

Article

Pathological changes in traumatization of the upper jaw under the conditions of sinus lifting simulation in rats

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Abstract: Background. Simulation of surgical interventions in the maxillofacial region provokes a number of physiological reactive changes in the body of experimental animals. Thus, it was revealed that there are changes in the balance of the autonomic nervous system, activation of the hypothalamic-pituitary-adrenal and adrenergic systems, changes in behavioral reactions, as well as the occurrence of anxiety state. At the same time, the morphological causes of such reactions are not fully understood. Aims. The study provides data on morphological changes in the area of experimental trauma of the upper jaw during modeling of sinus lifting, dental implantation in rats. Materials and Methods. The study used male rats of the Wistar line weighing 210-280 g. Surgical interventions in all groups were performed under general anesthesia with the introduction of a solution of Zoletil 100 into the tail vein. In the first group, septoplasty (n=10) was simulated by the standard method by zigzag scarification of the nasal mucosa according to the standard method. In the second group (n=10), dental implantation with a titanium implant was performed after the hole was formed using a drill. In the third group (n=10), only a hole was made in the alveolar process of the upper jaw without subsequent manipulations. This group was a comparison group for groups with dental surgical interventions. In the fourth group, 10 rats underwent sinus lifting with bone chips with simultaneous implantation of a titanium implant. In the fifth group (n=10), with the help of a microdrill through a pre-formed hole in the alveolar process of the upper jaw, maxillary sinus was performed with damage to the mucous membrane of the ipsilateral maxillary sinus. Results. First group. On day 2, there was focal desquamation of a single-layer multi-row ciliated epithelium with local defects up to the basement membrane, multiple hemorrhages (extensive, with the presence of blood clots) in the mucosal lamina proper, mucosal edema (common), moderate diffuse infiltration (polymorphocellular). On the 4th day, signs of acute exudative serous inflammation were revealed. Second group. On the 2nd day, the wound surface contained cellular detritus, leukocytes, blood clots and a scab that did not adhere to the wound surface. (Fig. 2). On the 4th day, the signs of inflammation were not significant, macrophages, fibroblasts and lymphocytes predominated at the site of injury. On the 6th day, the formation of a clear demarcation line in the area of damage was noted with the formation of a shaft containing leukocytes and fibroblasts. Third group. On the 2nd and 4th days, the condition of the damaged tissues was characterized by the formation of scabs consisting of cellular detritus, necrotized tissue, leukocytes, erythrocytes (Fig. 4). On the 6th day, an accumulation of fibroblast-like cells, macrophages, and the formation of fibers of newly formed connective tissue was observed in the area of damage. Fourth group. On the 2nd and 4th days, extensive hemorrhages, the formation of scabs consisting of cellular detritus, necrotized tissue, leukocytes, erythrocytes were noted in this group. Fifth group. On the 2nd and 4th days, multiple hemorrhages with the presence of exudate blood clots were observed in the area of injury. Cellular detritus and necrotic tissue were present. Mucosal edema was widespread with extensive polymorphocellular infiltration. Conclusion. Different surgical interventions lead to different morphological changes, which probably affects the severity of physiological reactions under surgical stress.

Citation: Kostyaeva M., Dragunova S, Zindovic N., Emets I., Dragomirov I., Andryushin V., Amirkhanyan S. Pathological changes in traumatization of upper jaw under the conditions of sinus lifting simulation in rats. Journal of Clinical Physiology and Pathology (JISCPP) 2023; 2 (1): 4-10.

<https://doi.org/10.59315/JISCPP.2023-2-1.4-10>

Academic Editor: Igor Kastyro

Received: 15.11.2022

Accepted: 09.01.2023

Published: 01.03.2023

Publisher's Note: International Society for Clinical Physiology and Pathology (ISCPP) stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

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Keywords: septoplasty, deviated septum, sinus lift, dental implantation, inflammation.

1. Introduction

Simulation of surgical interventions in the maxillofacial region provokes a number of physiological reactive changes in the body of experimental animals [1-3]. Thus, it was revealed that there are changes in the balance of the autonomic nervous system, activation of the hypothalamic-pituitary-adrenal and adrenergic systems, changes in behavioral reactions, as well as the occurrence of anxiety state [4-12]. At the same time, the morphological causes of such reactions are not fully understood [13-14].

