FILIFORM, FUNGIFORM PAPILLAE AND TASTE BUDS: DISTRIBUTION AND AGE CHANGES: A MICROSCOPIC STUDY

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ABSTRACT

BACKGROUND

The organs of taste consists of taste buds- caliculus or gemma gestatorius, located in the lingual papillae.

The aim of this study was to note the number, distribution and age changes of fungiform and filiform papillae and taste buds.

MATERIALS AND METHODS

The study was conducted on 50 specimens of tongue collected from Department of Forensic Medicine and Labour Room, Medical College, Kozhikode.

RESULTS

In tip region, fungiform and filiform papillae were observed. The maximum number of 21 papillae per low power field was observed in a 13-week-old foetus. With increasing age, a reduction was noted in the number of papillae per low power field. Filiform papillae were first observed in a 27-week-old foetus and its number increased with age. The number of taste buds per fungiform ranged from 0-2. No significant age change was noted. Secondary papillae were first observed in filiform papillae at the age of 32 years. But in case of fungiform papilla, secondary papillae were present in younger age groups also and their number showed a mild increase with age, although not in all cases.

CONCLUSIONS

As age advances, there occurs a significant reduction in the number of fungiform papillae per low power field and a significant increase in the number of filiform papillae. Secondary papillae showed a significant positive correlation with age in case of filiform papillae. There was no significant age change in the number of taste buds.

KEYWORDS

Filiform, Fungiform Papillae, Taste Buds.

HOW TO CITE THIS ARTICLE: Vinubal S. Filiform, fungiform papillae and taste buds: distribution and age changes: a microscopic study. J. Evolution Med. Dent. Sci. 2016;5(79):5905-5910, DOI: 10.14260/jemds/2016/1333

BACKGROUND

Organs of special senses are highly sophisticated sensory receptors, in which the specific neural receptors are incorporated in a non-neural structure which enhances and refines the reception of incoming stimuli.¹

Taste buds are numerous on all types of lingual papillae except filiform papillae.² Of these, fungiform papillae are present in the greatest numbers on the tongue and are thought to be correlated to the overall number of taste buds.³ In fact, fungiform papillae are the first line of the gustatory apparatus to provide information about taste.⁴

Fungiform papillae appear as mushroom shaped pink or red spots scattered among the filiform papillae.⁵ They have a short slightly constricted stalk and a slightly flattened hemispherical upper part.⁶ Fungiform papillae have a thin non-keratinised epithelium and a richly vascularised

supporting tissue core.¹ Strawberry or raspberry tongue refers to the appearance in scarlet fever, where there is hypertrophy of fungiform papilla along with changes in filiform papilla.⁷

Filiform papillae appear as short bristles and consist of a dense supporting core and a heavily keratinised surface projection.¹ They are numerous and are arranged in V shaped rows that are parallel to the terminal sulcus except at the apex, where they tend to be arranged transversely.⁵ These papillae appear to subserve a purely mechanical function. Their roughness facilitates licking of semisolid foods and they contain afferent nerve endings that are sensitive to touch.⁸ In a pathological condition called geographic tongue, there is rapid loss and regrowth of filiform papillae leading to denuded red patches 'wandering' across the surface of the tongue. And in hairy tongue, there is elongation of filiform papillae with a lack of normal desquamation.⁷

Taste buds are seen in sections under low power as pale, oval bodies in darker stained epithelium.⁶ They extend from the basal lamina, almost to the surface.⁶ The lifespan of each taste cell is about 10 days in lower mammals, but is unknown for humans.⁹

AIMS AND OBJECTIVES

1. To note the number and distribution of fungiform and filiform papillae in the tip of the tongue and to look for any age change.
2. To study any change in the location and number of taste buds in fungiform papillae as age advances.

Financial or Other, Competing Interest: None.

Submission 25-08-2016, Peer Review 17-09-2016,

Acceptance 24-09-2016, Published 03-10-2016.

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DOI: 10.14260/jemds/2016/1333

MATERIALS AND METHODS

50 specimens of tongue and epiglottis in the age group 0-80 years were collected. Autopsy specimens were collected from the Department of Forensic Medicine, Medical College, Kozhikode. Specimens of still born babies were taken from the Labour Room of Medical College, Kozhikode. Ethical Committee clearance was obtained for the same.

Exclusion Criteria

1. Post mortem bodies of burns cases.
2. Decomposed bodies.
3. Bodies with severe maxillofacial injuries.

Tissue bits were taken from tip region and fixed in Bouin's fluid overnight. They were then processed using ascending grades of alcohol, cleared in xylene and were embedded in paraffin wax. Sections with 6 microns thickness were taken and stained with haematoxylin and eosin. Ehrlich's haematoxylin was used since it could be kept for years after ripening and gave brilliant nuclear stain. Results of the microscopic study were analysed statistically using Spearman's correlation.

