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Role of α and β Adrenoceptors on the Salivary Secretion in the Mandibular Gland of the Rabbit

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The stimulation of the superior cervical ganglion increased the salivary flow rate (about five-fold) in all 35 rabbits studied but two.

The administration of α or β adrenoceptor blocking drugs was unable to eliminate the positive effect of the sympathetic stimulation on the salivary flow, though the flow rate fell about 50 % with the administration of each of the blockers. According to these results both types of receptors may be involved in the secretory response of this gland. Nevertheless it seems that the β-adrenoceptors play a more important role in the secretory response and the α-adrenoceptors in the motor one.

Key words: Rabbit, Saliva, Adrenoceptors.

The role of the parasympathetic system controlling the salivary flow is very well known whereas the role of the sympathetic system needs further studies.

The submaxillary salivary gland of the rabbit and the parotid gland of the cat are not very sensitive to sympathetic stimulation (6, 7). According to SMAJE (16,17) sympathetic stimulation of the submaxillary gland always produces a significant increase of the salivary flow, but other authors (6, 13, 14) do not find a net increase of the flow in similar conditions.

Sympathetic secretory effects in salivary glands are brought about through the two different types of adrenergic receptors, for instance, in the cat's mandibular gland the sympathetic acts by α-adrenoceptors (1), in the dog's mandibular gland by β-receptors only (3) while in the rabbit's parotid gland both α and β-receptors are implied (10, 14, 15). On the other hand, the effect upon the myoepithelial cells is always due to α-adrenoceptors (2, 4, 5, 9).

The object of the present studies was to see the effect of the sympathetic stimulation on the mandibular gland of the rabbit at rest and to elucidate what types of

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adrenoceptors are involved. We have stimulated the cervical ganglion with and without prior administration of either α or β adrenergic blockers to search the contribution of each one to the total answer of salivary flow.

Materials and Methods

Animals. 35 rabbits weighing between 1.5-4 kg were used. Anesthesia with ethyl-uretane (20 % w/v) was administered through the marginal vein in the ear.

Surgical preparation. The submaxillary salivary duct was cannulated using a P.V.P. tubing, after tracheotomy and drainage of the urinary bladder. Both femoral vessels were catheterized, one to monitor arterial pressure and the other to administer the adrenergic blockers.

Nervous stimulation. The superior cervical ganglion was isolated and stimulated (15 V, 0.5 ms, 25 HZ) during five minutes (11, 12).

Blood flow. To measure the blood flow rate, the external jugular vein was catheterized and all the veins draining into it were tied, except the mandibular vein. An open recording system (Drop counter, Physiograph E and M) was used and the blood was pumped back through the femoral vein. The animal and the external circuit were heparinized and the temperature was maintained around 38 ± 1° C.

Salivation. The salivary flow was measured using a capillary tube (a 0.1 ml pipette) (14, 16). It was expressed as μl min^{-1} g gland^{-1}. Mean values are given for the 5 min stimulation period, for the 5 min period prior to stimulation, and for the three 10 min periods after stimulation. Stastistical analysis was made by the student «t» test.

Drugs. Phentolamine (Regitine CIBA) 4 mg/kg. Propranolol (Sumial ICI-PHARMA) 2.5 mg/kg.

Results

The submaxillary gland of the rabbit has a basal secretion of saliva. In our experimental conditions, the secretion rate varied from 0.1 to 1.3 μl g^{-1} gland min^{-1} with a mean value of 0.4 ± 0.04 μl g^{-1} gland min^{-1}. There were marked differences among animals. These results confirm those given by other authors (8, 14, 16).

The electrical stimulation of the cervical ganglion (25 HZ and supramaximal voltage) in 35 rabbits increased the salivary flow rate in all the cases except two, where the rate either did not change or even went down.

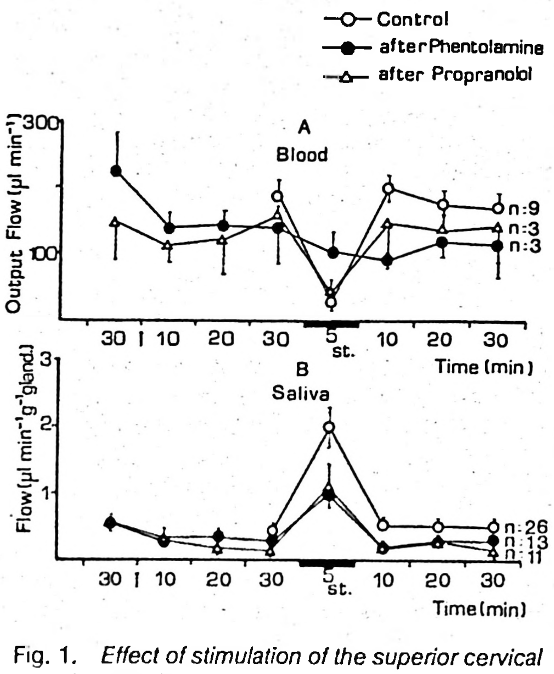

Fig. 1. *Effect of stimulation of the superior cervical ganglion (25 Hz) on salivary (B) and blood flow (A) in the gland under resting conditions.*
Influences of α and β adrenergic blocking agents. The values represented in the figure are the mean ± S.E.M. (st: sympathetic stimulation).