2. Materials and Methods

The study used male rats of the Wistar line weighing 210-280 g. Surgical interventions in all groups were performed under general anesthesia with the introduction of a solution of Zoletil 100 into the tail vein. In the first group, septoplasty (n=10) was simulated by the standard method by zigzag scarification of the nasal mucosa according to the standard method [4, 5]. In the second group (n=10), dental implantation with a titanium implant was performed after the hole was formed using a drill (Fig. 1a).

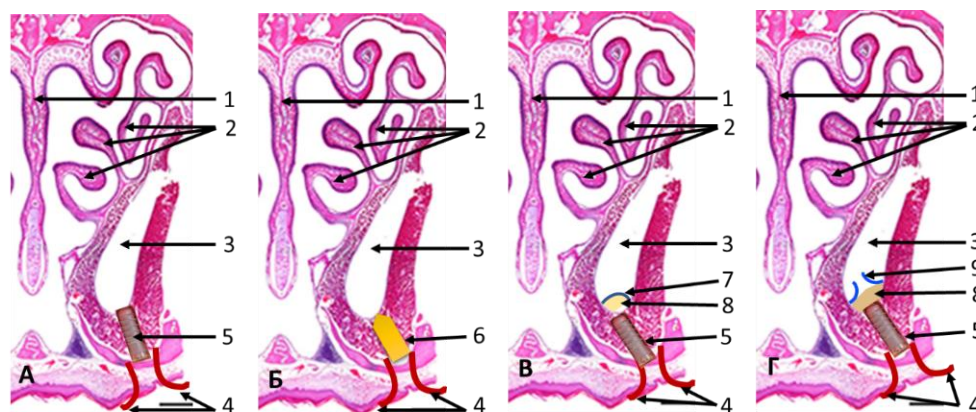


Figure 1. Schemes for modeling dental implantation (group 2) (a), the formation of a well in the alveolar process of the upper jaw (group 3) (b), sinus lifting with simultaneous implantation (group 4) (c) and sinus lifting complicated by maxillary sinusitis (group 5) (d).

Note: 1 – nasal septum; 2 – nasal concha; 3 – maxillary sinus; 4 – mucous-periosteal leaves after incision; 5 – implant; 6 – hole; 7 – mucous membrane of the paranasal sinus; 8 – bone chips; 9 – damaged mucous membrane of the paranasal sinus.

In the third group (n=10), only a hole was made in the alveolar process of the upper jaw without subsequent manipulations (Fig. 1b).

This group was a comparison group for groups with dental surgical interventions. In the fourth group, 10 rats underwent sinus lifting with bone chips with simultaneous implantation of a titanium implant (Fig. 1c).

In the fifth group (n=10), with the help of a microdrill through a pre-formed hole in the alveolar process of the upper jaw, maxillary sinus was performed with damage to the mucous membrane of the ipsilateral maxillary sinus (Fig. 1d).

3. Results

3.1. First group

On day 2, there was focal desquamation of a single-layer multi-row ciliated epithelium with local defects up to the basement membrane, multiple hemorrhages (extensive, with the presence of blood clots) in the mucosal lamina proper, mucosal edema (common), moderate diffuse infiltration (polymorphocellular). On the 4th day, signs of acute exudative serous inflammation were revealed. The exudate in damage is cloudy, with an admixture of erythrocytes, leukocytes, mucus. On the surface of the mucous membrane is an accumulation of cellular detritus containing necrotized epithelial cells, neutrophils and eosinophils. Hyperemia of the mucous membrane is moderate with diapedetic hemorrhages, moderate edema, widespread. Inflammatory infiltrates in the



own plate of the mucosa are multiple, abundant, mainly neutrophilic. On the 6th day, the exudate in damage was insignificant, there were also foci of cellular detritus. Hyperemia of the mucous membrane at this time was moderate along with minor local edema. The inflammatory infiltrate in the mucous membrane was moderate, polymorphocellular with the representation of macrophages.

