in which a litter was found was estimated to be day 0. Pups were fed by the mother until four weeks of age. Male and female pups were placed into separate cages after weaning. Data were obtained from 42 rats of both sexes. Animals were sacrificed at postnatal ages of day 0–1, 2, 3, 4, 8–9 weeks and 28–31 months (approximately life-span) (n = 3 for each age).

Rats were given an overdose of Nembutal® (Abbott, 3ml/kg i.p.) and their heads were removed. The procedure for paraffin embedding was similar to that described previously (Harada et al.13; Yamaguchi et al.15). Complete serial sections were cut at 10μm, stained by Mayer’s hematoxylin and counterstained by Eosin. The method to record and process light microscopic digital image of each section with a computer (Power Macintosh 7300, Macintosh) was similar to that described previously (Harada et al.13; Yamaguchi et al.15). Observing the sequence of printed-out photographs of each section made it possible to check and identify each taste bud and its taste pore. To analyze differences between each of the developmental changes, data were analyzed by two-way analysis of variance (group versus age). Differences in the values among the four groups were analyzed using independent measures two-tailed t-test.

RESULTS AND DISCUSSION

At birth more than 100 taste buds (with or without pores) were observed on the SP and FF (SP: 126.7 ± 23.7 SD; FF: 110.3 ± 13.7). The number of SP and FF taste buds similarly increased and reached a steady level (SP: 203.7 ± 8.0; FF: 184.3 ± 26.3) at one week and did not change significantly up to age 28–31 months (SP: 273.7 ± 70.6; FF: 213.7 ± 44.9) (Fig. 1).

In contrast, the development of taste buds within the CV and FL was delayed compared to SP and FF taste buds. The CV and FL contained only a few taste buds at birth (CV: 1.0 ± 1.4; FL: 3.0 ± 4.2) similar to that previously reported (Hosley and Oakley10).
number of FL taste buds continuously increased until 8 weeks of age (247.0 ± 77.2 at one side) and reached a steady level, while CV taste buds continuously increased gradually up to 28–31 months of age, reaching 751.7 ± 72.7 (Fig. 1).

The functional maturation of SP taste buds preceded that of FF taste buds, as taste pores were identified at birth as 53% of SP taste buds compared to only 12% FF taste buds. At one-week of age, 90% of SP taste buds contained a taste pore, indicating that maturation was almost complete. A similar maturation of FF taste buds occurred weeks later. In a scanning electron microscopic study, only one taste pore was observed in one-day-old rat, whereas 72% of 12-day-old rat FF taste buds possessed a pore (Mistretta). Also in the hamster, 39% of SP taste buds possessed a taste pore at one day of age (Belecky and Smith). Electrophysiological (Harada and Smith; Harada et al.; Nejad) and behavioral experiments (Harada) suggest that the GSP, innervating SP taste buds, plays an important role in mediating taste information for nutrients and for suckling behavior in pre-weaning animals and that it functions during early postnatal development in rodents.

In contrast, no CV or FL taste buds with pores were observed at birth. The increase in the number of mature taste buds in the CV and FL was slower than that for the SP and FF; however, at two to three weeks of age, 70–80% of the CV and FL taste buds contained pores, reaching almost 100% at the end of life, 28–31 months of age. Similar results were shown previously in the rat, where CV taste buds with a pore were not observed at birth and reached a maximum of 610 ± 87 taste buds at 90 days (Hosley and Oakley). Rat FL taste buds with taste pores were observed at ten days of postnatal age (State et al.). Also, in the hamster, few CV and FL taste buds were observed at birth; however, 121 FL taste buds were observed at 71 days of age, and 150 FL taste buds were reported at 120 days (Miller and Smith). In the marmoset, the total number of taste buds increased with increasing age, reaching a maximum at two months of age, and decreasing thereafter (Yamaguchi et al.). Investigation of human CV and FL papillae showed that the number of taste buds decreased in old age (Arey et al.). In contrast, age did not affect the number of taste buds within the FF, CV and FL in adult rhesus monkey (Bradley et al.).

It can be concluded that there are species differences in both taste bud morphology and distribution during aging in mammals.

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Reprint requests to:
Dr. Shuitsu Harada
Department of Oral Physiology
Kagoshima University Dental School
8-35-1 Sakuragaoka, Kagoshima 890-8544, Japan