RESULTS

In the youngest foetus studied (13 weeks), 21 fungiform papillae were observed per low power field. Filiform papillae were observed from the age of 27 weeks (Fig. 3). In foetal specimens, the number of taste buds varied from 0-2 per LPF. However, not more than 1 taste bud was observed per fungiform papilla. No secondary papillae were observed.

Number of papillae per low power field decreased after birth. Connective tissue core of fungiform papilla showed secondary papillae. The number of taste buds varied from 0-1/fungiform papilla. It was present on top of fungiform papilla. Two taste buds were seen on top of some fungiform papilla from the age of 27 years.

After the age of 30 years, number of filiform papillae increased compared to fungiform papilla (Fig. 6). Secondary papillae were observed in filiform papillae in some cases from 32 years onwards. Number of secondary papillae per fungiform also increased. Taste buds per fungiform papilla varied from 0-2 (Fig. 5).

At the age of sixties and seventies, number of taste buds varied from 0-1. Degenerating taste bud was observed at the age of 12 years (Fig. 4) and 78 years. See Table 1 for details.

Age	No./LPF	Fungi-form	Fili-form	CT/Fung	CT/Fil	Taste Bud
13 wks.	21	21	0	0	0	1
14 wks.	17	17	0	0	0	1
20 wks.	13	13	0	0	0	1
21 wks.	13	13	0	0	0	0
23 wks.	14	14	0	0	0	0
27 wks.	10	8	2	0	0	2(1/F)
28 wks.	8	5	3	0	0	1
30 wks.	10	10	0	0	0	1
33 wks.	8	7	1	0	0	1
3 yrs.	5	4	1	2	0	1
5 yrs.	3	2	1	3	0	0
9 yrs.	3	1	2	8*	0	1
10 yrs.	4	2	2	6*	0	1
12 yrs.	5	2	3	3	0	2(1/F)
14 yrs.	4	2	2	4	0	1

18 yrs.	1	1	0	2	0	1
19 yrs.	4	3	1	2	0	0
20 yrs.	3	2	1	3	0	1
22 yrs.	1	1	0	0	0	1
24 yrs.	5	2	3	3	0	0
25 yrs.	3	2	1	2	0	0
26 yrs.	3	1	2	3	0	0
27 yrs.	4	4	0	5*	0	2
32 yrs.	5	2	3	3	2	2
34 yrs.	4	2	2	6	2	1
36 yrs.	4	2	2	4	0	0
38 yrs.	5	2	3	2	0	1
40 yrs.	5	2	3	3	0	1
43 yrs.	5	1	4	0	0	1
45 yrs.	3	2	1	4	0	2
46 yrs.	4	2	2	2	2	0
47 yrs.	3	0	3	0	3	0
48 yrs.	4	1	3	2	0	1
50 yrs.	4	1	3	3	0	0
52 yrs.	4	1	3	3	0	0
55 yrs.	5	1	4	3	2	2
56 yrs.	4	2	2	5	4	0
58 yrs.	3	1	2	4	0	2
60 yrs.	3	1	2	3	2	0
61 yrs.	3	2	1	6	2	0
62 yrs.	2	0	2	0	3	0
64 yrs.	2	1	1	2	0	0
70 yrs.	3	1	2	5	0	0
73 yrs.	5	2	3	5	2	1
75 yrs.	5	0	5	0	2	0
78 yrs.	4	1	3	3	2	1

Table 1

Fungiform = Fungiform papillae/LPF.

Filiform = Filiform papillae per LPF.

CT/Fung = Connective tissue papillae per fungiform.

CT/Fil = Connective tissue papillae per filiform.

Taste bud = Taste buds/LPF.

1/F = 1 taste bud per fungiform

*= minor connective tissue papilla.

Statistical Analysis: Spearman's Correlation

			Age
Spearman's Rho	Fungiform Papillae	Correlation Coefficient Sig. (2-tailed) N	-.505** .001 37
	Filiform Papillae	Correlation Coefficient Sig. (2-tailed) N	.389* .017 37
	Taste Buds/LPF	Correlation Coefficient Sig. (2-tailed) N	-.311 .061 37
	CT Papillae/Fungiform	Correlation Coefficient Sig. (2-tailed) N	.085 .617 37
	CT Papillae/Filiform	Correlation Coefficient Sig. (2-tailed) N	.554** .000 37

Table 2

**Correlation is significant at the .01 level (2-tailed)

*Correlation is significant at the .05 level (2-tailed)

Statistical Analysis: Spearman's Correlation

Table 2

Shows the statistical analysis of the data representing the tip region of the tongue (Excluding foetal specimens).

