A comparative study of the dynamics of the bacterial population in the pathological focus, in different parts of the cavity wall, the lung tissue surrounding the cavity, and the parenchymatous organs of the animals gave the following results: During the month after infection the number of *M. tuberculosis* cells in the vaccinated animals fell in all organs and tissues. The period of decline of viability of the pathogenic agent last up to 3 months from the beginning of vaccination and from 1.5 to 4 weeks correspondingly after infection. For instance, by 2 weeks after infection the seeding index for the animals of this group was 1.2 ± 0.03. The bacteriological indices fell considerably, depending on changes in the technique used ($P < 0.001$). In the period of decline of hypersensitivity of tuberculin, which was observed toward 3 months after vaccination, the number of *M. tuberculosis* cells in the pathological material again increased. The seeding index by this time rose to 2.8 ± 0.14. The difference is statistically significant ($P < 0.01$). The largest number of *M. tuberculosis* cells was observed in the cavity wall and in the lung tissue surrounding the cavity. Parallel with the increase in the number of bacterial cells, reactivation of the pathological process was observed. The number of *M. tuberculosis* cells in the pathological material increased directly proportionally to the time after infection. Between 1 and 2 weeks after infection accumulation of the bacterial population took place in the focus of infection only. The seeding index of the animals of this group was 2.8 ± 0.14, after 3-4 weeks it reached 4.0 ± 0.23 ($P < 0.01$), and after 3-5 months it was 70 times higher ($P < 0.001$).

The suggested model of experimental destructive tuberculosis of the lungs thus resembles human tuberculosis much more closely than other types of model which have hitherto been used.

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CHANGES IN THE TACTILE PAPILLAE OF THE HUMAN TONGUE IN ONTOGENY (DATA OF SCANNING ELECTRON MICROSCOPY)

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KEY WORDS: tactile papillae of the tongue; keratinization; electron microscopy.

The formation of the mechanoreceptor structures of the mammalian and human tongue has hardly been studied. Yet the tactile papillae of the tongue at different periods of human life play an important role in the formation and development of such complex acts as sucking, swallowing, chewing, determination of the solid component of the food, and the articulation of speech [5]. The approximate times of formation of keratinization of the filiform papillae of the human and animal tongue are given in a number of publications [1-4, 6, 7].

This paper gives the results of an investigation of the tactile receptor structures of the human tongue at different ages.

EXPERIMENTAL METHOD

Autopsy material was used. The tongues of 3-week fetuses, newborn and 5-month-old infants, adults (40 years), and older people (age 60-80 years) were investigated. The tongues were washed to remove saliva, for 30 min initially in tapwater, then in distilled water, after which they were fixed in 4% formalin solution or 2.5% glutaraldehyde solution. The surface of the tongue was then washed again to remove the fixing solution, quickly frozen, and dried. Different parts

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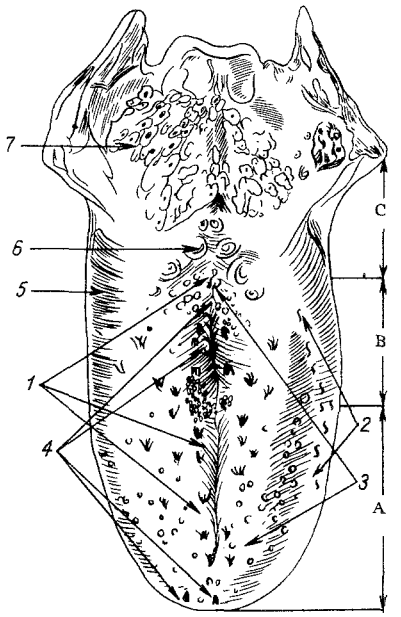

Fig. 1. Topography of papillae of adult human tongue. A) Tip of tongue; B) body of tongue; C) root of tongue. 1) Papillae with digitate processes; 2) filiform papillae; 3) fungiform papillae; 4) club-shaped and conical papillae; 5) foliate papillae; 6) vallate papillae; 7) efferent ducts of lymphadenoid papillae.

of the tongue were studied in Stereoscan-2A and JSM-50A scanning microscopes.

EXPERIMENTAL RESULTS

On the anterior free surface of the human tongue most papillae have digitate processes (Fig. 1A; Fig. 2, 1, 3; Fig. 3, 1, 2). The number of digitate processes varies from 2 to 20. As a rule they decrease in number in the lateral direction (Fig. 3, 8, 10). Under high power granules of keratin, of which these processes consist, are clearly visible (Fig. 1, 2).

Among papillae with digitate processes along the anterior border of the tip and medial part of the tongue there are conical papillae (Fig. 3, 9), whose processes are gathered into rosettes (Fig. 2, 6, Fig. 3, 3), and in the lateral part of the tongue smaller filiform papillae can be seen (Fig. 2, 9). The wide diversity, the large number, and the high density of papillae in the anterior part of the tip of the adult human tongue must be emphasized.

