

CHANGES IN THE FUNCTIONING OF THE PAROTID GLAND OF GUINEA PIGS DURING REGENERATION

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It is typical of the majority of work devoted to the study of the regeneration of the salivary glands after injury that only morphological methods of investigation are used. Nevertheless, there is an insistent need for morpho-physiological analysis of the changes which occur during trauma and of the subsequent degeneration of the gland. In order to study more fully the mechanisms which are typical of the regeneration of the salivary glands, we set as our problem the use of both morphological and physiological indicators of regeneration in the study of this process. The problems which interested us were the functional changes in the gland after its partial resection and the effect of increased functional load on the process of regeneration of a salivary gland. Data have been obtained on a number of organs which indicate the stimulating effect of increased functional load on the regenerative process (Birkun [2], 1955; Samsonidze [6], 1954, and others). It was important to discover whether the hypothesis regarding the more complete process of regeneration under conditions of increased functional load is justified with the salivary gland as an example.

The changes in the salivatory function during regeneration of the parotid gland were studied by us on guinea pigs with a fistula of the duct of the left gland placed by the method worked out by A. M. Ugolev [7] (1953). The saliva which was secreted during 3-minute time intervals was collected on cotton tampons and weighed on a torsion balance. In studying the changes caused by injury to the gland, the level of secretion during the period immediately preceding the experiment was taken into account. The experiment consisted of the complete extirpation of the right salivary gland, resection of the left salivary gland at the lower edge of the mandible.

In one paper [1], we established that under these conditions the parotid gland of guinea pigs regenerates well and reestablishes its original weight and size.

Study of the functioning of the parotid gland of normal guinea pigs (12 animals) showed that, first of all, spontaneous saliva secretion (Ugolev [8], 1956) completely disappears by the 16th day after the fistulization of the duct. The study of the secretion caused by food stimulation showed that with the course of time after fistulization a decrease occurs in the amount of secreted saliva (about 3-5 times approximately in 45 days), i.e., fistulization leads to a certain weakening of the functioning of the salivary gland. Histological investigation of the gland with the externalized duct showed that externalization of the duct leads to degenerative changes in the gland, which increase as the length of time increases after fistulization of the duct.

It can be assumed that the observed degenerative changes in the gland and the decreased amount of saliva secreted through the fistula are caused by interference with the normal reception from the oral cavity, as well as by interference with the normal topography of the duct.

* Deceased.

The indicated weakening of salivary secretion does not however, interfere, with the study of the ability of the gland to function during its regeneration, since the basic mechanisms which are peculiar to secretion in response to food stimulation do not change, namely, during a unit of time more saliva is secreted in response to juicy food than in response to dry food; the change in the food stimulus leads to an increase in secretion in comparison with the last test with the first type of food; in the first tests, more saliva is secreted, then the amount of saliva secreted gradually decreases.

Experiments with extirpation of the right and resection of part of the left gland with fistulization of the duct of the latter, which were carried out on 8 guinea pigs, showed that the functioning of the gland after its partial resection was severely disturbed. This disturbance was evidenced in the fact that in the first days after the operation (2-7 days), salivary secretion in response to food stimuli stopped completely. The disturbance of the functioning caused by resection of an area of the gland was noted also in animals with an intact duct. In these experiments (15 animals) the disturbance of the functioning of the gland was discovered when the duration of the latent period for the appearance of saliva in response to the administration of pilocarpine was being studied. The experiments were carried out under conditions of direct observation of the orifice of the ducts in the mouth cavity.

From the results of the experiments, the prolongation of the average duration of the latent period during the first seven days following the operation was found to be from 3 minutes 42 seconds to 5 minutes 32 seconds.

A few days after the operation (from the 3rd to the 7th day) saliva secretion in response to food stimuli was gradually reestablished in the animals with a fistula of the duct. The amount of saliva secreted, as a rule, reached the preoperational level, but this occurred at different periods in different animals: complete reestablishment of the level of saliva secretion was observed in some by the 4th day, in others the time for reestablishment extended to 3 weeks.

The basic reason for the observed inhibition of the gland's functioning in our opinion, consists of a specific reaction of the gland to the trauma connected with the removal of a portion of it.

We came to this conclusion by eliminating all other reasons capable of causing depression of function. Narcosis could be such a reason. However, in special experiments with unilateral extirpation of the gland (2 guinea pigs), which were also carried out under ether narcosis, we did not obtain depression of the secretion; on the contrary, the amount of saliva secreted through the fistula increased sharply.

The result of these experiments with unilateral extirpation of the organ eliminated the possibility of reflex inhibition of saliva secretion due to removal of the paired organ.

The second reason which could cause decreased secretion is the decreased volume of glandular tissue. However, the fairly rapid reestablishment of the functioning of the resected gland (sometimes by the 4th day) indicated that the remaining piece of gland could also assure normal saliva secretion, apparently through the inclusion of all the secretory cells into the functional process (normally not all the end sections are in functioning condition).

The same rapid reestablishment of functioning preceding the regeneration of the structural elements of the organ, was described for the liver (Meister [4], 1894; Nisnevich [5], 1947, and others), the pancreas (Kravchenko [3], 1954), the kidneys (Frankshtein [9], 1948) and a number of other organs.

Following the reestablishment of the functioning of an operated gland of animals with an externalized duct, its depression is again observed. We explained this by the degenerative changes in the gland caused by the fistulization of the duct. We ran into the same phenomenon of gradually decreasing secretion among guinea pigs with fistulas of the duct of an uninjured salivary gland. A special series of experiments, in which a fistula was formed 3½ months after extirpation of part of the gland (7 guinea pigs) shows that our explanation is correct. These experiments showed that the level of saliva secretion by the regenerated gland did not differ substantially from the salivary secretion of normal animals.

Another group of experiments was to have shown the role of functional loading of the gland in the process of its reparative regeneration. An increased functional load was created by the daily administration of 0.1% pilocarpine solution.

In experiments in which the functional load on the gland occurred during the post-operative period, it was found that the functioning of the organ whose regeneration occurred under conditions of increased functional loading, reestablished itself more rapidly. Thus 3¹/₂ months after the operation the maximum value, indicating saliva secretion during 9 minutes, was 710 mg for the gland which regenerated during increased functional loading; while the maximum amount of saliva secreted by a gland which regenerated under normal functional conditions was 327 mg.

In relation to the rest of the indicators-weight, structural regeneration- the stimulating effect of functional loading on the regenerative process was also observed. However, these experiments are of a preliminary nature due to their small number and require an increase of material.

As is apparent from the above experimental result, regeneration of the parotid gland is characterized by rapid reestablishment of the original level of secretion. The reestablishment of function occurs more rapidly than the morphological regeneration, which, according to our data, takes about 3 weeks. One can think, however, that, as the regeneration proceeds, new structural relations acquire greater significance in the functioning of the organ and the subsequent normal physiological activity is determined to a considerable extent by the regenerative process. The problem of the interrelations between the functional and morphological aspects of the regenerative process remains unclear in this case still and requires further deeper analysis.

SUMMARY

In guinea pigs, resection of the left parotid gland accompanied by simultaneous extirpation of the right parotid gland caused cessation of secretion during 2-7 days (animals with fistula of the duct) and prolonged the latent period before the appearance of saliva in response to pilocarpine injection. Secretion was restored in all animals towards the 7th day. The initial level of secretion was recovered at different dates between the fourth and twenty-first days.

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