- There is a significant negative correlation between the number of fungiform papillae per LPF and age.
- There is a significant positive correlation between the number of filiform papillae/LPF and age.
- There is no significant correlation between the number of taste buds and age.
- There is no significant correlation between the number of CT papillae per fungiform and age.
- There is a significant positive correlation between the number of CT papillae per filiform and age.

			AGE
Spearman's Rho	Fungiform Papillae	Correlation Coefficient	-.862**
		Sig. (2-tailed)	.003
		N	9
	Filiform Papillae	Correlation Coefficient	.584
		Sig. (2-tailed)	.099
		N	9
	Taste buds/ LPF	Correlation Coefficient	.149
		Sig. (2-tailed)	.701
		N	9
	CT Papillae/Fungiform	Correlation Coefficient	.
		Sig. (2-tailed)	9
		N	9
	CT Papillae/ Filiform	Correlation Coefficient	.
		Sig. (2-tailed)	9
		N	9

Table 3

**Correlation is significant at the .01 level (2-tailed)

Table 3

This is the statistical analysis of the data representing the tip region of the tongue (Foetal specimens).

- There is significant negative correlation between the number of fungiform papillae per low power field and age.
- There is no significant correlation between any of the other factors and age.

		Ratio of Fungiform/ Filiform Papillae
Age	Pearson Correlation	-.514
	Sig. (2-tailed)	.002
	N	34

Table 4

Table 4

Shows the statistical analysis of the data representing the ratio of fungiform and filiform papillae seen per LPF with age.

- A significant negative correlation is observed.

Fig. 1: Section of Tip Region of Tongue of a 13-week-Old Foetus showing Fungiform Papilla and Taste Bud (Green Arrow). Haematoxylin and Eosin Staining. Magnification x 100

Fig. 2: Section of Tip Region of Tongue of 13-Week-Old Foetus showing Fungiform Papilla and Taste Bud (Green Arrow). Haematoxylin and Eosin Staining. Magnification x 400

Fig. 3: Section of Tip Region of Tongue of a 27-Week-Old Foetus showing Filiform Papillae with Keratin. Haematoxylin and Eosin Staining. Magnification x 400

Fig. 4: Section of Tip Region of Tongue of a 12-Year-Old showing Degenerating Taste Bud on Top of a Fungiform Papilla (Green Arrow). Haematoxylin and Eosin Staining. Magnification x 400

Fig. 5: Section of Tip Region of Tongue of a 45-Year-Old showing 2 Taste Buds on top of a Fungiform Papilla (Green Arrow). Haematoxylin and Eosin Staining. Magnification x 100

Fig. 6: Section of Tip Region of Tongue of a 75-Year-Old showing Filiform Papillae with Keratin. Haematoxylin and Eosin Staining. Magnification x 100

DISCUSSION

Taste is one of the sensations, which is essential for the existence of man. The robust nature of the peripheral sense of taste in old age appears to be in sharp contrast to other sensory systems.

Though studies on the structure of various papillae and taste buds can be traced back to 1868, most of the works were done on animals. Even now studies on human tissue are few. Observations of this study are discussed under 3 headings.

Fungiform papilla,
Filiform papillae,
Taste buds.

Fungiform Papillae

Fungiform papillae were observed in the youngest foetus studied (13-week-old).

Fig. 1: This is in agreement with the work of Bradley 1967¹⁰ and Witt 1997,¹¹ who observed fungiform papillae in 6, 7 weeks old embryo respectively. Before birth, the number of fungiform papillae are more. In this work, maximum number of fungiform papilla was observed in 13-week-old foetus (Table 1). As age advances, there is marked reduction in the number of papillae/LPF. After birth, the number of fungiform papillae per LPF ranges from 1-4 till the age of 32 years. From this age onwards, the number is limited to 0-2/LPF.

Statistical analysis revealed a significant negative correlation between the number of fungiform papillae per LPF and age (Table 2). As age advances, the increase in the number

of filiform papillae produces a reduction in the number of fungiform papillae per LPF. This agrees with Fischer (2013),¹² who stated that the mean fungiform papillae density was lower for each 5 years increase in age. Just (2003)¹³ found that the density of fungiform papillae varied among the investigated human subjects in different age groups. According to Chen (1998)¹⁴ and Konstantinidis (2010),¹⁵ the number of fungiform papillae showed no sex related differences. This aspect was not studied.

Becker (1908)¹⁶ considered fungiform papilla as a primitive type of vallate and foliate papilla. The present study could not find anything to agree with or disagree with the above.

Segovia (2002)¹⁷ observed increased fungiform papillae densities in children compared to adults. This work does not agree with the above. In the present work, we have noted only 1-2 fungiform papillae/LPF in children aged 5-12 years. According to Correa (2013),¹⁸ the number of papillae stabilised at 9-10 years of age.