3.2. Second group

On the 2nd day, the wound surface contained cellular detritus, leukocytes, blood clots and a scab that did not adhere to the wound surface. (Fig. 2). On the 4th day, the signs of inflammation were not significant, macrophages, fibroblasts and lymphocytes predominated at the site of injury. On the 6th day, the formation of a clear demarcation line in the area of damage was noted with the formation of a shaft containing leukocytes and fibroblasts. (fig. 3)

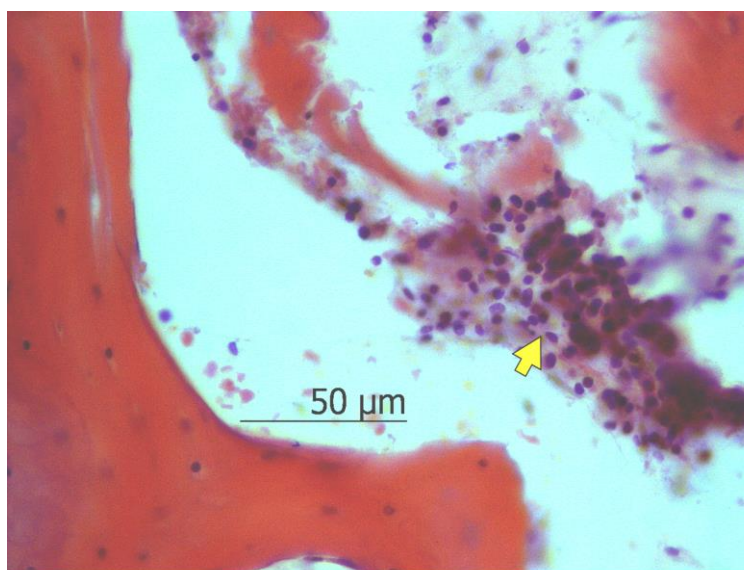


Figure 2. The arrow indicates a scab that is not adjacent to the surface of the bone.



Figure 3. Yellow arrows indicate the demarcation line in the area of damage to the upper jaw.

3.3. Third group



On the 2nd and 4th days, the condition of the damaged tissues was characterized by the formation of scabs consisting of cellular detritus, necrotized tissue, leukocytes, erythrocytes (Fig. 4). On the 6th day, an accumulation of fibroblast-like cells, macrophages, and the formation of fibers of newly formed connective tissue was observed in the area of damage (Fig. 5).

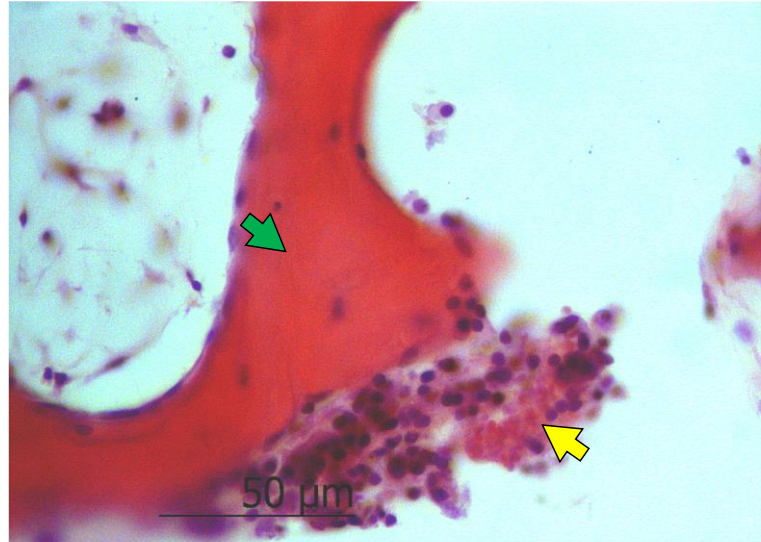


Figure 4. The yellow arrow indicates a scab adjacent to the surface of the spongy bone (green arrow)

