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Relationships between Catecholamine Levels in the Salivary Glands, Oral Mucosa, and Saliva of Rats with Experimental Staphylococcal Sialadenitis

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UDC 616.316.5-002-092.9-07:616.316.5-018-008.94:577.175.52

Translated from *Byulleten' Eksperimental'noi Biologii i Meditsiny*, Vol. 116, № 7, pp. 38-40, July, 1993.
Original article submitted February 1, 1993

Key Words: *sialadenitis; catecholamines; saliva; oral mucosa*

Since the condition of the oral mucosa and periodontium depends on the level of secretion by the salivary glands, the question arises as to how they interact. It has been shown that altered levels of catecholamines, mainly norepinephrine, in saliva are often associated with periodontitis, caries, aphthous stomatitis, and other oral diseases [2,4,5]. Severe disorders of salivation occurring in various forms of sialadenitis are frequently linked with abnormalities of the oral mucosa.

This study was undertaken to assess how catecholamine levels change in the salivary gland parenchyma, saliva (after stimulation of its secretion), and oral mucosa of animals during the development of staphylococcal sialadenitis.

MATERIALS AND METHODS

For the experiments, 95 random-bred rats of both sexes weighing 150.4 ± 11.3 g were used. They were

divided into six groups: 1) intact rats with background (basal) saliva secretion; 2) intact rats with saliva secretion stimulated by pilocarpine injected subcutaneously at 1 mg/kg body weight; 3 and 4) rats with background saliva secretion at an early (2 h) and late (24 h) stage, respectively, of acute experimental sialadenitis produced by injection of a staphylococcal toxin (LH-0.18, series 33, manufactured at the Gamaleya Institute of Experimental Medicine) under the capsule of the left submandibular gland under sterile conditions; 5 and 6) rats with pilocarpine-stimulated saliva secretion in the early and late stages of acute sialadenitis, respectively.

To synchronize salivary gland activities, all rats were deprived of food for 24 h before the acute experiment while being allowed to drink water *ad libitum*. Tissue pieces from the left submandibular gland and oral mucosa were taken under Nembutal anesthesia (40 mg/kg). In rats in the early or late stage of sialadenitis, tissue pieces were also taken from the right submandibular gland. In rats with stimulated saliva secretion,

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TABLE 1. Catecholamine Levels (ng/g Tissue) in Submandibular Glands and Oral Mucosa of Rats with Staphylococcal Sialadenitis. The Values are Means \pm SEM

Group	Submandibular glands:		Oral mucosa:	
	norepinephrine	epinephrine	norepinephrine	epinephrine
Intact rats with background saliva secretion	2524.7 \pm 197.8 (17)	99.5 \pm 9.6 (17)	251.3 \pm 39.1 (12)	60.1 \pm 8.3 (12)
Intact rats with stimulated saliva secretion	1800.0 \pm 213.7 (15) p^*	84.3 \pm 8.7 (15) p	109.3 \pm 10.6 (15) p^{***}	41.9 \pm 7.2 (15) p
Rats with background saliva secretion and early (2 h) sialadenitis	1787.7 \pm 199.7 (24) p^*	100.7 \pm 12.3 (24) p	243.1 \pm 33.9 (6) p	53.8 \pm 11.1 (6) p
Rats with stimulated saliva secretion and early (2 h) sialadenitis	2075.3 \pm 304.7 (11) PP_1P_3	79.2 \pm 8.8 (11) PP_1P_3	284.1 \pm 43.3 (10) $PP_1P_3^{***}$	37.3 \pm 5.6 (10) $P^*P_1P_3$
Rats with background saliva secretion and late (24 h) sialadenitis	1322.1 \pm 206.8 (10) $p^{***}P_1$	73.7 \pm 6.0 (10) P^*P_1	79.1 \pm 15.2 (7) $p^{***}P_1^{***}$	21.8 \pm 4.4 (7) $p^{***}P_1^{***}$
Rats with stimulated saliva secretion and late (24 h) sialadenitis	1040.3 \pm 215.1 (11) $P^{***}P_2P_3P_4^*$	120.4 \pm 14.6 (11) $PP_2^{***}P_3^*P_4^*$	104.4 \pm 14.8 (7) $P^{***}P_2P_3P_4^{***}$	53.6 \pm 4.5 (7) $PP_2^{***}P_3P_4$

Note. Here and in Table 2 p is the significance of differences from intact rats, p_1 from rats with early sialadenitis, p_2 from rats with late sialadenitis, p_3 from intact rats with stimulated secretion, and p_4 from rats with stimulated secretion during early sialadenitis; p without asterisk denotes an insignificant difference while P with one, two, or three asterisks denotes a significant difference at < 0.05 , < 0.01 , or < 0.001 levels, respectively. Figures in parentheses indicate the number of rats.

mixed saliva (oral liquid) was collected during 40 min prior to tissue sampling [3].