Mechanoreceptor accessory structures of the neonatal tongue differ considerably from adult human papillae not only in size, but also in structure. For instance, they have none of the digital processes characteristic of the adult human tongue. Most papillae during this period are conical in shape (Fig. 4, 1-3, 7) and digitate processes were observed only on a few of them (Fig. 4, 4, 5). Conical and club-shaped papillae were seen in the lateral part of the tip of the tongue (Fig. 5, 6).

Digitate processes in the papillae of the tip of the tongue are formed by the 5th-6th month after birth (Fig. 5, 10-12). By this time they become similar to adult human papillae.

In persons aged 60 years as a rule the mechanoreceptor formations no longer possessed the long digitate processes, and only their remains were found (Fig. 2, 12, Fig. 3, 3, 4).

Papillae on the medial part of the body of the tongue (Fig. 1B) also had long digitate processes (Fig. 4, 5; Fig. 3, 3). Among these papillae some were conical, but nearer the lateral part they were filiform (Fig. 3, 10). In the lateral papillae the digitate processes were much shorter and they were fewer in number than in the medial papillae (Fig. 3, 6, 7). Besides digitate and conical mechanoreceptors, massive formations resembling rosettes composed of lobules also were seen in the medial part of the body of the tongue (Fig. 2, 6). Usually they were surrounded by papillae with digitate processes. Primordial digitate processes were found in the mechanoreceptor formations on the body of the tongue of 30-week fetuses

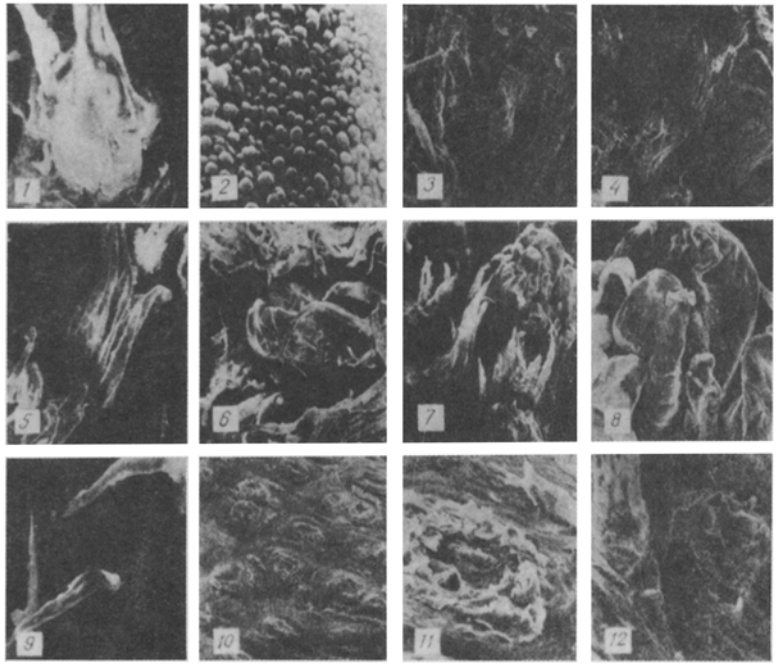

Fig. 2. Mechanoreceptor papillae of tip and body of human tongue. Subject aged 60 years, tip of tongue: 1) digitate mechanoreceptor formations, 300 X; 2) keratin granules of digitate processes of mechanoreceptor formations, 6000 X; 3) papillae, 300 X. Medial part of body of tongue: 4) general appearance, 50 X; 5) mechanoreceptor formations, 120 X; 6) papillae of rosette shape, 50 X. 7) Papillae in medial part of root of tongue, 60 X; 8) middle of "rosette," 400 X; 9) filiform papillae in lateral part of tongue, 300 X. Tongue of subject aged 80 years: 10) general appearance of medial part of body, 50 X; 11) tactile papilla in medial part of body, 200 X; 12) papillae of tip of tongue, 250 X.