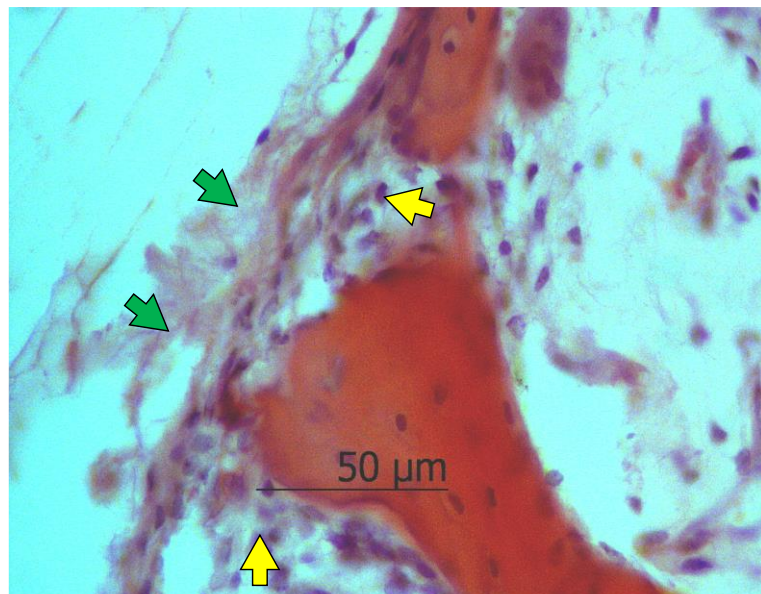


Figure 5. Fibroblasts (yellow arrows), connective tissue fibers (green arrows).

3.4. Fourth group

On the 2nd and 4th days, extensive hemorrhages, the formation of scabs consisting of cellular detritus, necrotized tissue, leukocytes, erythrocytes were noted in this group (Fig. 6). On the 6th day, there was a representation of macrophages, fibroblasts, mast cells in the area of surgical damage, and the absence of scabs, hemorrhages and detritus (fig. 7).



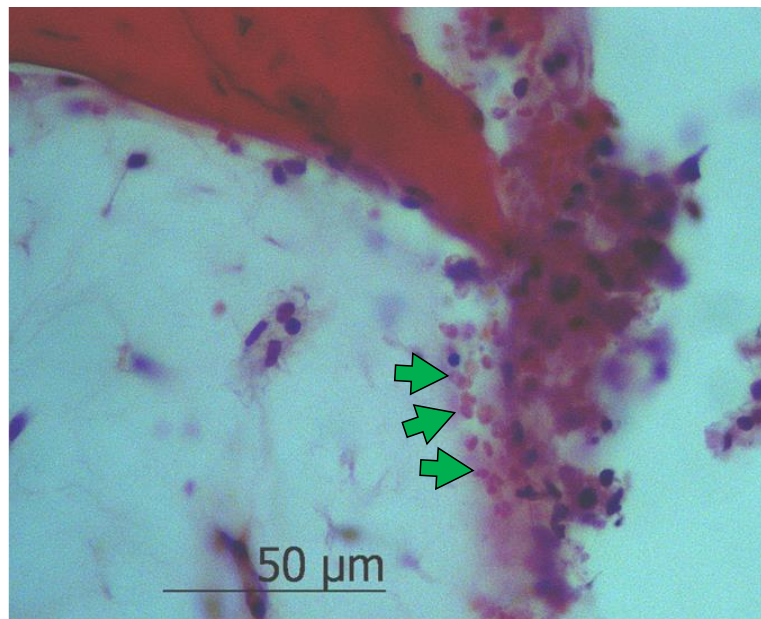


Figure 6. The arrows indicate the leukocytes in the scab.

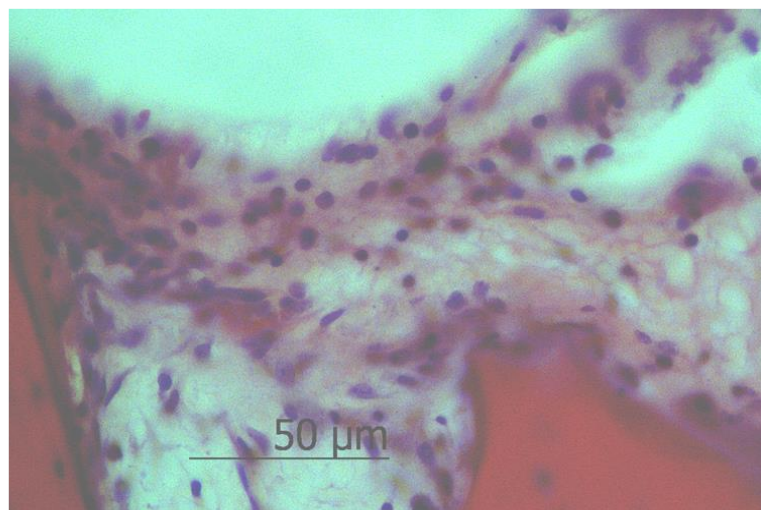


Figure 7. The healing process after sinus lifting with bone chips with simultaneous implantation of a titanium implant.