The connective tissue papillae per fungiform papillae were also counted. It was first observed at the age of 3 years. With advancing age, the number of connective tissue papillae showed a mild increase, although not in all cases. Statistical analysis revealed no significant correlation between the number of connective tissue papillae and age (Table 2). This is not in agreement with the work of Kobayashi et al (2001),¹⁹ who observed thinning of the connective tissue core with age. However, Kobayashi, also emphasised that there was a great deal of individual variation of human lingual papillae regardless of age.

Filiform Papillae

Filiform papillae appeared in this study only in 27-week-old foetus (Fig. 3). This does not agree with the work of Witt 1997,¹¹ who observed filiform papillae in a 15-week-old foetus. But it is in agreement with the above study in the fact that filiform papillae appear later in development and the first papilla to develop is fungiform. As this papilla does not have any taste bud, the function of this papilla is not for appreciation of taste. Filiform papillae give a rough surface for the tongue and increase the surface area of the tongue. The keratin makes the surface of the papilla rough and the amount of keratin increase with age. An interesting observation is that the number of filiform papillae increase with age (Fig. 6). When the number of filiform papillae increase, there is a corresponding reduction in the number of fungiform papillae (Table 4). This points to the fact that the filiform papillae by giving roughness to the surface of the tongue allows the food to remain on the tongue, so that taste can be appreciated better. And this may be the reason why old people appreciate taste better than the younger ones. This does not agree with the work of Kobayashi 2001,¹⁹ in which a reduction in the number of filiform papillae was observed in old age.

The time of appearance of connective tissue papillae is later in life in case of filiform papilla. In this study, the secondary papillae were first observed at the age of 32 years. The formation of secondary papillae might be to give more stiffness to the papillae. This is supported by the fact that the connective tissue papillae appear very early in life in case of fungiform papilla. The filiform papilla covered with keratin is already stiff and do not require a stiff connective tissue core with secondary papilla. There is no decrease of connective

tissue papillae as pointed out by Kobayashi 2001.¹⁹ Instead, a significant positive correlation was noted between the number of connective tissue papillae and age in case of filiform (Table 2).

Taste Buds

There are various studies done on taste buds. Different cell types are identified by various workers. In this work different types of cells could not be studied, as it is a light microscopic study.

Taste bud was observed in the youngest embryo studied (13 weeks) (Fig. 1). It was present on the upper surface of the fungiform papilla. Of the 21 papillae, taste bud was present on only one. Different types of cells were visible (Fig. 2). Basal cells and cells with elongated nuclei and round nuclei were seen. All were crowded together. This agrees with Bradley (1967),¹⁰ who stated that morphologically many cells were recognisable at 13-15 weeks.

In fungiform papilla, it was always on the upper surface. This is in agreement with the works of Arvidson (1979)²⁰ and Richard O Davies et al (1979).²¹

The number varied between 0-2/fungiform papilla (Fig. 5). Never more than 2 were seen. But according to Cheng et al (1991),²² average taste buds varied from 0-3.

Arvidson K (1979)²⁰ had studied 182 fungiform papillae and had observed taste buds on the dorsal surface. According to him while the number of taste buds in a single papilla varied from 0-27, 63% of the papillae had no taste buds at all, 26% had 1-3 buds and the remainder 4 or more buds. The mean number of taste buds per papilla varied from 0-9 between individuals and no dependence upon sex or age could be demonstrated for this variation. This work also agrees with the above study, but not more than 2 taste buds per fungiform papilla were seen per LPF. Majority of fungiform papilla showed only one. Degenerating taste bud was observed in the fungiform papilla at the age of 12 years and 78 years.

Statistical analysis revealed no significant correlation between the number of taste buds in the various papillae and age (Table 1). This is in agreement with Saito (2016),²³ who found that the average number of taste buds was similar among all age groups.

Yamaguchi (2001)²⁴ mentioned that the effect of aging on taste bud number was different among individuals and did not simply depend on increasing age. This study agrees with this. Inglis J Miller (1986)²⁵ also found wide variations in fungiform taste bud densities in tongues of human cadavers.

Ernest R Lalonde (1961),²⁶ stated a clustering effect on taste buds. According to him, taste buds were grouped together. Arey and Monzingo (1942),²⁷ attributed the clustering effect "to the innervation of taste buds and the formative influence that nerves had on taste bud development." No such clustering was seen in the present study.

CONCLUSION

As age advances, there occurs a significant reduction in the number of fungiform papillae per low power field. Secondary papillae in case of fungiform showed no significant change with age, though there was a mild increase.

The number of filiform papillae per low power field shows a significant increase with age. The number of connective

tissue papillae of filiform also showed a significant positive correlation with age.

Taste buds observed on top of fungiform papillae varied from 0-2 and showed no significant correlation with age.

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