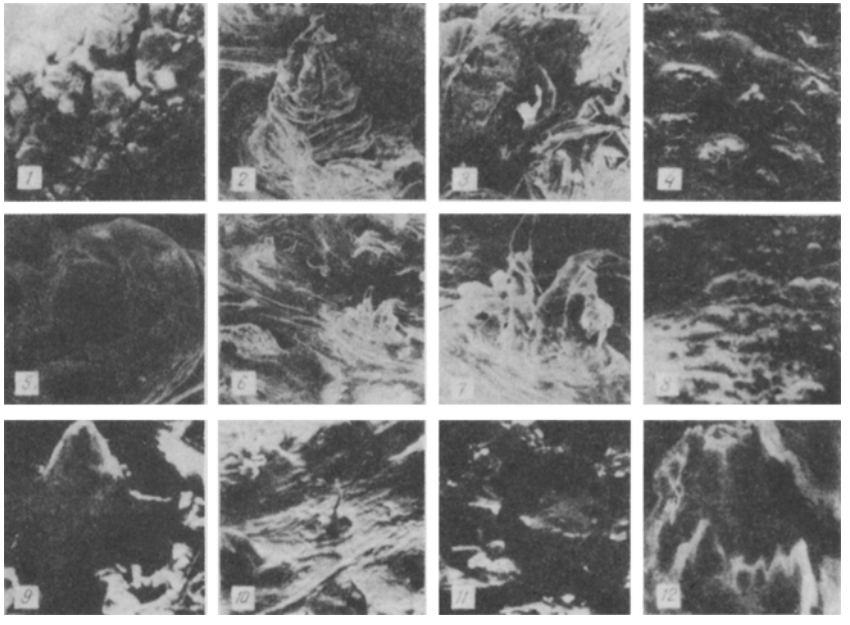

Fig. 3. Tactile mechanoreceptors of papilla of human tongue: subject aged 60 years: 1) fragments of tip, 20 X; 2) papilla of lateral part of tip, 50 X; 3) mechanoreceptor formations of mediate part of body, 50 X. Subject aged 80 years: 4) fragment of medial part of body, 50 X; 5) mechanoreceptor formations of tip, 500 X. Subject aged 60 years: 6) fragment of lateral part of body, 50 X; 7) receptor with digitate processes, 180 X; 8) general appearance of lateral part, 20 X; 9) conical papilla, 100 X; 10) general appearance of lateral part of body, 100 X; 11) papillae of lateral part of root, 20 X; 12) papilla of lateral part of root of tongue near a lateral vallate papilla, 180 X.

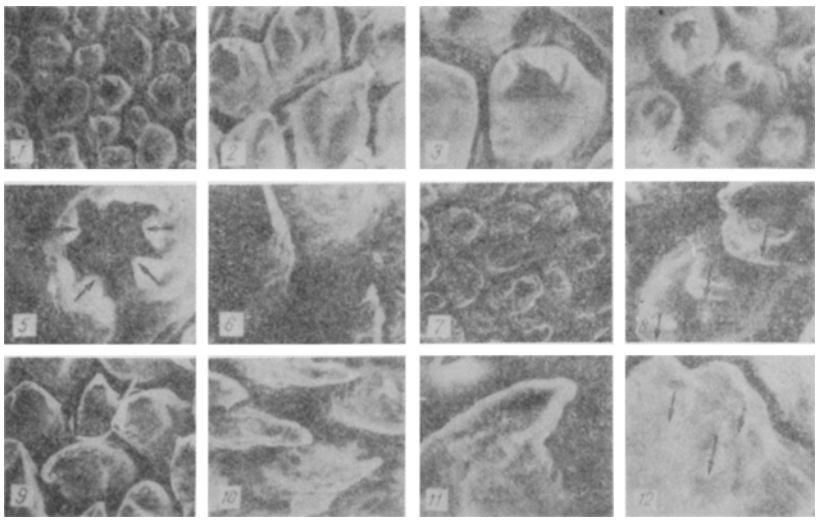

Fig. 4. Tactile receptor formations of anterior free surface and body in early ontogeny. Neonatal tongue: 1) general appearance, 100 X; 2) the same, 240 X; 3) the same, 300 X; 4) mechanoreceptor formations in different parts of anterior free surface, 250 X; 5) digitate processes (arrows) in papillae on tip of tongue, 800 X; 6) filiform papillae on lateral surface of tip, 50 X. Tongue of 30-week fetus: 7) anterior part, 100 X; 8) digitate processes (arrows) in papillae of medial part of body, 360 X. Neonatal tongue: 9) general appearance of papillae in medial part of body, 100 X. Tongue of 30-week fetus: 10) general appearance of medial part of body, 180 X; 11) papilla on medial part of body, 500 X. Neonatal tongue: 12) papilla on medial part of body with digitate processes with a tubercular appearance (arrows), 600 X.