In the biological material thus collected, norepinephrine (NE) and epinephrine (E) were measured by means of HPLC with electrochemical detection [1]. The results were treated statistically by Student's t test [6].

RESULTS

In rats with acute sialadenitis, catecholamine levels in the salivary gland, saliva, and oral mucosa were different at different stages of the inflammatory process. Rats with background saliva secretion had reduced NE concentrations in the left salivary gland 2 h after staphylococcal toxin injection, i.e., at an early stage of sialadenitis development when the glands did not yet appear edematous (Table 1). Similar changes in NE were recorded in the contralateral gland of such rats at that time. However, the finding that the NE and E levels remained unchanged in the oral mucosa 2 h after toxin injection indicated that adequate amounts of these neurotransmitters were still entering from the saliva into the mucosa at this stage of sialadenitis in rats with background saliva secretion. The salivary gland of rats with stimulated saliva secretion ex-

hibited atypical responses to pilocarpine. In rats with stimulated saliva secretion and sialadenitis, as compared to the corresponding control rats (i.e., intact animals with stimulated saliva secretion), saliva secretion was decreased and the NE concentrations in the glandular tissue remained unchanged, whereas the concentrations of this neurotransmitter in the saliva and its secretion with it were markedly increased (Table 2); the NE and E levels in the oral mucosa were close to those in the controls.

Twenty-four hours after toxin injection, the salivary glands were edematous and hyperemic in most rats. At this stage of sialadenitis, both the ipsilateral and contralateral glandular tissues of rats with background secretion had markedly reduced NE and E levels, and these two catecholamines were also present at reduced levels in the oral mucosa of these rats. The glandular tissue of rats with stimulated saliva secretion also contained lowered NE concentrations but nearnormal E concentrations. Similarly, the oral mucosa of these rats contained reduced NE levels and normal E levels (Table 1). NE levels in the saliva and its secretion with it were increased (Table 2).

The results of this study indicate that in rats with basal or stimulated saliva secretion the NE

TABLE 2. Catecholamine Concentrations in, and Excretion with, Saliva in Rats with Staphylococcal Sialadenitis. The Values are Means \pm SEM.

Group	Amount of saliva (ml/40 min)	Concentration (mg/ml) of		Secretion (ng/40 min) of:	
		norepinephrine	epinephrine	norepinephrine	epinephrine
Intact rats with stimulated saliva secretion	0.58 \pm 0.08 (11)	0.96 \pm 0.17 (13)	0.49 \pm 0.12 (13)	0.43 \pm 0.10 (13)	0.20 \pm 0.05 (13)
Rats with stimulated saliva secretion:					
early sialadenitis	0.24 \pm 0.10 (7) P_3	4.16 \pm 0.61 (7) P_3	0.75 \pm 0.13 (7) P_3	0.80 \pm 0.09 (7) P_3	0.21 \pm 0.06 (7) P_3
late sialadenitis	0.43 \pm 0.11 (22) P_3P_4	1.48 \pm 0.43 (12) P_3P_4	0.88 \pm 0.12 (10) P_3P_4	0.65 \pm 0.13 (12) P_3P_4	0.41 \pm 0.08 (10) P_3P_4

concentrations in the glandular tissue are reduced even in the early stage of sialadenitis, when less saliva is secreted. The increased NE concentrations in, and secretion with, the saliva noted at this stage suggests that NE is mobilized and its excretion is activated during the secretory cycle. The elevated NE levels in the oral mucosa in the early stage of sialadenitis indicate that absorption of NE into the mucosa is increased at this stage. These changes are bilateral because the submandibular salivary glands are located in close proximity to one another in rats. In the late stage of sialadenitis, changes in the NE and E concentrations in the salivary glands, oral mucosa, and saliva are mainly due to alterations in the permeability of the histohematic barrier of the salivary glands, as is indicated not only by the increased E concentrations in and excretion with the saliva, but also by the relatively high levels of this neurotransmitter in the salivary glands and oral mucosa.

In conclusion, abnormal catecholamine excretion with the saliva in rats with experimental staphylococcal sialadenitis leads to altered levels of catecholamines in the oral mucosa, which may impair nourishment of the latter and be conducive to its disorders.

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