3.5. Fifth group

On the 2nd and 4th days, multiple hemorrhages with the presence of exudate blood clots were observed in the area of injury. Cellular detritus and necrotic tissue were present. Mucosal edema was widespread with extensive polymorphocellular infiltration (Fig. 8). On the 6th day, mucosal hyperemia was moderate, cellular infiltration was insignificant with a predominance of macrophages. In some foci, a significant representation of fibroblasts and vascular neoplasm in the resorption niche was noted (Fig. 9).



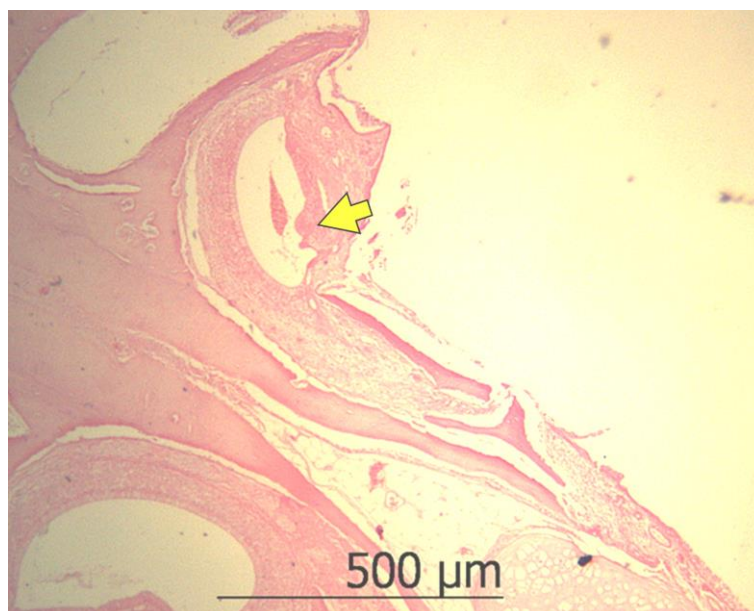


Figure 8. A section of the damaged mucous membrane of the maxillary sinus.

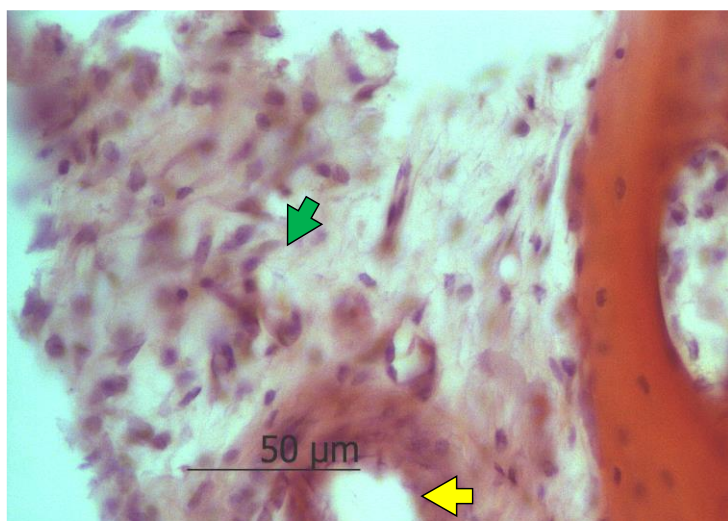


Figure 9. A newly formed vessel (yellow arrow) in the resorption niche, surrounding connective tissue (green arrow).

4. Conclusions

Different surgical interventions lead to different morphological changes, which probably affects the severity of physiological reactions under surgical stress.

Conflicts of Interest: The authors declare no conflict of interest.

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