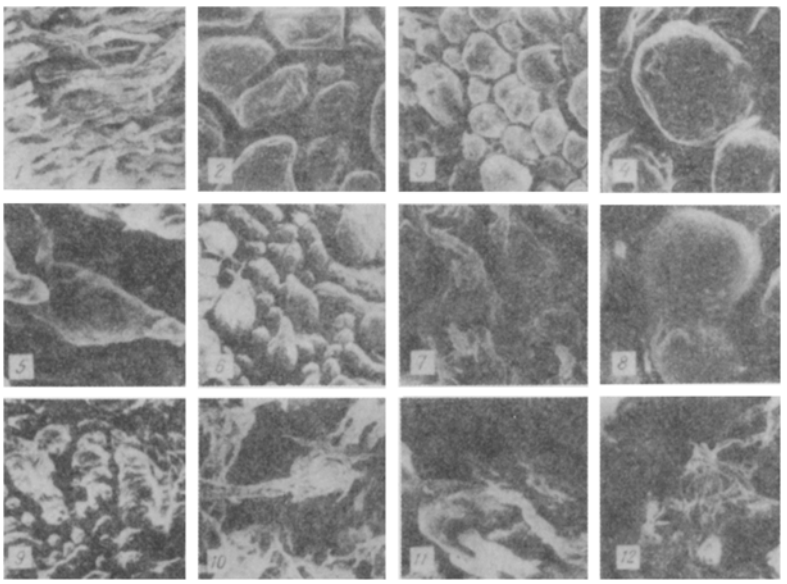

Fig. 5. Tactile receptor formations of human tongue in ontogeny. Neonatal tongue: 1) papillae of lateral part of body (nearer to root), 50 X; 2) papillae of medial part of body near foliate papillae, 100 X; 3) mechanoreceptor papillae near foliate papillae, 100 X. Tongue of 30-week fetus: 4) mechanoreceptor papillae near vallate papillae, 300 X; 5) papillae on medial part of body (nearer root), 300 X; 6) general appearance of tip of tongue, 100 X. Neonatal tongue: 7) papillae, 300 X. 8) Papillae of 30-week fetus, 100 X; 9) folds in front of vallate papillae in medial part of neonetal tongue, 50 X; 10) the same 150 X; 11) the same, 300 X. 12) Papillae with digitate processes on different parts of anterior free surface of tongue of 5-month-old infant, 100 X.

and newborn infants (Fig. 4, 7-9). The lateral papillae were filiform (Fig. 4, 6) and resembled adult human papillae.

In the older subjects the long digitate processes had disappeared, apparently worn away (Fig. 3, 5). The surface of the medial part of the tongue, richest in tactile papillae, of the 80-year-old subject appeared almost smooth (Fig. 2, 10; Fig. 3, 4).

The dorsal surface of the root of the tongue (Fig. 1C) also had several types of mechanoreceptor papillae. In the medial part, for instance, there were formations with digitate processes (Fig. 2, 4, 5). In some papillae these processes were thick and massive (Fig. 2, 8; Fig. 3, 11, 12), whereas in others they were thin (Fig. 2, 7). The number of digitate processes differed in different papillae (Fig. 2, 7, 9; Fig. 3, 10).

Papillae near to and on the root of the neonatal tongue were formed earlier than papillae on the anterior part of the body and tip of the tongue. Some papillae in this part of the tongue were usually long and conical in shape (Fig. 4, 10, 11), others were convex formations with numerous tubercles (Fig. 4, 12). Digitate processes later developed from these tubercles, and in infants aged 5-6 months they were already well marked on all parts of the tongue (Fig. 5, 10-12).

At birth the mechanoreceptor formations lying laterally to the vallate and medial fungiform papillae (Fig. 5, 1-7) had very long digitate processes. The earlier formation of these papillae can evidently be explained by their role in creating an airtight space around the mother's nipple during sucking and swallowing.

In the 30-week fetus (Fig. 5, 4-6, 8) the processes of these papillae were much shorter. This may perhaps explain the difficulty experienced by premature infants in performing swallowing movements.

Besides formations concerned with reception of tactile stimuli, on the medial part of the tongue there are also structures which evidently perform simple mechanical functions. These structures include folds of the mucosa of part of the tongue in front of vallate papillae (Fig. 5, 9). It must be assumed that these folds direct the flow of liquid food (milk) toward the vallate and medial fungiform papillae, which is necessary for contact to be made between the chemical stimulus and chemoreceptor structures.

In man, as in many mammals, numerous tactile papillae of different types are thus found on the surface of the tongue. Differences in their structure and density in different parts are evidence of their different roles in the mechanoreceptor functions of the tongue. Papillae of the neonatal tongue differ considerably in structure from those of the adult human tongue. They are characterized by asynchronous formation, and it is evident that the possibility of performing complex acts of sucking and swallowing depends on the degree of maturity of the mechanoreceptor apparatus of the tongue. These papillae perform not only a receptive function, but they also help to make an airtight space around the mother's nipple. That is why the papillae of the body and root of the tongue are the first to form, followed by those on the anterior free surface.

Since considerable changes in the mechanoreceptor formations of the dorsal surface of the tongue take place in man with age it can be postulated that this must also lead to changes in the tactile sensitivity of the tongue. However, psychophysiological experiments are necessary to prove or disprove this statement.

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