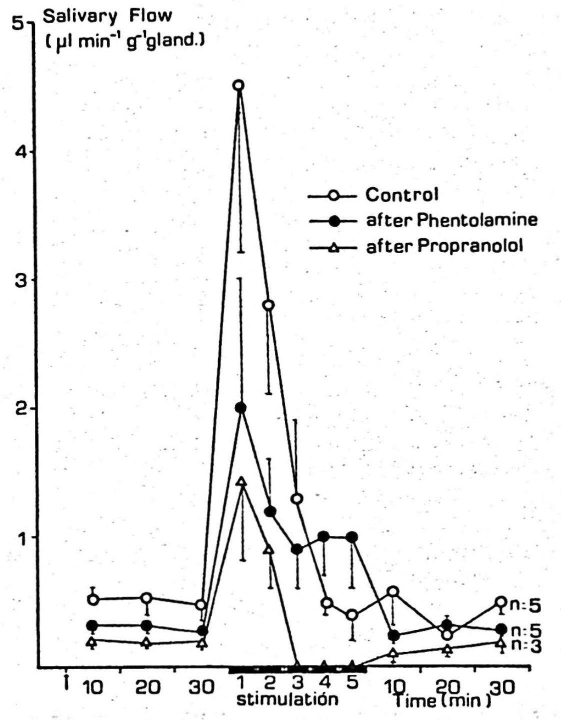

Fig. 2. *Temporal evolution of salivary flow during the sympathetic stimulation*
Influence of α and β adrenergic blocking agents (→). The values represented in the figure are the mean ± S.E.M. (st: sympathetic stimulation).

The increment due to the stimulation was higly significant ($p < 0.001$). The increase was around five fold and the flow came back to basal values within ten minutes after stimulation (fig. 1). During the sympathetic stimulation there was a great increase of the salivary flow within the first minutes, this increase remained during the second and third and returned to basal values in the last minutes of the stimulation (fig. 2).

The prior administration of the α-adrenergic blocker (phentolamine 4 mg/kg) did not totally suppress the increase of the salivary flow rate due to the sympathetic stimulation; an increase of some 50 % remained (fig. 1). The flow reached basal values again within ten minutes after the stimulation. The development of the response is different here because the increment is lower and is maintained during the whole period of sympathetic stimulation.

The previous administration of the β-adrenergic blocker (propranolol 2.5 mg/kg) also reduced the effect of sympathetic stimulation to about 50 % of the control values. The development is different from that produced with the α-blocker, the flow only increased during the firts two minutes of the stimulation and was zero throughout the last three minutes (fig. 2).

Figure 1A shows the changes of the rate of blood flow. There is a clear decrease during the stimulation in the control animals that coincides with the increase of the salivary flow. Similar results were obtained with the β-blocker, but in this case, the decrease of the blood flow rate was smaller. The injection of phentolamine only produced a slight decrease of the blood flow rate.

The β-adrenergic blocking agent significantly reduced the basal salivary flow in our experimental conditions.

Discussion

The results show that sympathetic stimulation increases five fold the previous salivary flow values ($p < 0.01$) in spite of the sympathetic vasoconstriction (figure 1). This increase could be either a pure secretory or a motor effect upon myoepithelial cells or a combination of both. The development of the response (fig. 2) may suggest that the initial sharp increase during the first minute of stimulation is due to a motor effect since there is a marked diminution when an α-adrenergic blocker was administered previously. In this case the flow decreased more slowly than in the control animals suggesting that the vasoconstriction could be the cause of this decrease. The development of the response with prior administration of β-adrenergic blocker agrees with that of the control animals although the increase in flow is clearly lower.

Our results seem to agree with those of SMAJE (16) but not fully with the obtained by GJORSTRUP (8) therefore we concluded with the former that either the secretory effect is β-adrenergic and myoepithelial cells activation is α-adrenergic, or there is also a secretory mechanism mediated by α-receptor.

The vasodilatation which follows sympathetic stimulation is small and variable (fig. 1A), which agrees with the data of MORLEY *et al.* (13). This after-dilatation disappears after administration of an α-adrenergic blocker in all animals, but it does not always with β-blocker, results that are different from those reached by MORLEY *et al.* (13). This observation suggests a role of vasoactive peptides, but does not exclude the existence of vasodilatatory β-adrenergic fibers.

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Resumen

La estimulación del ganglio cervical superior aumenta el flujo salival aproximadamente cinco veces, en los 35 conejos estudiados, excepto en dos.

La administración de agentes bloqueantes α o β adrenérgicos no eliminaba el efecto positivo de la estimulación simpática sobre el flujo de saliva, aunque tanto uno como otro reducían esta respuesta aproximadamente al 50 %. Según estos resultados ambos tipos de receptores deben estar implicados en la respuesta secretora de esta glándula, si bien parece que los receptores β-adrenérgicos son más importantes en la respuesta secretora mientras que los α-receptores lo son en la motora.

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